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# How to recognize and avoid cargo cult-based research


## Prof. Dr. Andrej Šorgo
## University of Maribor


~Chania, 17 – May – 2023~

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# How to recognize and avoid cargo cult-based research

Prof. dr. Andrej Šorgo, University of Maribor, Slovenia
Faculty of Electrical Engineering and Computer Science; Faculty of Natural Sciences and Mathematics

~Chania 17th May, 2023~

# Slovenija

- 2 millions of inhabitants;
- about 40% is nature protected area;
- one of the safest countries in the World


# According to some sources, however, Slovenia is covered by tundra

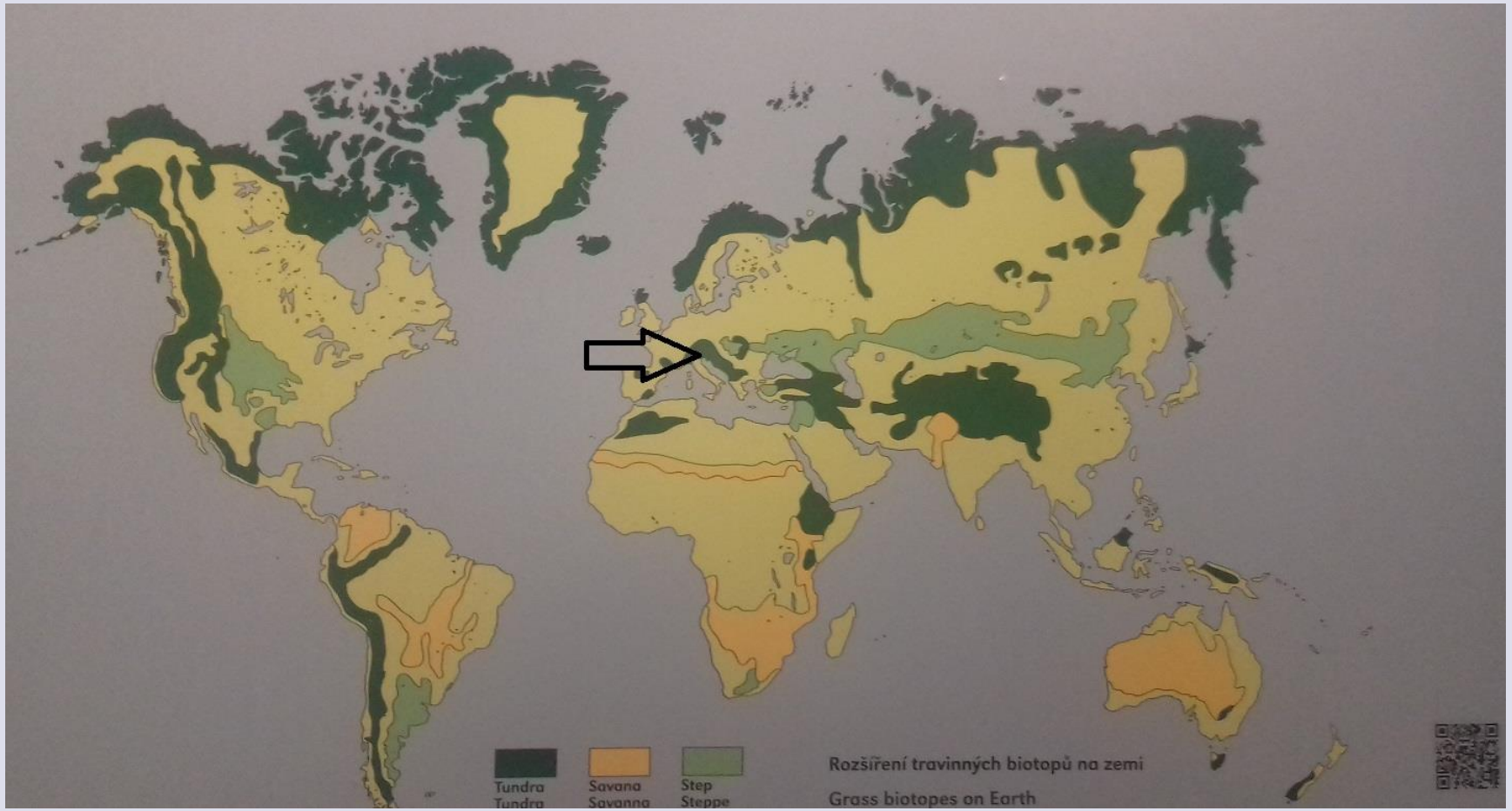


Photo: Andrej Šorgo, 2018

# Pre-university period (23 years in secondary and higher schools)

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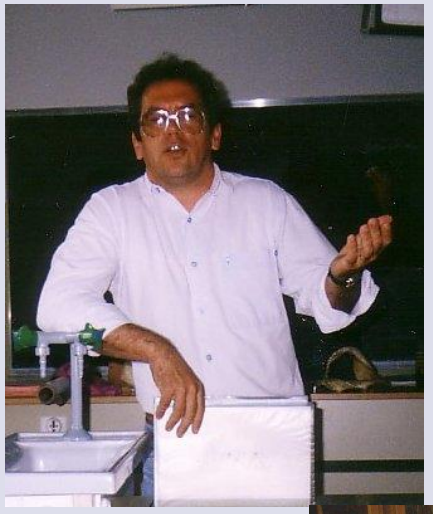

