

# DIGITAL SKILLS & LEARNING ANALYTICS

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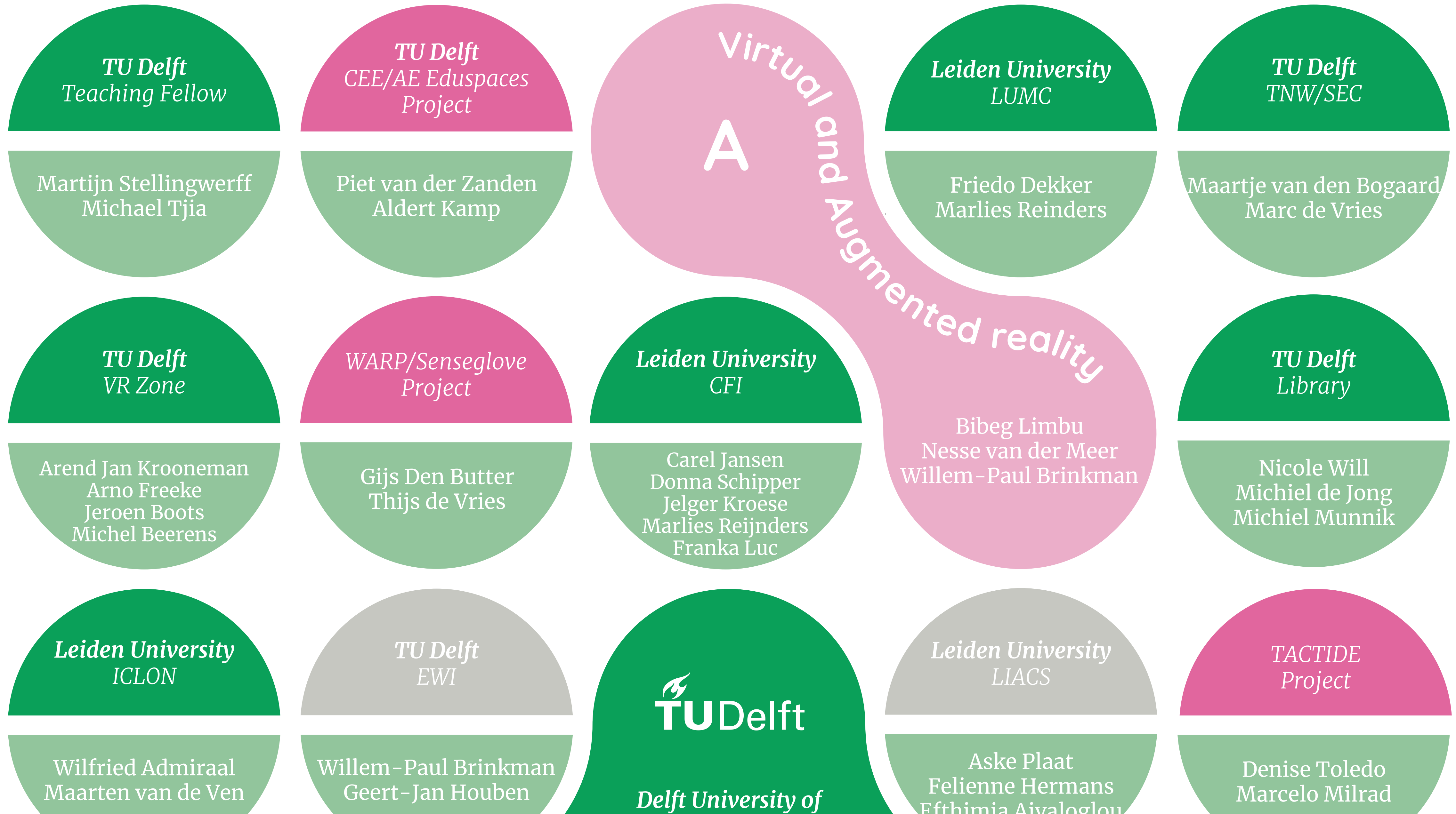
**Universiteit  
Leiden**  
The Netherlands



**Erasmus  
University  
Rotterdam**



# Become a CEL Collaboration Partner



Save the dates!

# LDE CEL EVENTS 2020

20 March  
Innovation Room #15: CLASH - Developing a Culture of Learning Analytics

8 June  
Innovation Room #16: Augmented and Virtual Reality

21 September  
Innovation Room #17: Digital Skills

7 December  
Annual Meeting 2020

Innovation Room #15

## CLASH - Developing a Culture of Learning Analytics

### PROGRAMME

12:00 Walk-in lunch and registration  
13:00 Welcome  
13:15 Keynote prof. Simon Buckingham Shum  
14:00 Pitches World Café tables  
14:15 Round 1 World Café  
15:00 Coffee break  
15:15 Round 2 World Café  
16:00 Results and Discussion World Café  
16:30 Fishbowl Panel  
17:00 Drinks and Networking

### LOCATION

TU Delft Teaching Lab  
Landbergstraat 15, Delft

### REGISTER NOW!

[educationandlearning.nl/new/events](https://educationandlearning.nl/new/events)



### FAST DEVELOPING FIELD

Learning Analytics (LA) is one of the fastest developing fields in the last decade. Tracing and logging human activities in online systems has led to a plethora of monitoring dashboards, models for early detection of student drop out, feedback and recommendation systems and others to support learners, educators and organisations in the development, implementation and operation of educational processes.

### MORE THAN A TECHNICAL CHALLENGE

LA in authentic contexts is more than a technical challenge, but rather a web of cognitive, social, organisational and political challenges (Buckingham Shum, Ferguson & Martinez-Maldonado, 2019). Organisations have their own

culture of living educational processes and therefore supporting processes need to be customised to these. Educators have their own interpretations of student performance and consider different indicators for student feedback and coaching. Learners and educators live their own culture, which is also closely linked to the vision of leadership and learning rooted in the organisation.

### MAKE USE OF A NETWORK OF EXPERTS

The Culture of Learning Analytics event (CLASH) will feature some of the most advanced thinkers on Learning Analytics and opens the opportunity to make use of a network of experts to kick-start LA culture in your own organisation and discuss the challenges you are facing.

# Digital footprints



- Dragan Gasevic, Professor Learning Analytics
- Felienne Hermans, Director PERL, LIACS

# Understanding the role of software in the world



# Trusted Learning Analytics



# Why to learn coding ?

Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- Automating solutions through algorithmic thinking (a series of ordered steps)
- Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources
- Generalizing and transferring this problem solving process to a wide variety of problems

Copyright 2011. International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA). This material is based upon work supported by the National Science Foundation under Grant No. CNS-1030054.



**Felienne Hermans**

Associate Professor at Leiden University and  
head of the Programming Education Research Lab (PERL)

# Effects of learning coding ?

These skills are supported and enhanced by a number of dispositions or attitudes that are essential dimensions of CT. These dispositions or attitudes include:

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- Tolerance for ambiguity
- The ability to deal with open ended problems
- The ability to communicate and work with others to achieve a common goal or solution

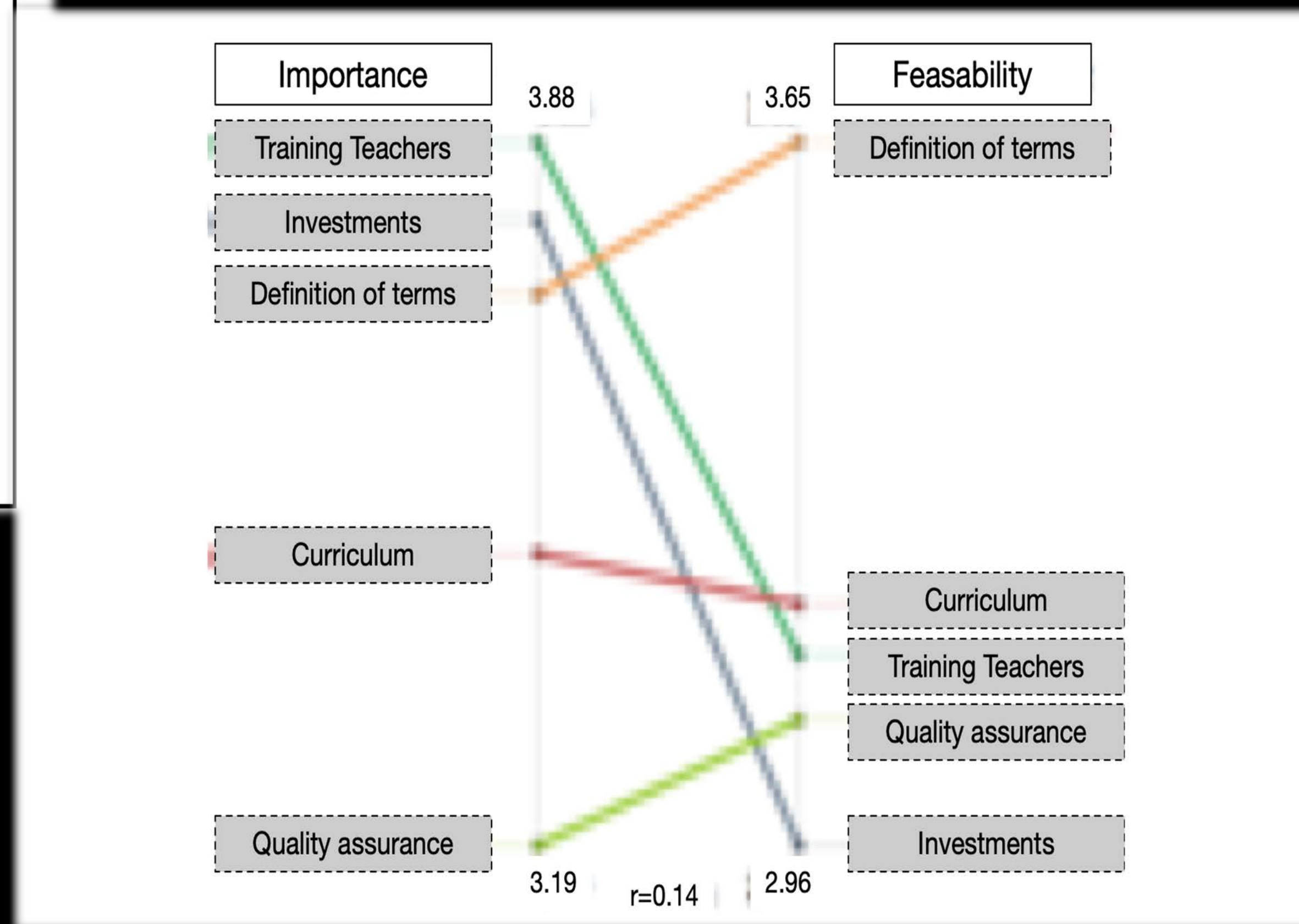
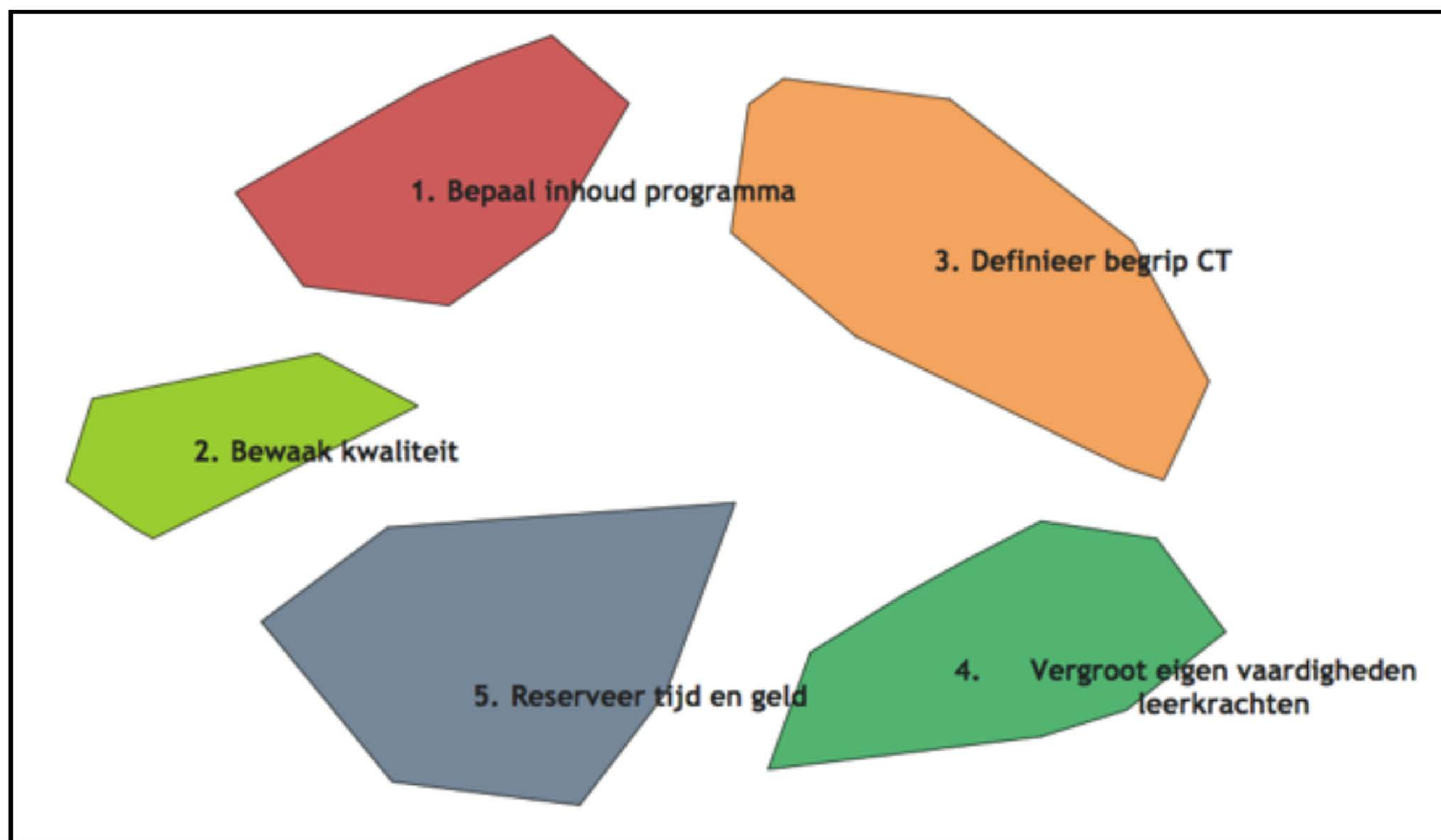
- general competences: Problem solving, creativity, reflection, metacognitive skills, mathematical thinking
- computer science related skills: CS concepts, analysis, planning, control flow, debugging, abstraction

