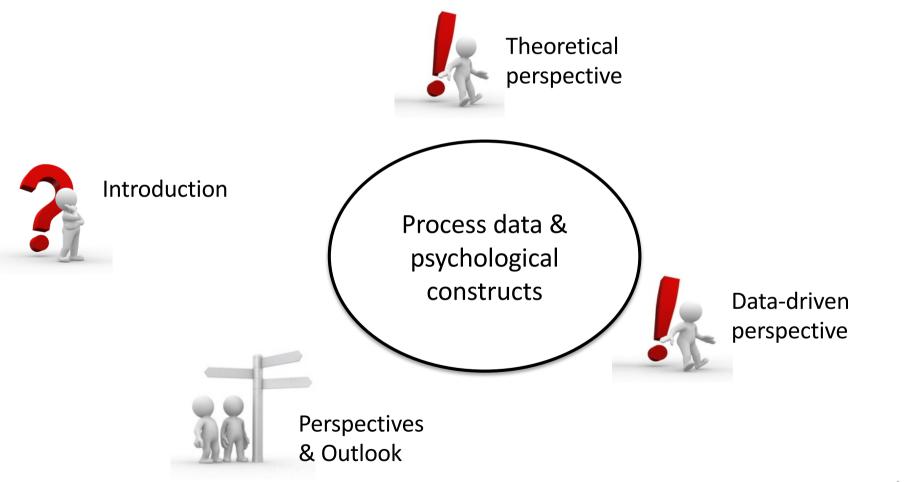


# The Benefits of Process Data Analysis for a Better Understanding of Complex Psychological Constructs

Samuel Greiff & Björn Nicolay University of Luxembourg









## Large-Scale Assessments

 Comparison and benchmarking of countries and economies

Promotion of educational equity & showing disparities

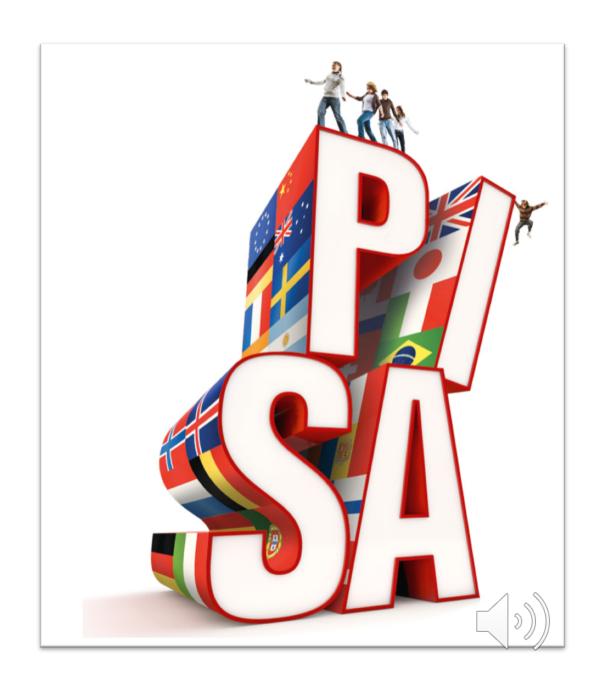
Monitoring and evaluation of educational processes and systems



Retrieved from http://international-assessments.org/why-does-pisa-appear-to-be-everyones-solution



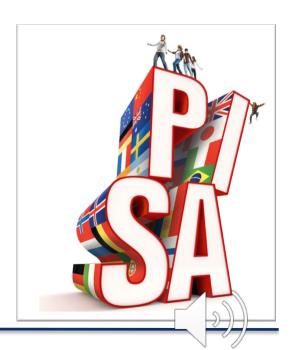


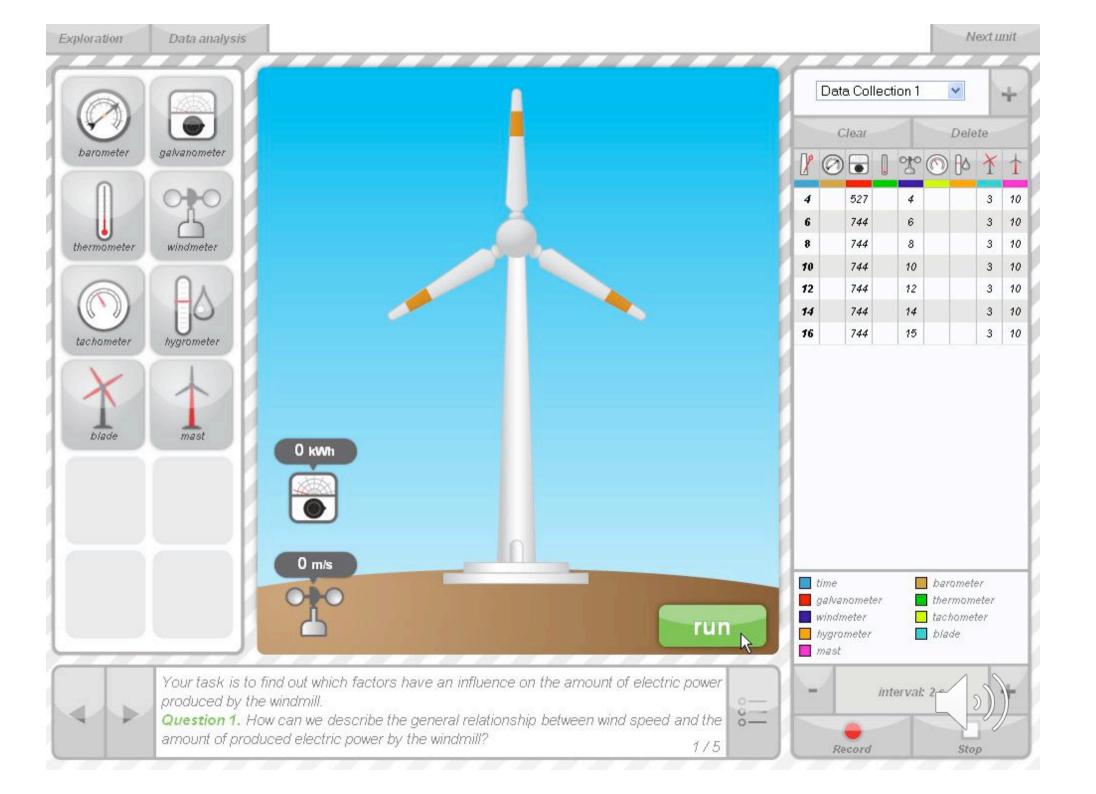


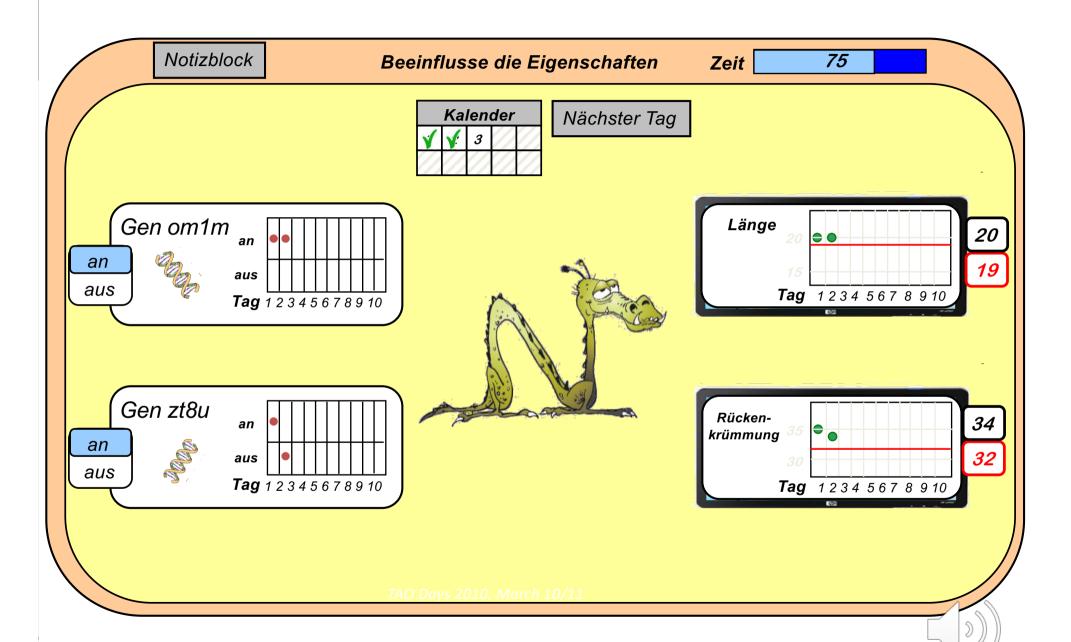


### Complex Psychological Constructs in PISA/PIAAC

- Digital Reading (PISA 2009)
- Complex Problem Solving (PISA 2012)
- Collaborative Problem Solving (PISA 2015)
- Global Competencies (PISA 2018)
- Creative Thinking (PISA 2021)
- PS in Technology-Rich Environments (PIAAC 1)
- Adaptive Problem Solving (PIAAC 2)









## Benefits of Computer-Based Assessment

- Standardization
- Automatic scoring
- Tailored testing (CAT)
- Facilitating new item types
- Facilitating complex constructs
- Collecting additional information

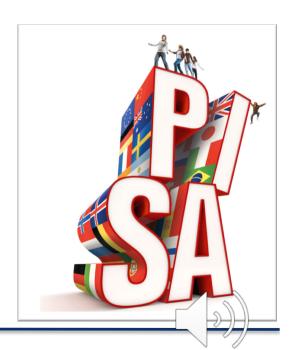