# Integration in Curriculum

- How to integrate CT skills in the curriculum
- Applying skills to relevant problems
- Possible integration into a wide variety of subjects from math to language, arts (STEAM and more)

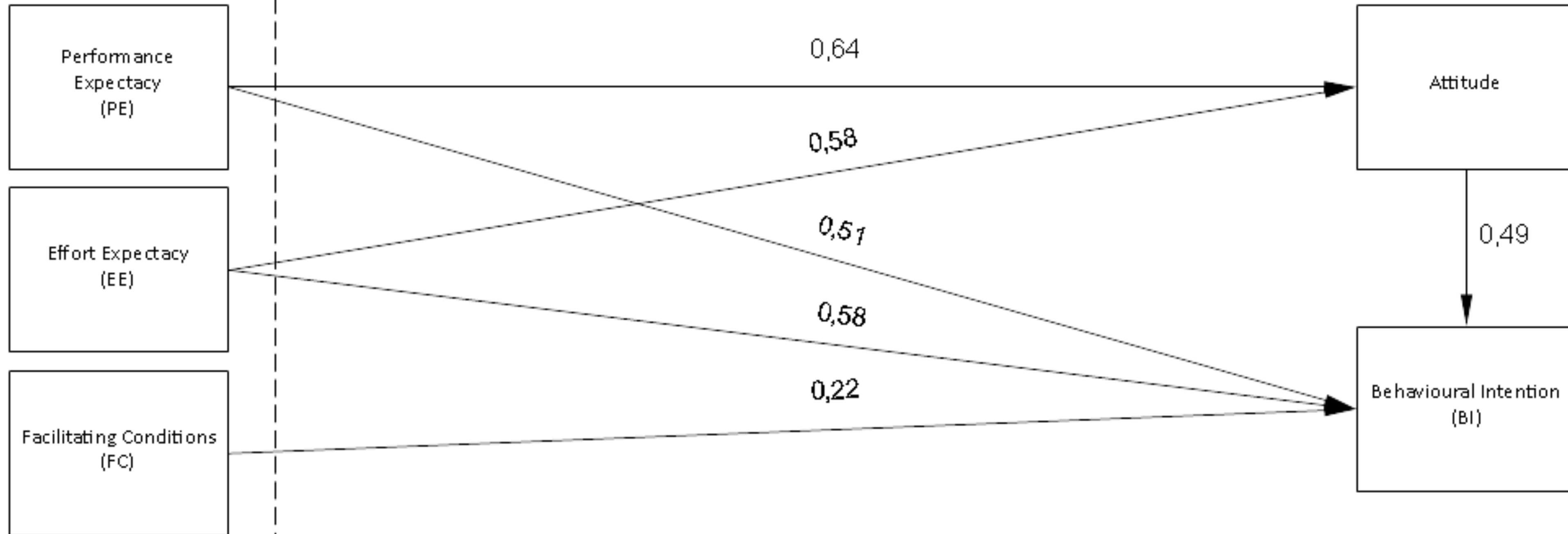
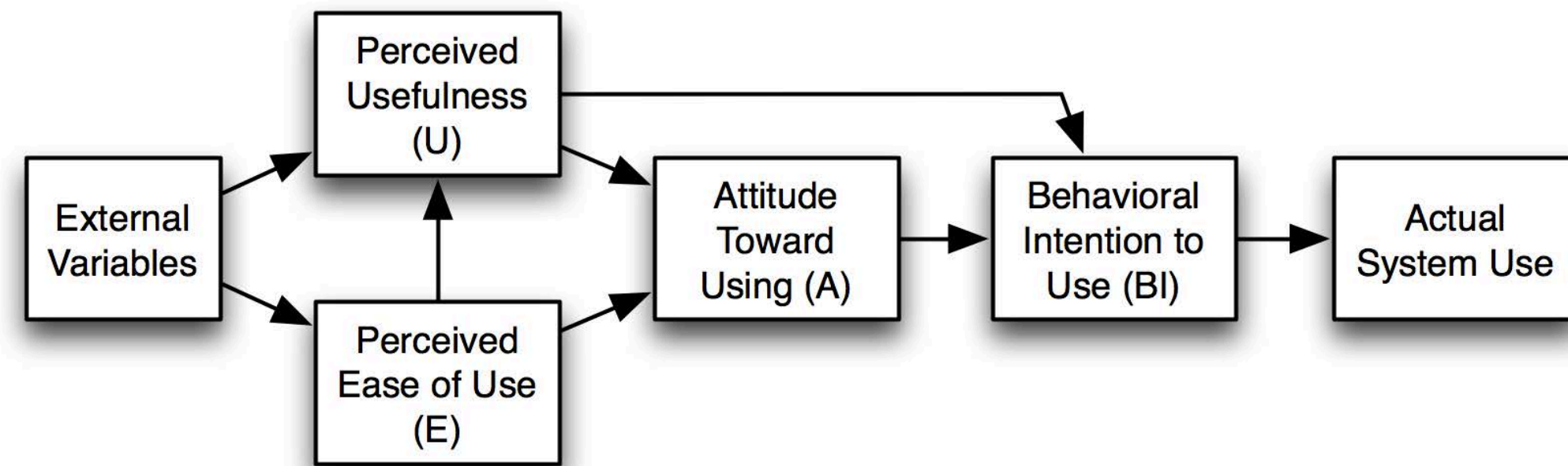
CT Concept, Capability	CS	Math	Science	Social Studies	Language Arts
Data collection	Find a data source for a problem area	Find a data source for a problem area, for example, flipping coins or throwing dice	Collect data from an experiment	Study battle statistics or population data	Do linguistic analysis of sentences
Data analysis	write a program to do basic statistical calculations on a set of data	count occurrences of flips, dice throws and analyzing results	analyze data from an experiment	identify trends in data from statistics	identify patterns for different sentence types
Data representation	use data structures such as array, linked list, stack, queue, graph, hash table, etc	use histogram, pie chart, bar chart to represent data; use sets, lists, graphs, etc. to contain data	summarize data from an experiment	summarize and represent trends	represent patterns of different sentence types
Problem decomposition	define objects and methods; define main and functions	apply order of operations in an expression	do a species classification		write an outline
Abstraction	use procedures to encapsulate a set of often repeated commands that perform a function; use conditionals, loops, recursion, etc.	use variables in Algebra; identify essential facts in a word problem; study functions in algebra compared to functions in programming; use iteration to solve word problems	build a model of a physical entity	summarize facts; deduce conclusions from facts	use of simile and metaphor; write a story with branches
Algorithms & procedures	study classic algorithms; implement an algorithm for a problem area	do long division, factoring; do carries in addition or subtraction	do an experimental procedure		write instructions
Automation		use tools such as: Geometer Sketch Pad; Star Logo; Python code	use Probeware;	use Excel	use a spell checker

# What is necessary, important and feasible ?






# Are teachers ready ?



# Assessment of CT



<https://vimeo.com/114430745>



Score: **10/21** [Tweet](#)

The level of your project is...  
**DEVELOPING!**

You're doing a great job. Keep it up!!!

[Come back to your Scratch project.](#)

### Bad habits

- 0 duplicated scripts.
- 1 sprite naming.
- 1 backdrop naming.
- 2 dead code.

Level up	Level
Flow control	<div><div style="width: 66%;">2/3</div></div>
Data representation	<div><div style="width: 100%;">3/3</div></div>
Abstraction	<div><div style="width: 33%;">1/3</div></div>
User interactivity	<div><div style="width: 66%;">2/3</div></div>
Synchronization	<div><div style="width: 0%;">0/3</div></div>
Parallelism	<div><div style="width: 0%;">0/3</div></div>
Logic	<div><div style="width: 66%;">2/3</div></div>


Logic	Data representation	Parallelism	Synchronization	User interactivity	Flow control	Abstraction
Duplicated scripts		Incorrect names		Dead code		Attribute initialization

The ability of abstraction and decomposition of problems helps you to **break a problem into smaller parts that are easier to understand, program and debug.**


# Using rubrics with tutors ?

Thema CT	Low level	Medium level	High level
<b>Denken in stappen</b> <ul style="list-style-type: none"><li>– Een probleem opdelen in kleinere deelproblemen of in deelvragen.</li><li>– Een probleem zo formuleren dat het met behulp van een computer is op te lossen.</li></ul>	<i>“...Vaak kregen mensen gewoon taken, van hee, kan jij dit voor ons doen? Dan werd het aangeleverd, vervolgens als een persoon dat had aangeleverd, dan werd het in de groep gegooid. En dan ging iedereen kijken of hij nog zelf kon uitbreiden of verbeteren. Dus zelf code toevoegen aan het gemaakte deel...dat geleverd werd.” (ST108)</i>	<i>“...Die tussenstap, daar waren we te laat achter gekomen. En daarna hebben we vanaf het herkansingmoment de draad weer opgepakt. Want we hadden de database al opgezet en vervolgens gingen we toen echt tutorials zoeken, een connectie maken met de database. En vervolgens dat je de gegevens uit de database filtert om het in een grafiek weer te geven” (ST111)</i>	<i>“...Dat zijn alle stappen en moet ik dus stap voor stap gaan kijken hoe ik dat moet doen. En dan in code om gaan zetten. Of opdelen van problemen. Als je een groot probleem hebt, krijg je het nooit opgelost”. (ST69)</i>
<b>Abstraheren</b> <ul style="list-style-type: none"><li>– De essentie verduidelijken zonder zich in details te verliezen.</li><li>– Schematiseren/modelleren door gebruik te maken van schetsen, tabellen, grafieken of modellen.</li></ul>	<i>“...De belangrijkste onderdelen, op de manier van hoe we het uiteindelijk gedaan hebben? Oké. Voornamelijk de voorkennis die mensen al hadden in de projectgroep en Internet.”(ST52)</i>	<i>“...De code is in die zin belangrijk, dat je iets moet hebben om te kunnen laten zien. Maar het hoeft niet ingewikkeld te zijn, als je het maar mooi kan presenteren. Dus die code is wel degelijk belangrijk, anders heb je niks. Maar buiten dat, als je het af hebt dan zorg je ervoor dat de randzaken ook allemaal in orde zijn”. (ST68)</i>	<i>“...Uiteindelijk kwam ik dus met een tabelletje met alle requirements. In die requirements stonden bepaalde termen, termen die dus niet uitgelegd waren...Die moeten goed gedefinieerd worden voordat we kunnen beginnen aan het project en dat is dus ook wat we gedaan hebben.” (ST32)</i>
<b>Algoritmisch denken</b> <ul style="list-style-type: none"><li>– Stap-voor-stap specifieke en expliciete instructies maken om een proces uit te voeren.</li><li>– Logische volgorde van toepassing.</li></ul>	<i>“...Nee, ja, maar dat was gewoon tussendoor. Zo van: hee, let je daar nog effe op? Maar dat werd niet behandeld in zo'n bestand, bijvoorbeeld op OneDrive. Dat was meer hoe ben je, doe je goed mee. Maar we gingen niet echt inhoudelijk in op de code ...”(ST68)</i>	<i>“...Gewoon zoveel mogelijk opties, gekke dingen die je maar kan bedenken, altijd proberen. En zodra ik het uit zou willen geven wat ik heb gemaakt, dan ga ik gewoon aan kennissen en vrienden vragen van joh, kan je het testen? Om de een of andere reden krijgen ze het altijd voor elkaar om het alsnog te breken!” (ST52)</i>	<i>“...Door overal comments neer te zetten. En als het eenmaal werkt, dus ook wat netter te maken, dus dingen in functies zetten. Het zijn vaak heel lange codes en het wordt echt spaghetticode als we ook nog code to gaan gebruiken.” (ST69)</i>


# Task-based assessment with bebras



About Organizing the contest **Tasks** Contacts



**Bebras**  
International Challenge on Informatics  
and Computational Thinking



What is Bebras

Bebras is an international initiative aiming to promote Informatics (Computer Science, or Computing) and computational thinking among school students at all ages. Participants are usually supervised by teachers who may integrate the Bebras challenge in their teaching activities. The challenge is performed at schools using computers or mobile devices.

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## Programming Lamps

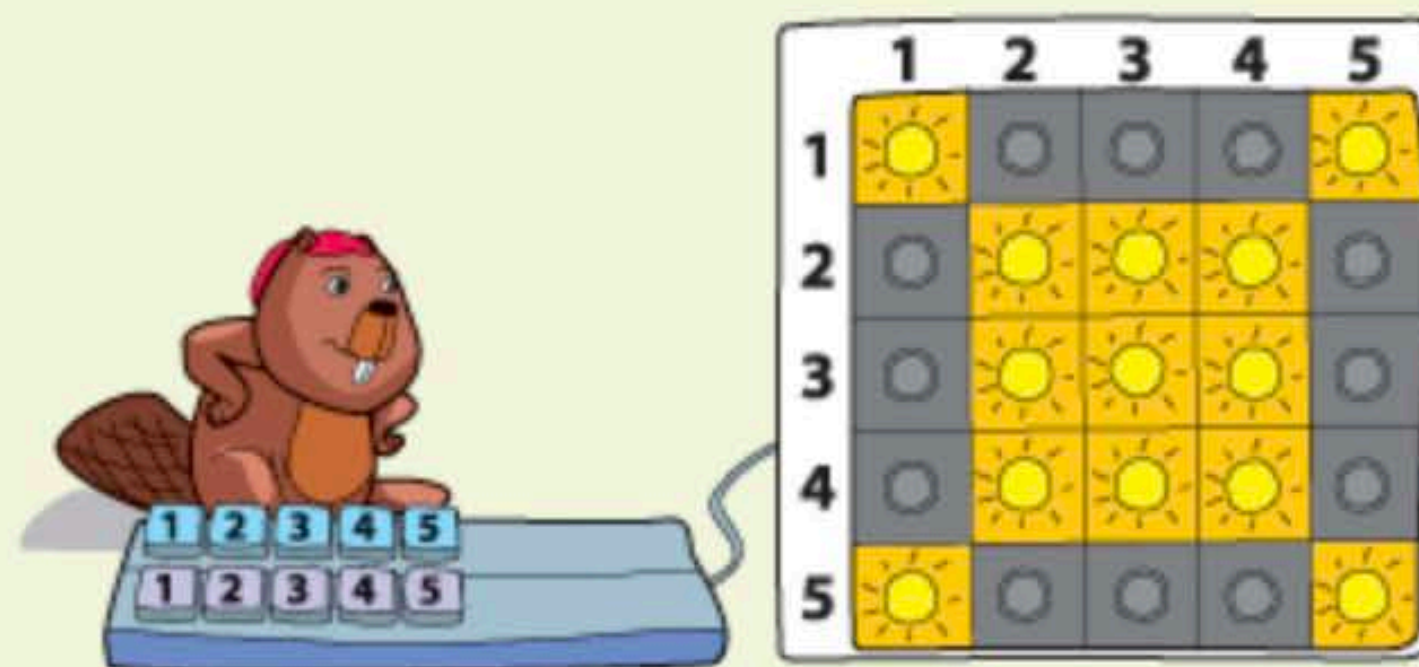
(Age group: Primary; Difficulty: medium)

A beaver controls a grid of lamps by using a special keyboard. By one command he can change states of all lamps in respective column or row: if a lamp is shining – it is turned off, if a lamp is not shining – it is turned on. Beaver wrote 4 programs:

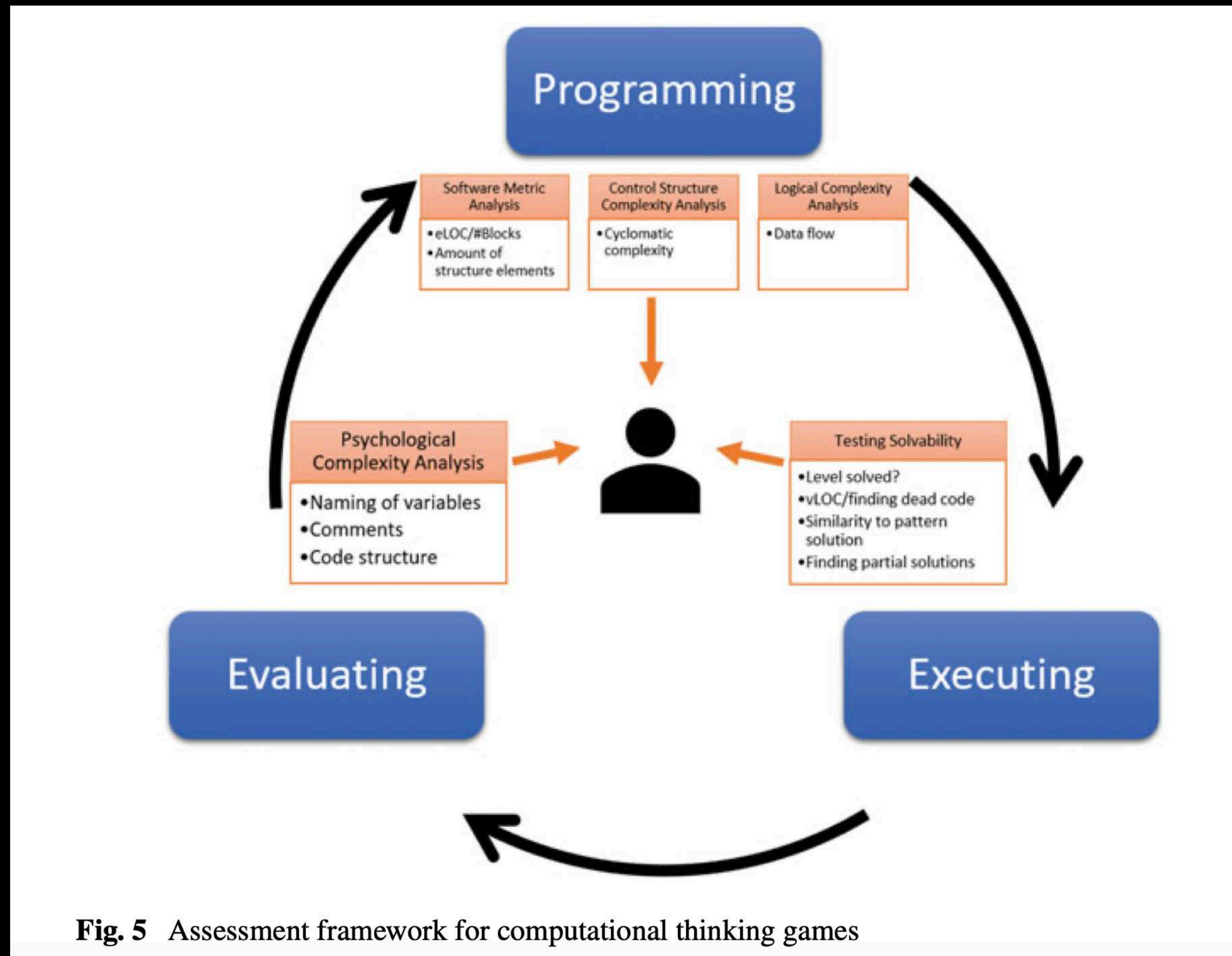
- 1C 5C 2R 3R 4R
- 1R 5R 2C 3R 4R
- 1R 5R 3R 4R 5R 1C 5C
- 1C 2C 3C 4C 5C 1C 5C 1R 5R

C represents a column and R a row. For example, a command 1C turns on all lamps of the first column. If we repeat the same command (1C), all lamps of the first column will be turned off. Two of the above programs give the result as shown in the picture.