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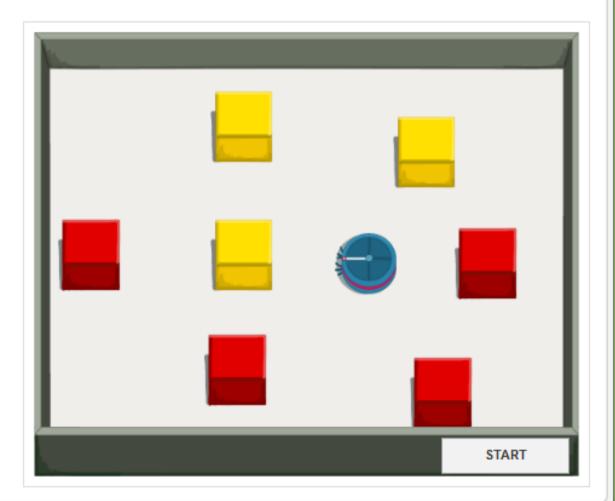


#### **ROBOT CLEANER**

The animation shows the movement of a new robotic vacuum cleaner. It is being tested.

Click the START button to see what the vacuum cleaner does when it meets different types of objects.

You can use the RESET button to place the vacuum cleaner back in its starting position at any time.





#### Question 1: ROBOT CLEANER CP002Q08

What does the vacuum cleaner do when it meets a red block?

- It immediately moves to another red block.
- It turns and moves to the nearest yellow block.
- It turns a quarter circle (90 degrees) and moves forward until it meets something else.
- It turns a half circle (180 degrees) and moves forward until it meets something else.