Two of the programs presents a different result. Which of them?



# LA Framework for CT Assessment



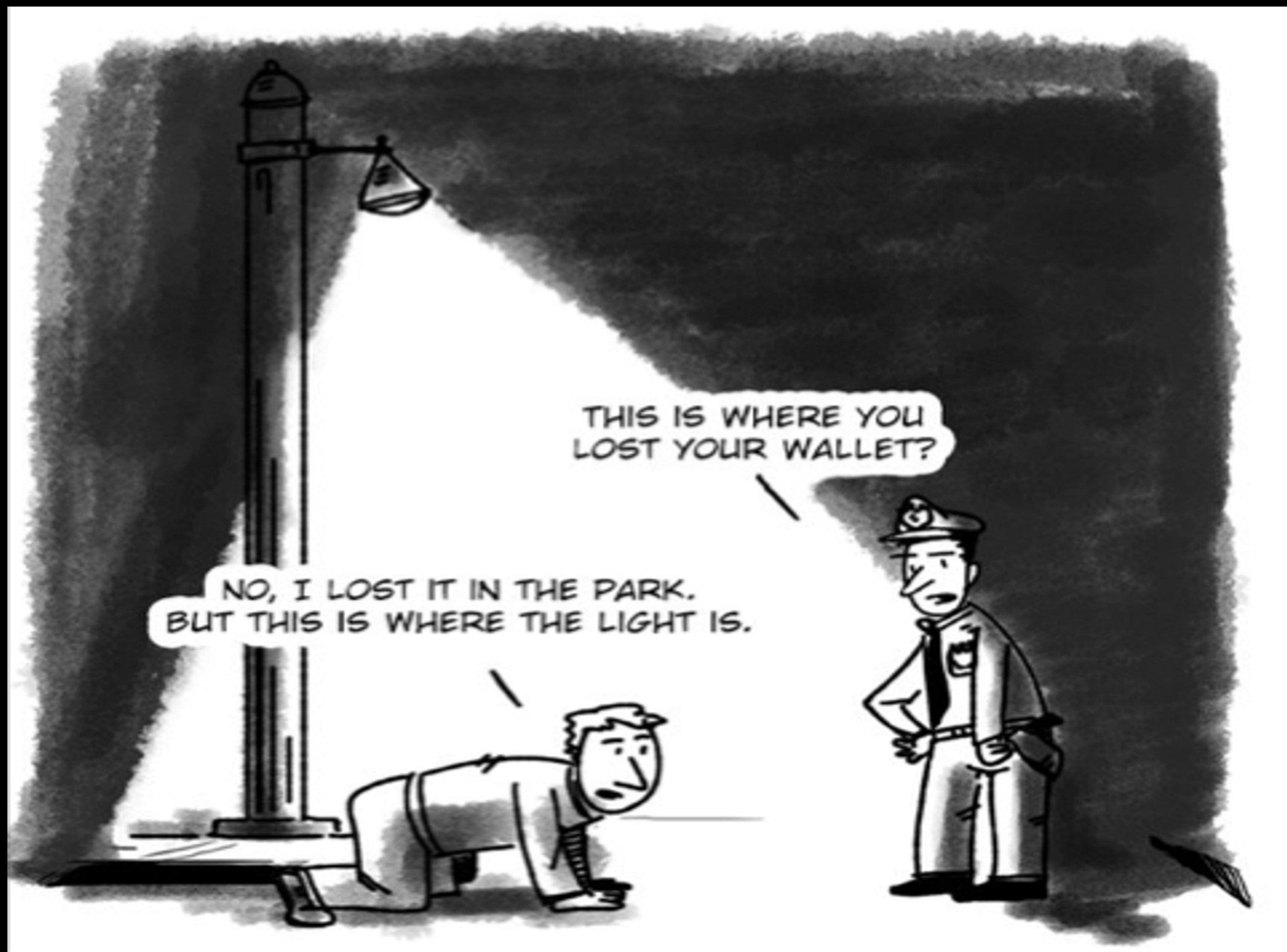
**Table 3** Interpretation of the activity metrics according to Werneburg et al. [61]

Indicator	Interpretation
# Runs	Testing and evaluating behavior of the created programming code
# Changes per run	Trial-and-error behavior or advanced planning
# Creates	Active extensions of the programming solution
# Consecutive changes per create	Structured editing
Time spent in minutes	Measure for efficiency

# Learning analytics is...

... the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs.

Siemens (2011)



THIS IS WHERE YOU  
LOST YOUR WALLET?

NO, I LOST IT IN THE PARK.  
BUT THIS IS WHERE THE LIGHT IS.

# Current issues ... with LA

- Complicated interfaces and algorithms
- Low adoption of learning analytics (Viberg et al., 2018)
- No re-modelling of educational approaches  
(Macfadyen, Dawson, Pardo & Gašević, 2014)
- Little grounding in educational theories and didactic driven approaches  
(Jivet. et al., 2018), (examples to follow)
- Lack of trust among stakeholders (Tsai et al., 2019)



# Human-Centred Learning Analytics

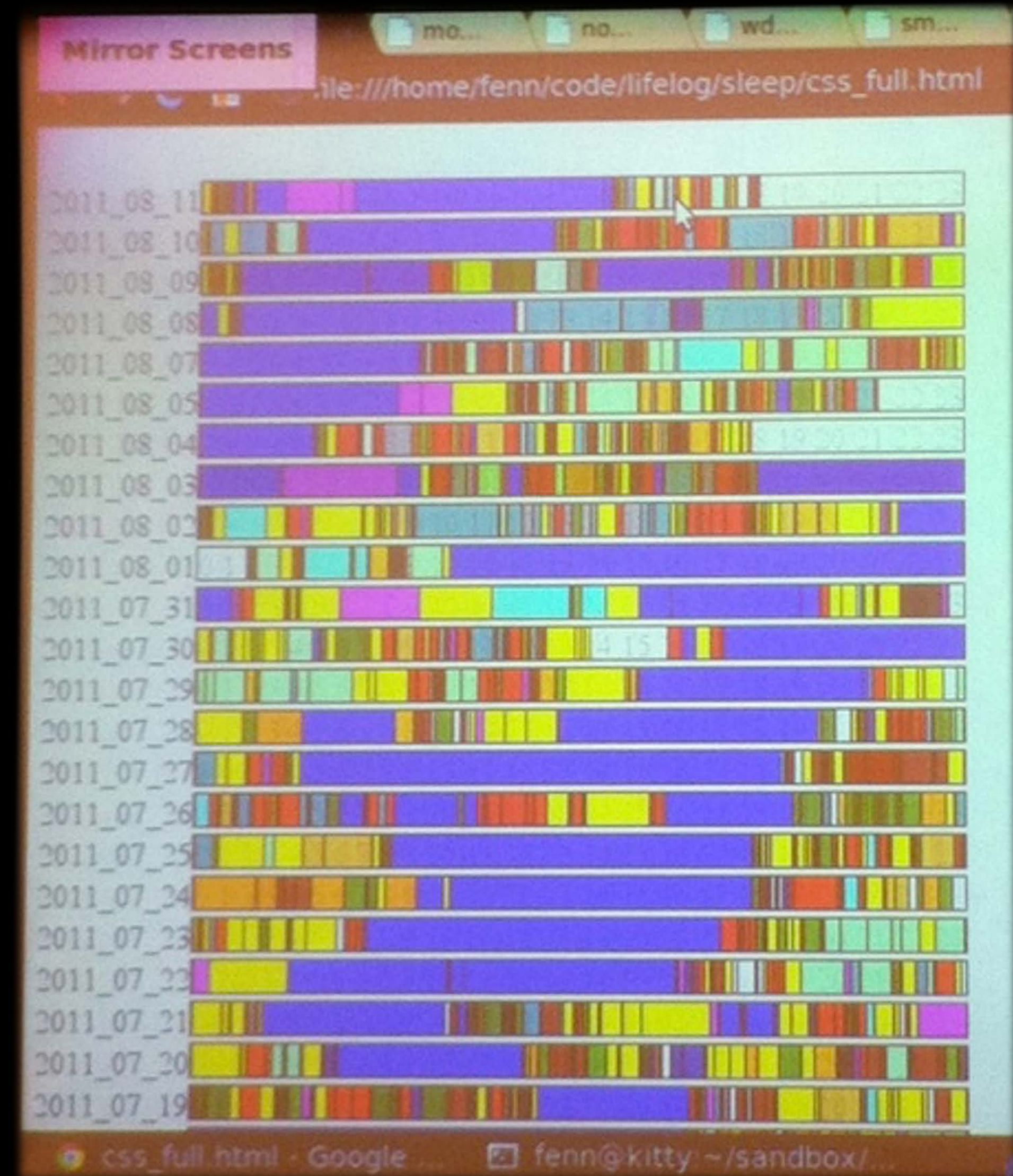
“... meanings, interaction opportunities, functions, and system attributes should be defined by the people for whom the system is intended, rather than imposed by designers or researchers.”

(Buckingham Shum et al., 2019)

# The Quantified Self

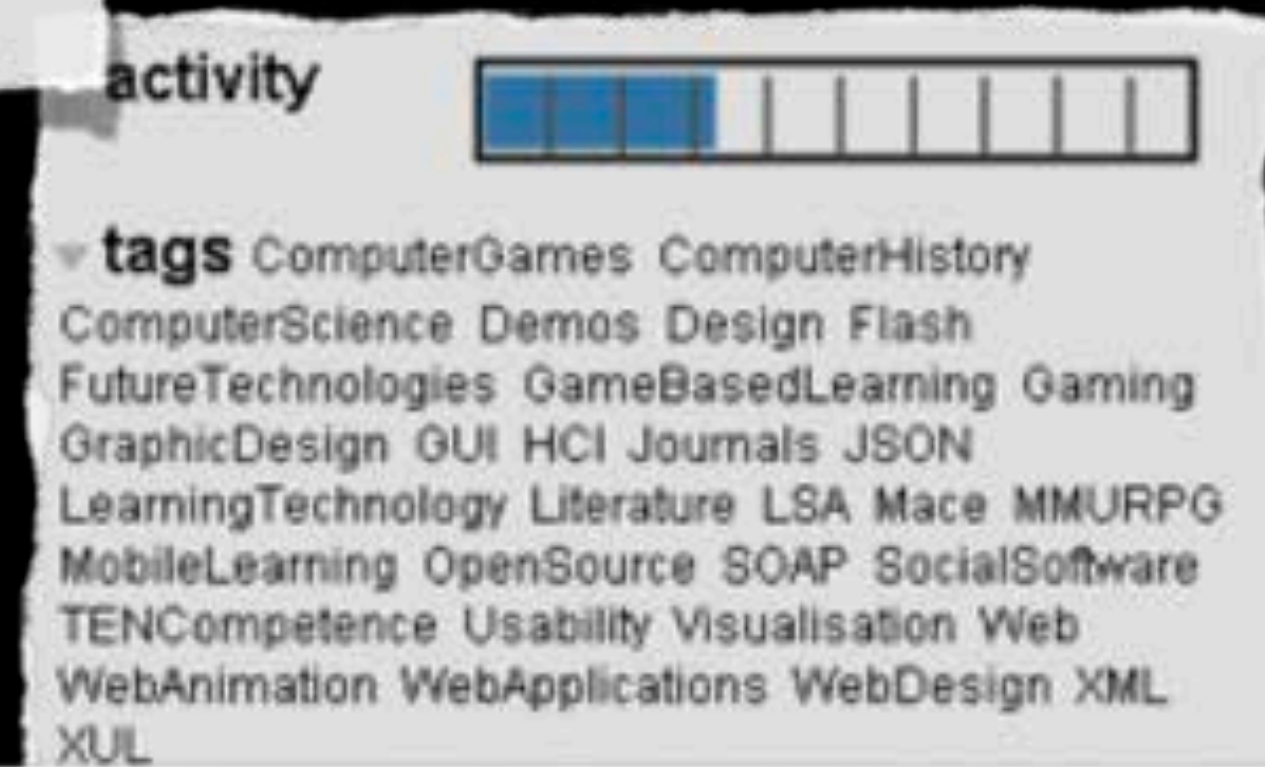
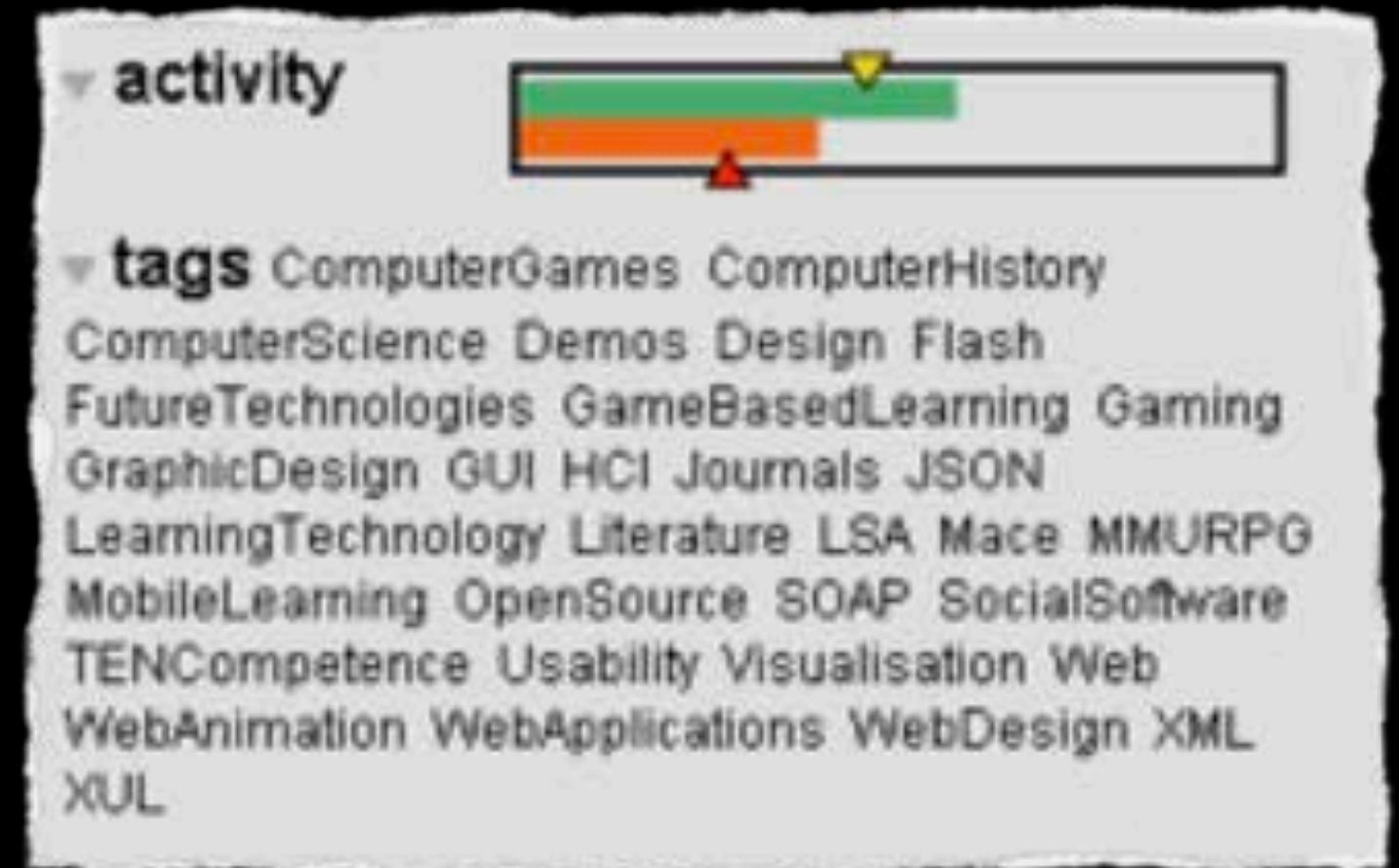
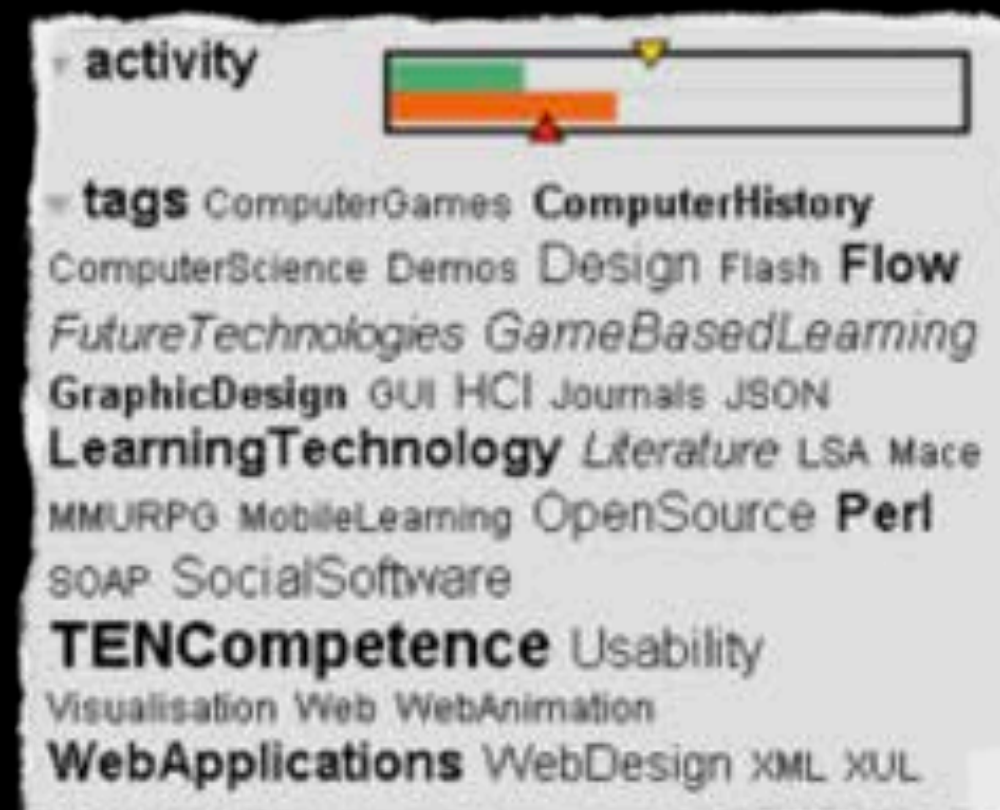


- Questioning
- Awareness
- Self Experimentation
- Measuring
- Data Collection
- Behaviour Change



# Current Focus in Learning Analytics, Stakeholders and Applications

# #Case1 Learner Dashboards



**Indicators**

My actions

17 actions. Previous group in the course performed in average 73 actions (for an average final test score of 13/20)

**Figure 4.1.** The reflection trigger (type 1) confronts personal tracked data to a yardstick (image taken from the treatment "All RTs")

# Important criteria of Dashboards

1. **Transparency of design**, e.g. explanations on how displayed information is calculated, why this information is relevant
2. **Reference frames**, e.g. seeing their performance in comparison with their peers or teacher expectations
3. **Support for action**, e.g. recommendations on what to study next and how to study more efficiently