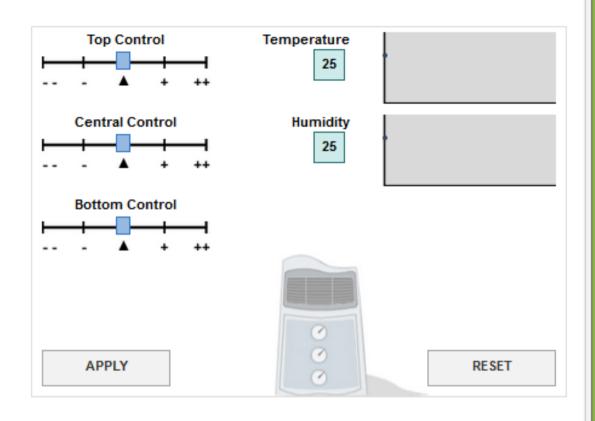


#### CLIMATE CONTROL

You have no instructions for your new air conditioner. You need to work out how to use it.

You can change the top, central and bottom controls on the left by using the sliders (-1). The initial setting for each control is indicated by **A**.

By clicking APPLY, you will see any changes in the temperature and humidity of the room in the temperature and humidity graphs. The box to the left of each graph shows the current level of temperature or humidity.



#### Question 1: CLIMATE CONTROL CP025Q01

Find whether each control influences temperature and humidity by changing the sliders. You can start again by clicking RESET.

Draw lines in the diagram on the right to show what each control influences.

To draw a line, click on a control and then click on either Temperature or Humidity. You can remove any line by clicking on it.

Central Control Bottom Control Temperature

Humidity



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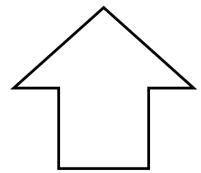
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## Theory or data?

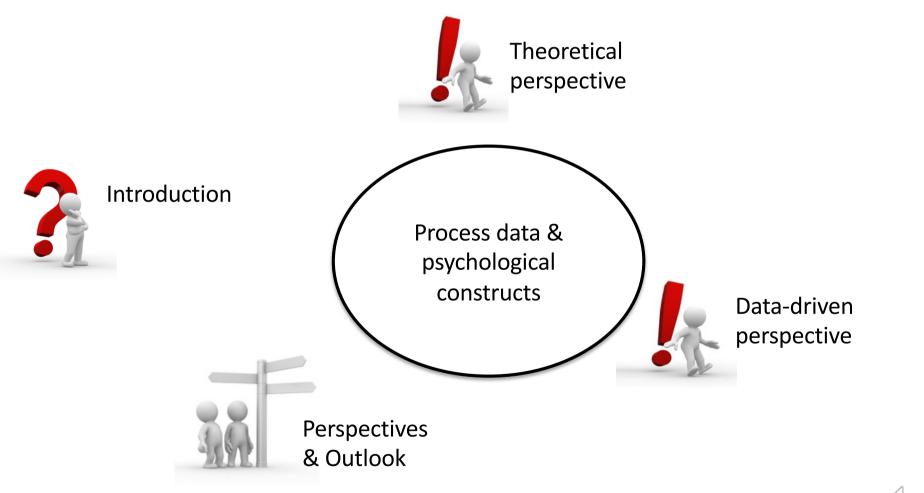


Datadriven / Bottom up







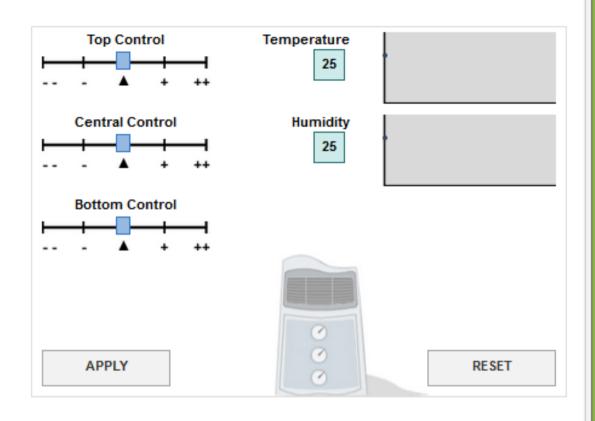


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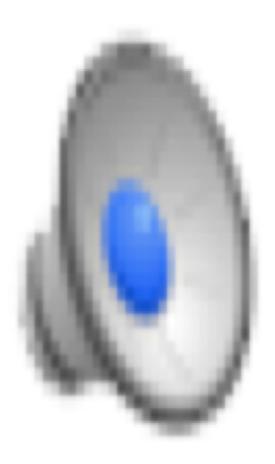
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Central Control Bottom Control Temperature