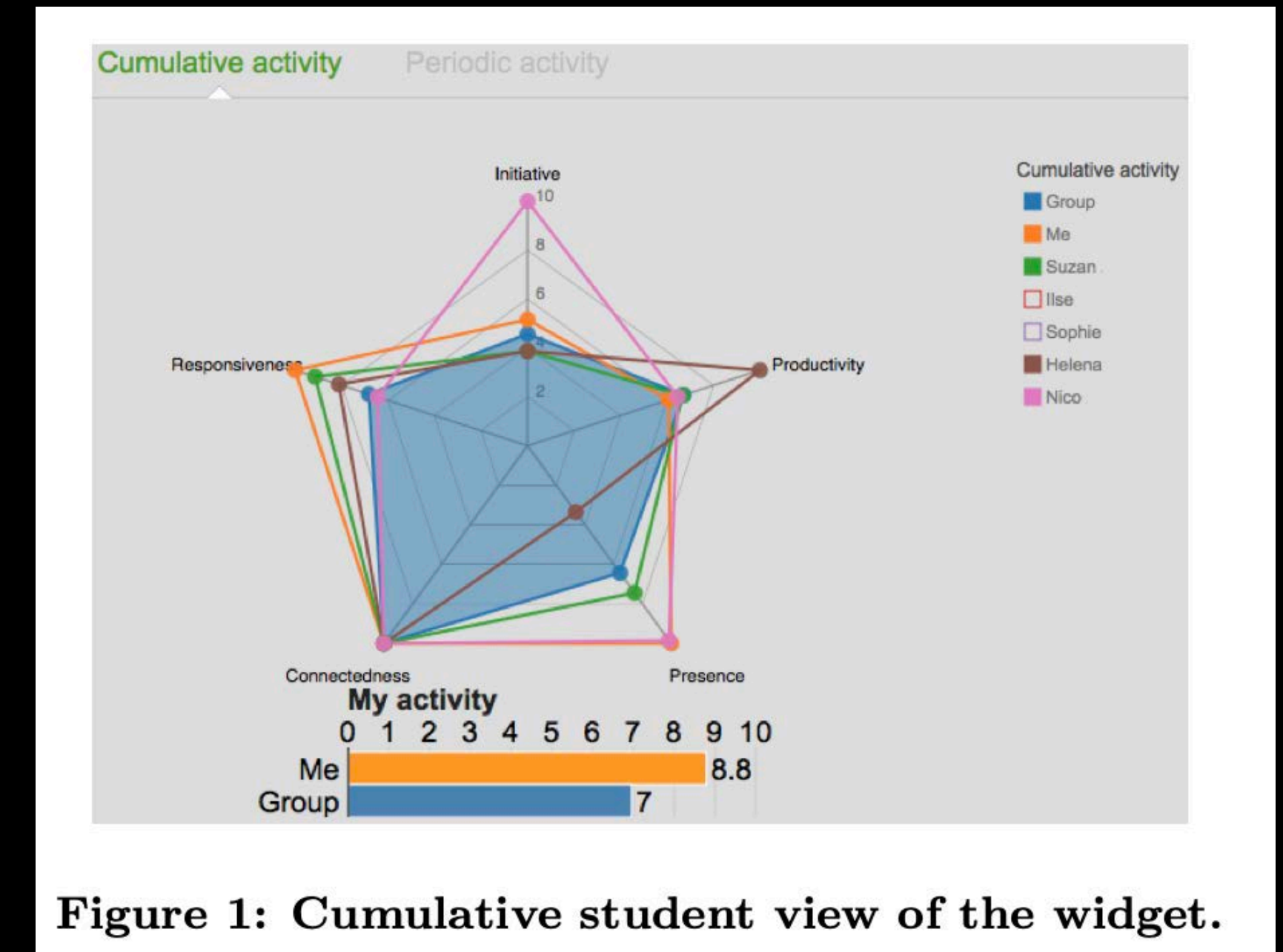
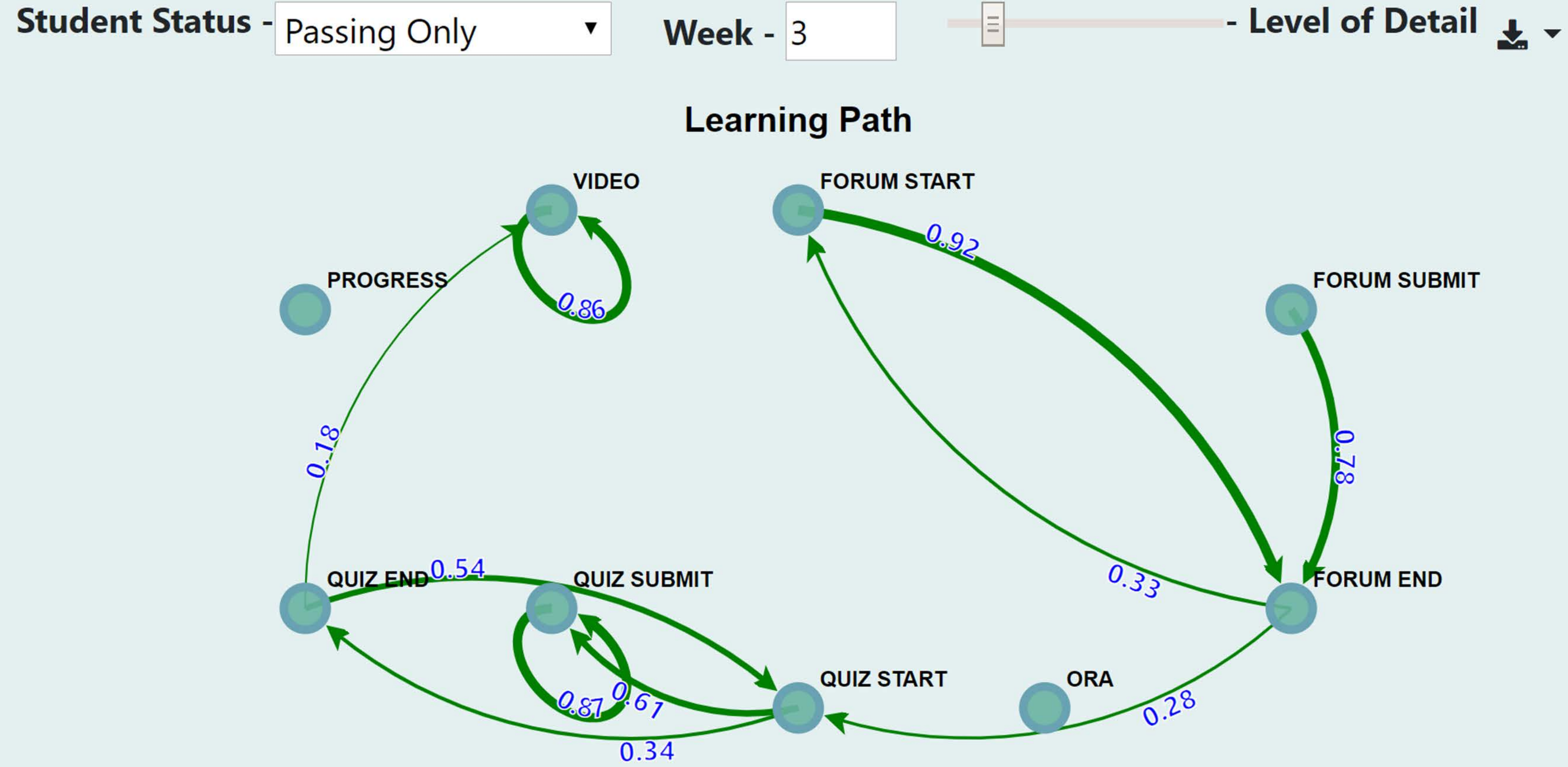


Figure 1: Cumulative student view of the widget.

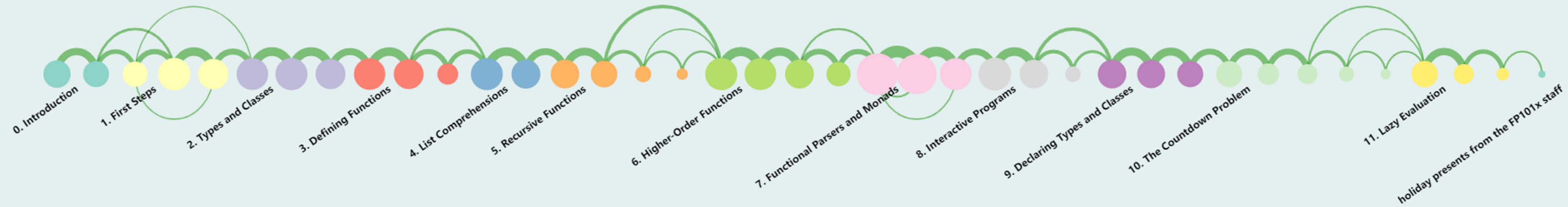
Scheffel, M., Drachsler, H., Kreijns, K., De Kraker, J., & Specht, M. (2017, March). Widget, widget as you lead, i am performing well indeed!: using results from an exploratory offline study to inform an empirical online study about a learning analytics widget in a collaborative learning environment. In Proceedings of the Seventh International Learning Analytics & Knowledge Conference (pp. 289-298). ACM.