Humidity







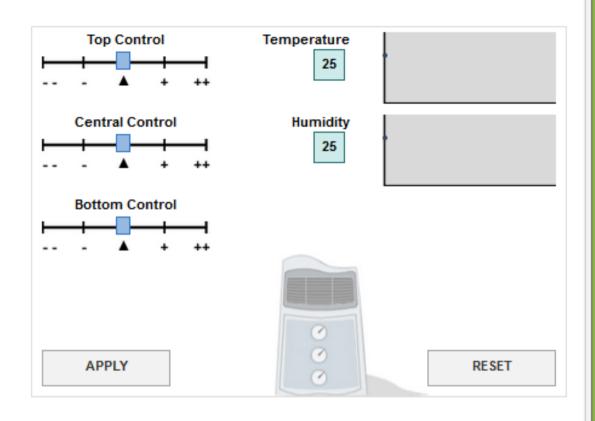


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## Can we identify "good" behavior?

- → Are students applying theoretically-derived strategies?
- → How do theoretically derived optimal behaviors relate to performance?



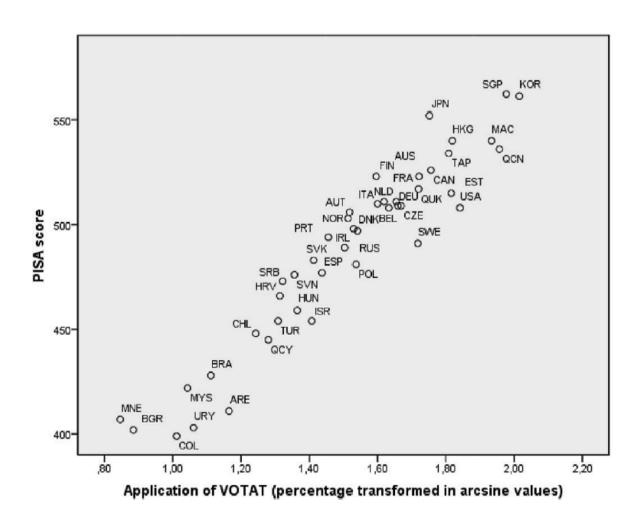


VOTAT strategy – strong relation to performance

	Climate Cor	Total		
	incorrect	correct	Total	
No VOTAT	42.2%	9.7%	51.9%	
VOTAT	6.9%	41.1%	48.1%	
Total	49.1%	50.9%	100.0%	

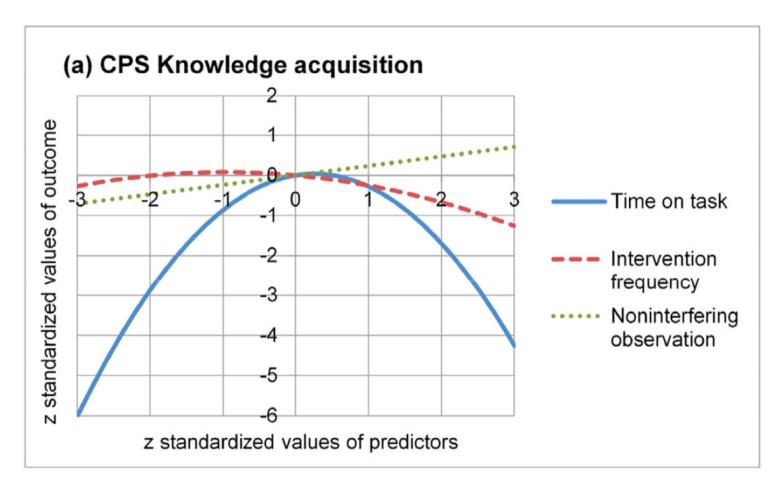
Greiff et al. in E (?015)





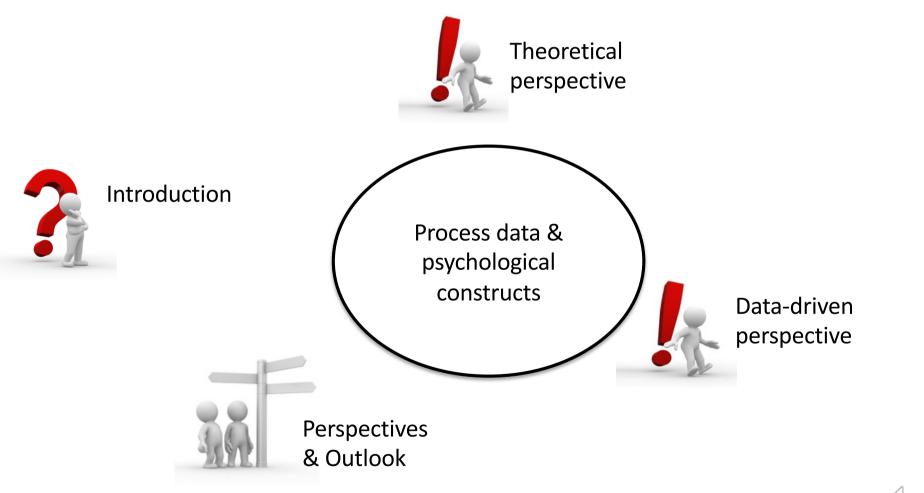
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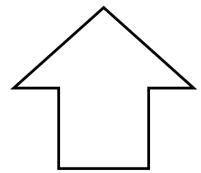