# #Case2 Lecturer Reports for teaching support, coaching, quality assurance, upscaling

ELAT - edX Logfile Analysis Tool

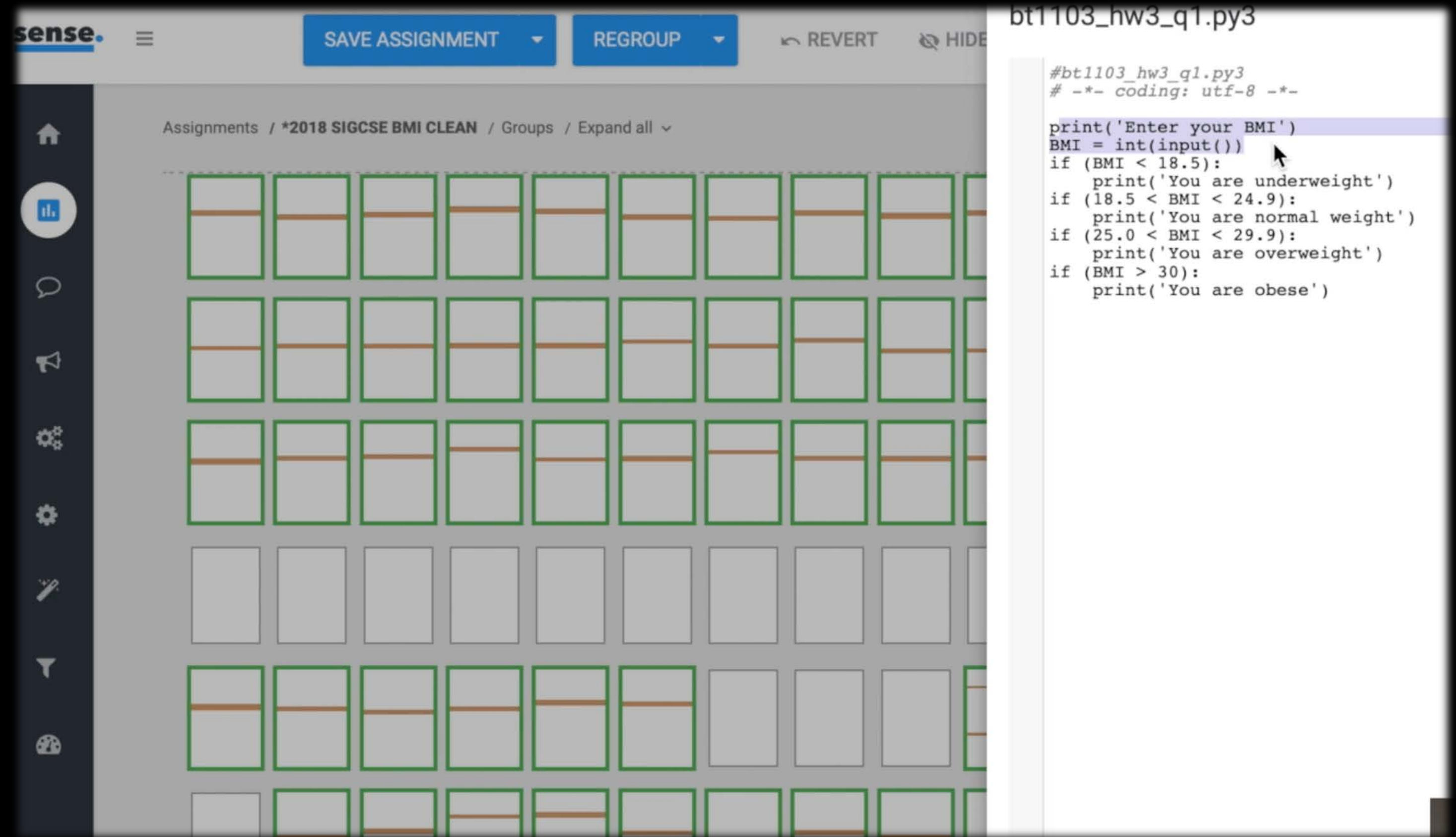


### Video Transitions



# Sense Education, automated feedback in programming

**Upscaling of personalised feedback by combining unsupervised machine learning and rule-based feedback**

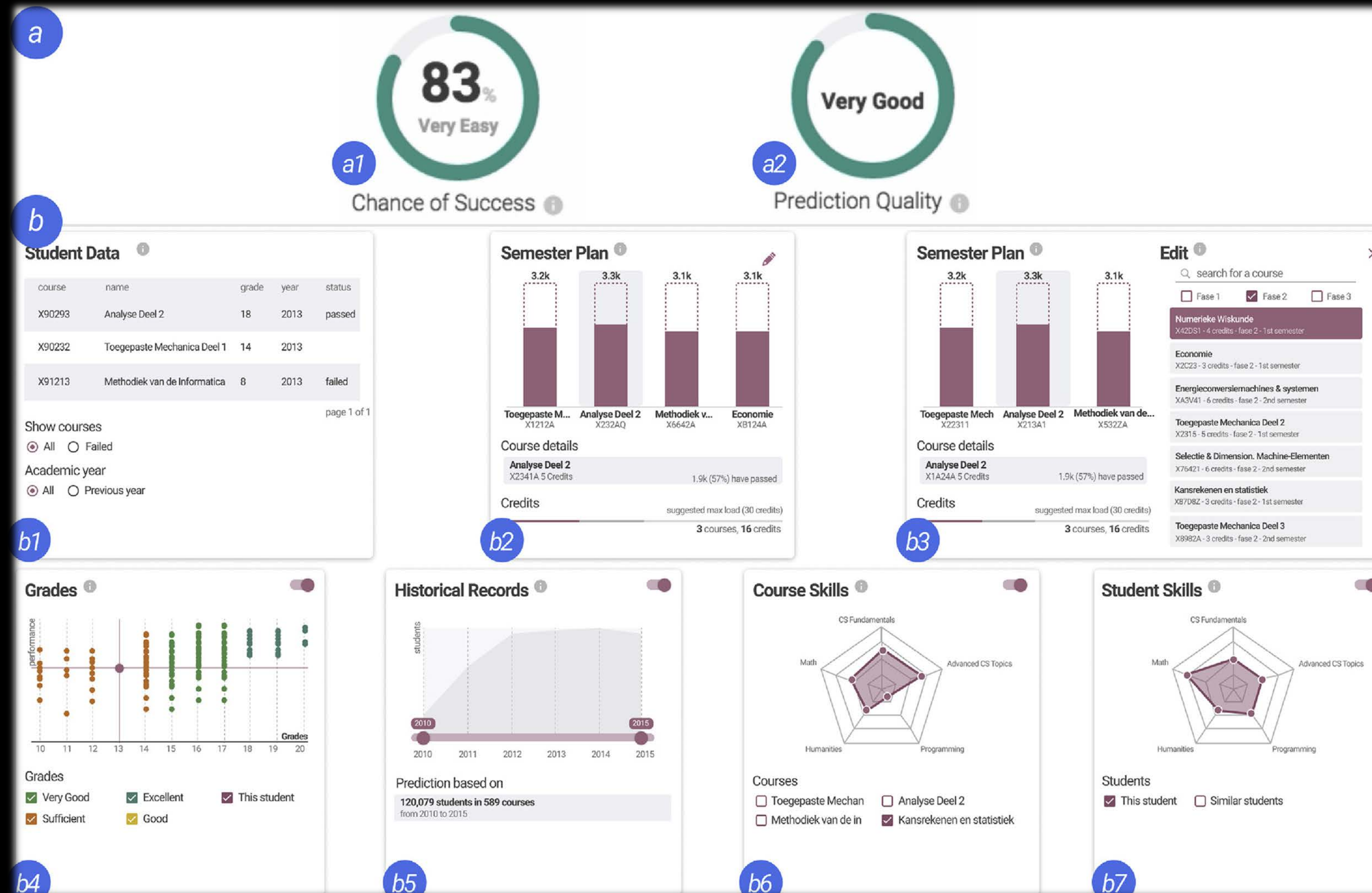


The screenshot displays the Sense Education interface. The top navigation bar includes the 'sense.' logo, a menu icon, and buttons for 'SAVE ASSIGNMENT', 'REGROUP', 'REVERT', and 'HIDE'. Below this, the breadcrumb trail reads 'Assignments / \*2018 SIGCSE BMI CLEAN / Groups / Expand all'. The main area shows a grid of student work, with some cells containing a horizontal line graph. On the right, a code editor window titled 'bt1103\_hw3\_q1.py3' shows the following Python code:

```
#bt1103_hw3_q1.py3
# -*- coding: utf-8 -*-

print('Enter your BMI')
BMI = int(input())
if (BMI < 18.5):
    print('You are underweight')
if (18.5 < BMI < 24.9):
    print('You are normal weight')
if (25.0 < BMI < 29.9):
    print('You are overweight')
if (BMI > 30):
    print('You are obese')
```

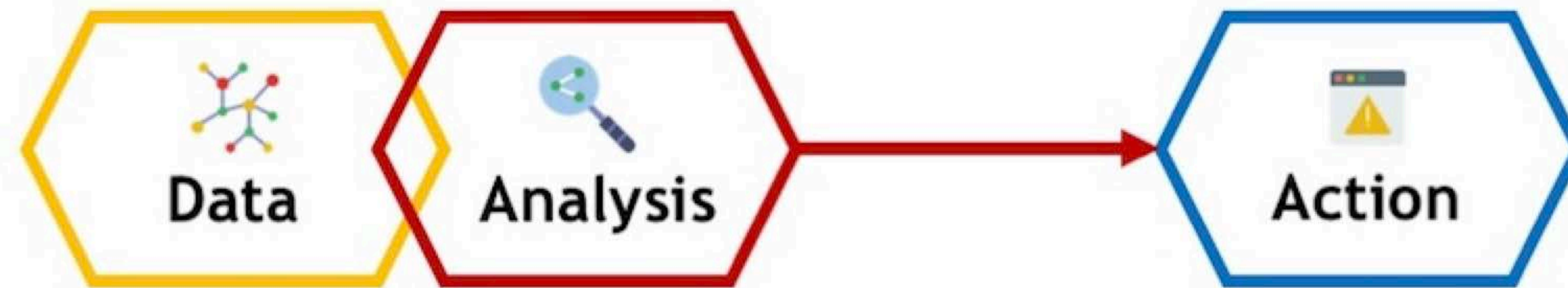
# Case#3: LADA: A learning analytics dashboard for academic advising



Gutiérrez, F., Seipp, K., Ochoa, X., Chiluiza, K., De Laet, T., & Verbert, K. (2018). LADA: A learning analytics dashboard for academic advising. *Computers in Human Behavior*.



# #Case4: Automated Actionable and Personalised Feedback



Basic asset.  
**Raw material**  
to be transformed  
into  
analytical insights.

Process to add  
intelligence  
to data using  
**algorithms.**

**Critical step** towards  
achieving the purpose:  
Improving **students'**  
**performance**

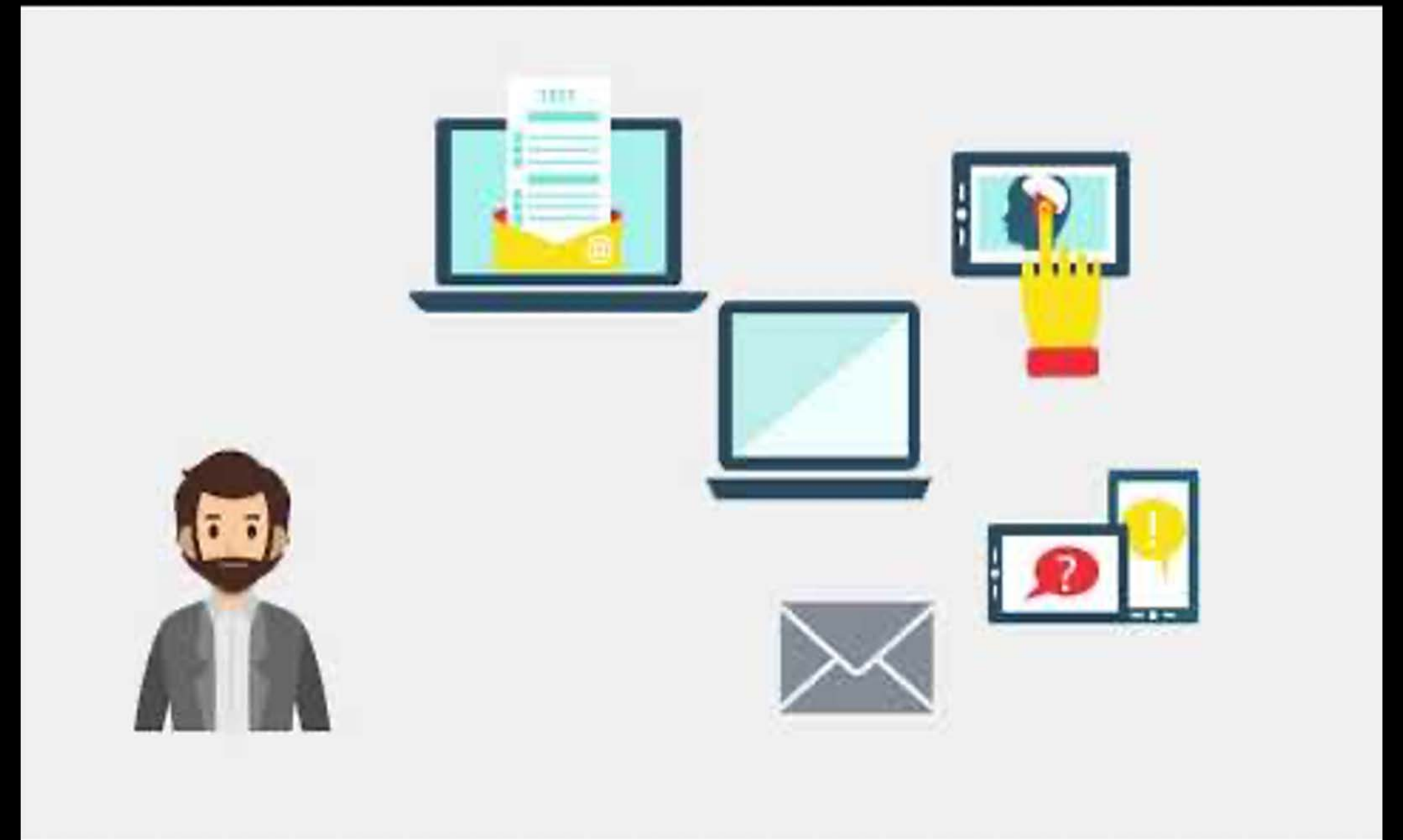
# OnTask: automatic personalised feedback for students

## Evaluation:

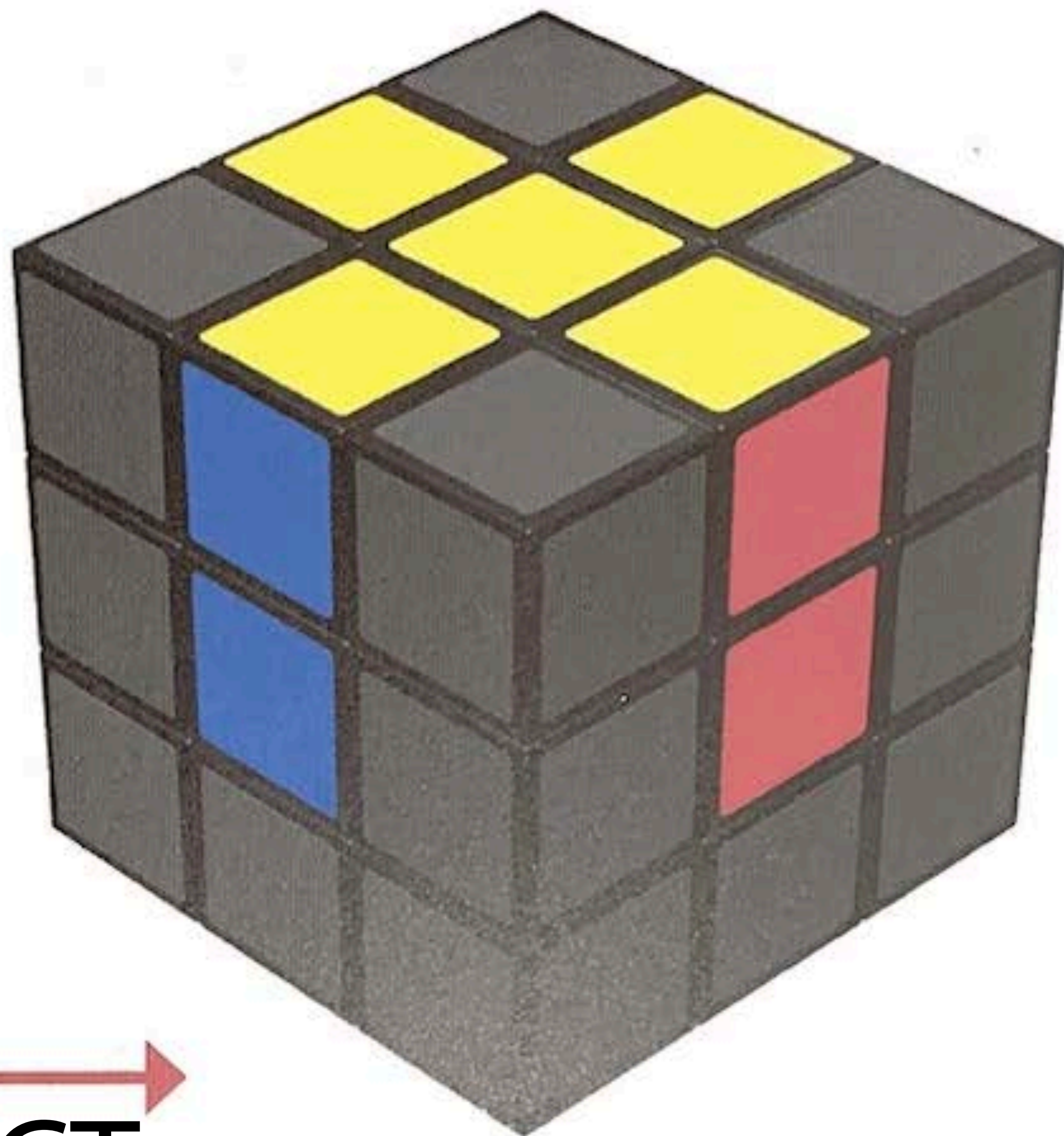
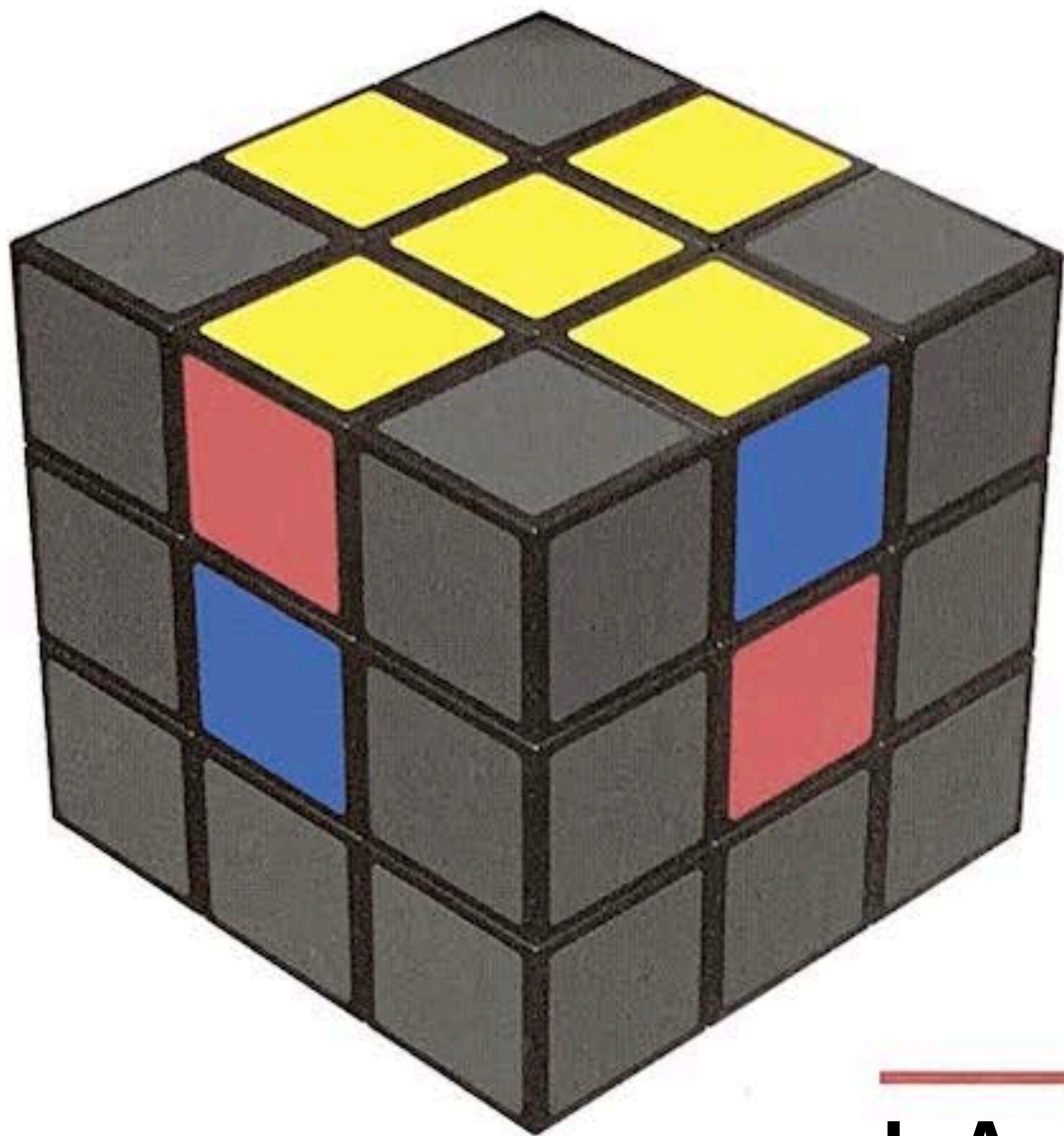
increased student satisfaction with feedback

increased student performance measured as midterm scores (small to medium positive effect)

\* across 2013-2016 first-year student cohorts in a computer engineering course, 300-400 students/cohort



OnTask: automatic personalised feedback for students - [ontasklearning.org](http://ontasklearning.org)



LA + CT =

# #1 Adaptive Education

## Episodic User Model

## Learning by Example

**User Modeling and Adaptive Navigation Support in WWW-Based Tutoring Systems**

Gerhard Weber and Marcus Specht\*

Department of Psychology, University of Trier, Germany

**LISP Course**

- Lesson 1
  - Functions
    - List-access Functions
      - First and Quote
      - Rest
      - Examples of List-access (with exercises)
      - Further List-access Examples (with exercises)
      - GET-FIRST-ELEMENT (programming task)**

[To the Exercises](#)

**Exercises for Practicing**

Here are some exercises for the calling of list access functions. The correct solutions are given and explained on the following page. But firstly, try to solve the problems yourself.

**Exercises:**  
You should work at the following exercises:

**What is the result of evaluating the following expression?**

**(ERROR, if the evaluation will result in an error!):**

(FIRST (REST (BROT KAFFEE MILCH ZUCKER)))  
Error

(FIRST (REST '(BROT KAFFEE MILCH ZUCKER)))  
Kaffee

(FIRST '(REST (BROT KAFFEE MILCH ZUCKER)))

**Chat Room**

**LISP Constructs**  
\* + = / FIRST QUOTE  
REST

**Private Notes on this Page**

store



# #2 Best Agents



- Create an open problem playground motivate and inspire
- Enable transfer to more complex problems
- Link core skills to everyday challenges, work with unstructured information
- Enable student agency and use analytics and agile process
- Scalable Analysis of solutions for given problem within given constraints using an **expert model**
- Give **personalized feedback** on misconceptions in a given problem space
- Can create a more restricted training ground for students within guided and specified problems
- focused on core skill sets and feedback on these

# *Hybrid* Programming Education

- CS TU Delft starts with 900 first year students and give programming instruction
- Scaling UP: Checking assignments is most time consuming, a check once -> give classified feedback to assignments -> AI systems learns from Teacher feedback and can classify student errors and misconceptions
- Programming hands on tutorials with open problems and student projects
- Tutoring Support: 400 students in a tutoring space, QUEUE <https://queue.tudelft.nl> system handles students requests and coordinates 30-40 students assistants in handling requests
- Developing base educational material, towards smart feedback and open environments

# Summary

- CT helps developing cross curricular generic competences and skills
- It is challenging how to integrate is in the curriculum, define the terms and prepare educators
- Assessment and continuous measurements of skills are developed and internationally discussed
- LA and AI can help with scaling feedback and tutoring

# Learning Analytics

## Innovation Room #15: CLASH

Friday 20 March 2020, 12-5 pm, TU Delft Teaching Lab

Centre for  
Education and  
Learning



Universiteit  
Leiden  
The Netherlands



Learning Analytics is one of the fastest developing fields in the last decade. Do you want to learn more about this topic and share your challenges with others?

Come to Innovation Room #15 and meet LA's most advanced thinkers and kick-start LA culture in your own organisation.

## Register now!

More information: [www.educationandlearning.nl/events](http://www.educationandlearning.nl/events)



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