## Theory or data?

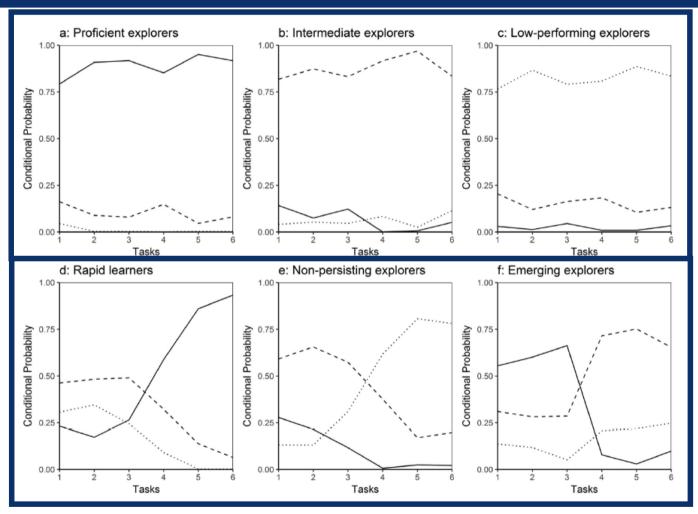


Datadriven / Bottom up









Approx. 40% deof students with varying exploration behavior

Greiff, Molnar, Martin, Zimmermann, Csapo (2018) in Computers & E





## N-Gram analyses

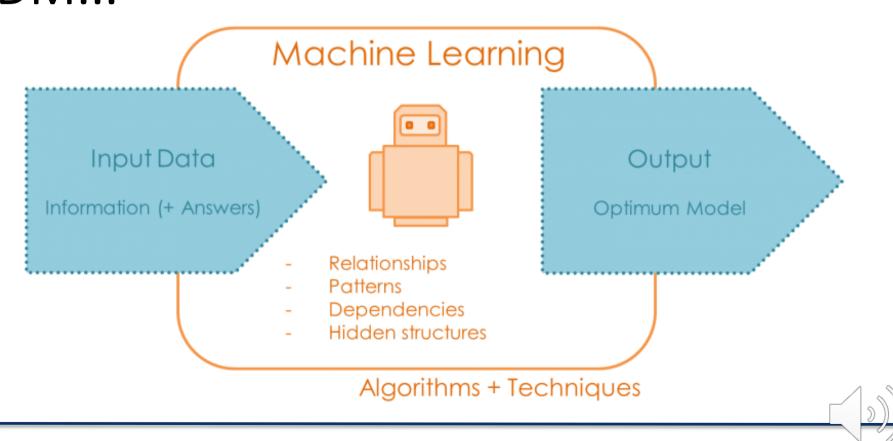
n = 2				n = 3			n = 4				
Sequence	χ²	p	Dir.	Sequence	χ2	Dir.	p	Sequence	χ2	Dir.	р
SS	31.98	<0.001	_	SSS	59.98	_	<0.001	SSSS	76.34	_	<0.001
MM	0.92	0.337	+	MMM	12.16	+	< 0.001	MMMM	67.09	+	< 0.001
MS	0.23	0.632	_	MSS	4.08	_	0.043	MSSS	7.21	_	0.007
SM	0.05	0.823	+	SMM	1.95	+	0.163	SMMM	5.43	+	0.020
				MSM	0.37	+	0.543	SSSM	5.30	_	0.021
				SSM	0.17	_	0.680	MMSS	3.64	_	0.056
				MMS	0.04	_	0.841	MSMM	2.70	+	0.100
				SMS	0.00	_	1.00	SSMM	2.01	+	0.156
								MMMS	1.52	+	0.218
								MMSM	0.87	+	0.351
								SMMS	0.69	+	0.406
								SSMS	0.36	_	0.549
								MSMS	0.32	_	0.572
								MSSM	0.27	_	0.603
								SMSS	0.03	_	0.862
I								SMSM	0.01	+	0.920

N-grams with higher chi-square values are more discriminative; Dir., Direction of the difference between groups. "+" represents behaviors that were more typical of students that solved the task "-" represents behaviors that were more typical of students that did not solve the task; S, working on the scenario; M, changing the model.

Stadler, Fischer & Greiff (2019) in Frontiers in Prochagy

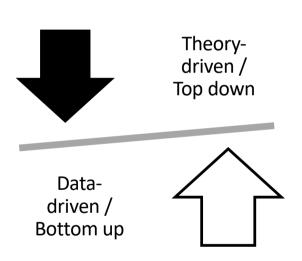


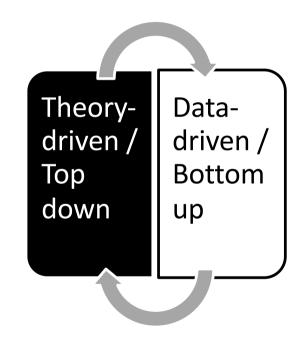
## Learning Analytics, Machine Learning, EDM...





## Theory and data









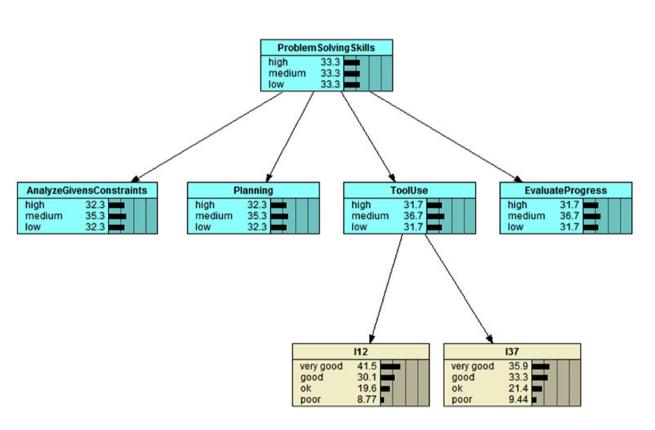


Shute, Wang, Greiff, & Zhao (2016) in Computers in Human [



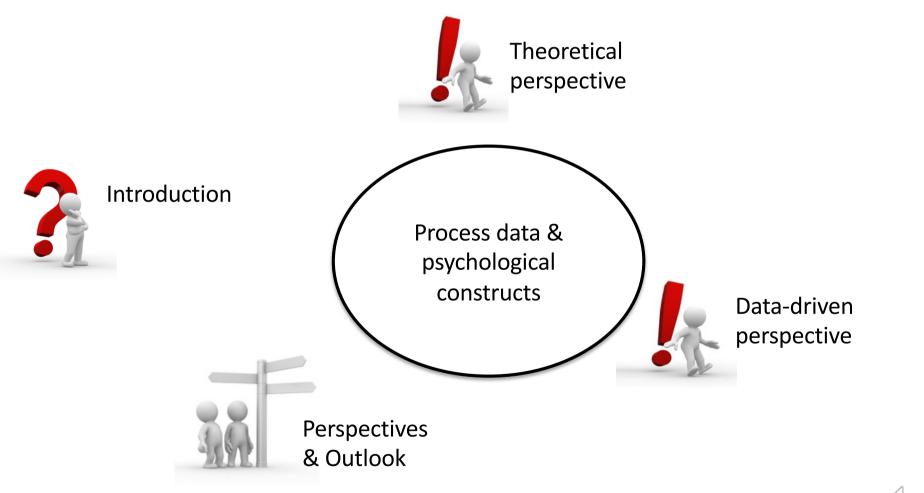






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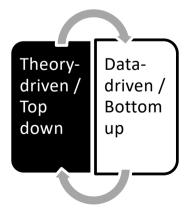




## A brief summary

- What has happened?
  - Shift to technology-based assessment
  - Innovative domains / complex constructs
  - New methods
- What will / might happen?
  - Combining theory & data
  - Formative assessment (AfL)
  - Complement for reporting
  - Understanding the "HOW"











1 APRIL 2014

Education

oblem Solving, but Trail Foreign Counterparts

Americ

Difficult to look into students' minds, but instead from the "What" to the "How"

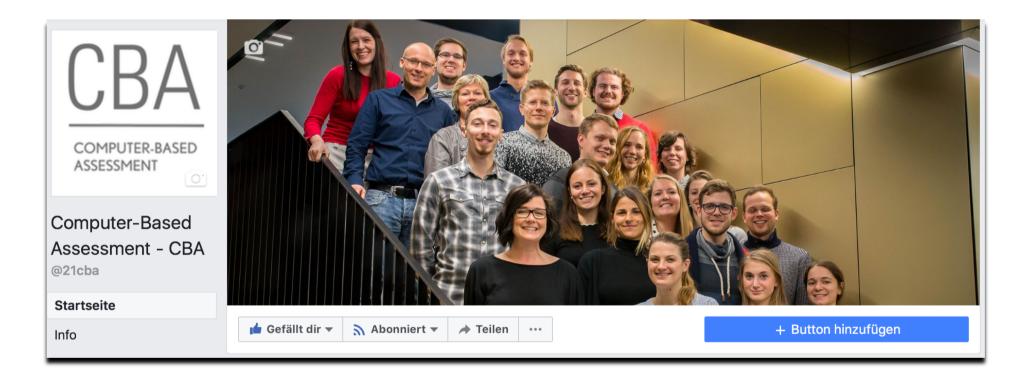
Introducing a new layer of understanding

www.telegraph.co.uk

OECD: English pupils 'more practical than academic'

El drama o





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facebook.com/21cba





#### **Questions and Discussion**



#### **Shared interests**









#### Contact



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4366 Esch, Luxembourg

Phone: +352-466644-9245