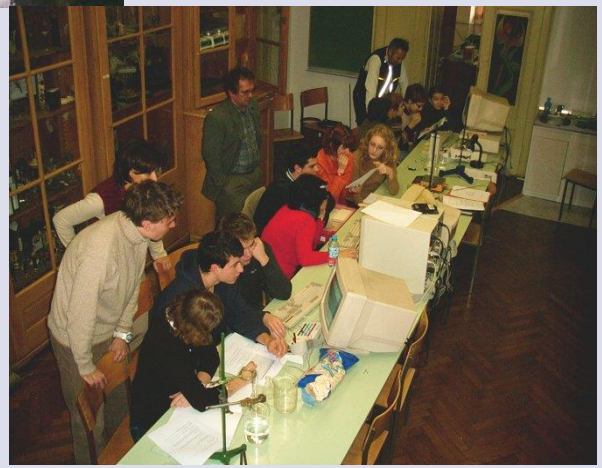

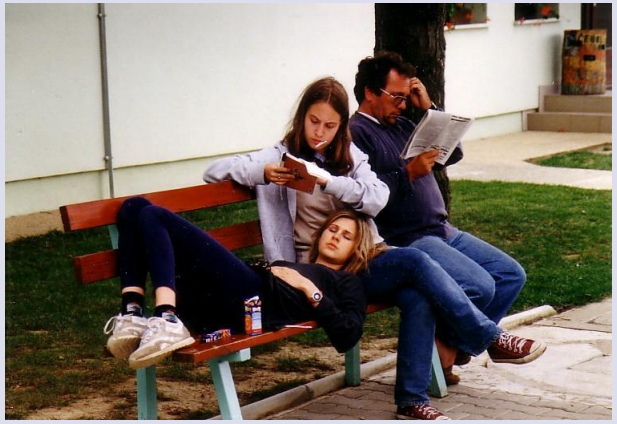

# As a secondary school teacher I did not know that it is impossible to publish in prestige journals

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ŠORGO, Andrej, HAJDINJAK, Zdravka, BRIŠKI, Darko. The journey of a sandwich: computer-based laboratory experiments about the human digestive system in high school biology teaching. *Advances in physiology education*, ISSN 1043-4046, 2008, vol. 32, no. 1, str. 92-99, [JCR, SNIP, WoS , Scopus]

ŠORGO, Andrej, KOCIJANČIČ, Slavko. Demonstration of biological processes in lakes and fishponds through computerised laboratory practice. *The international journal of engineering education*, 2006, vol. 22, num. 6, str. 1224-1230, [JCR, SNIP, WoS, Scopus ]

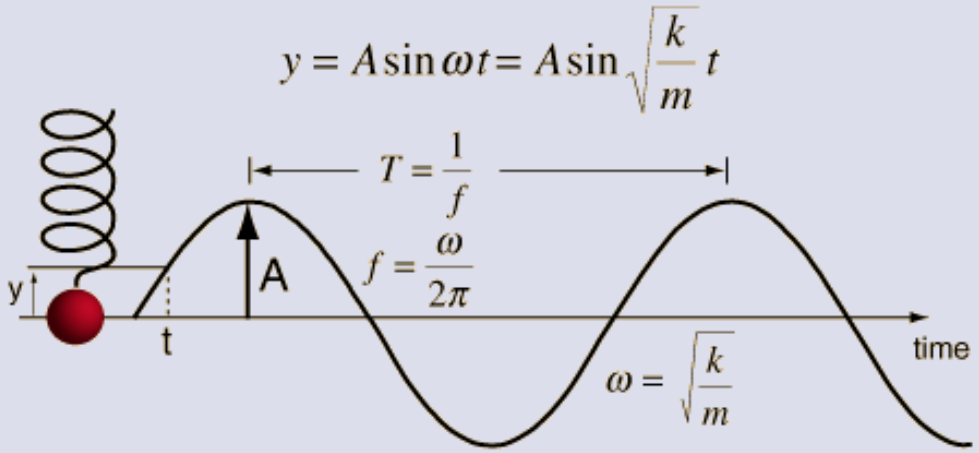
# Lessons learned as a teacher

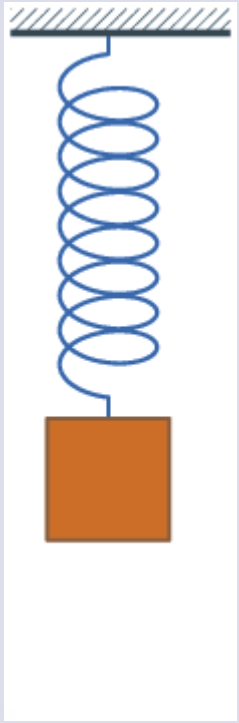

Teachers are people who help students solve problems that would not exist without them.

# Lesson learned as a teacher: There exists at least two parallel worlds

## World 1: School  World 2: Reality

## Example: Harmonic oscillations



# Recently: university teacher of the teachers and a researcher in different roles

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Introduction of contemporary methods and creativity in teaching;

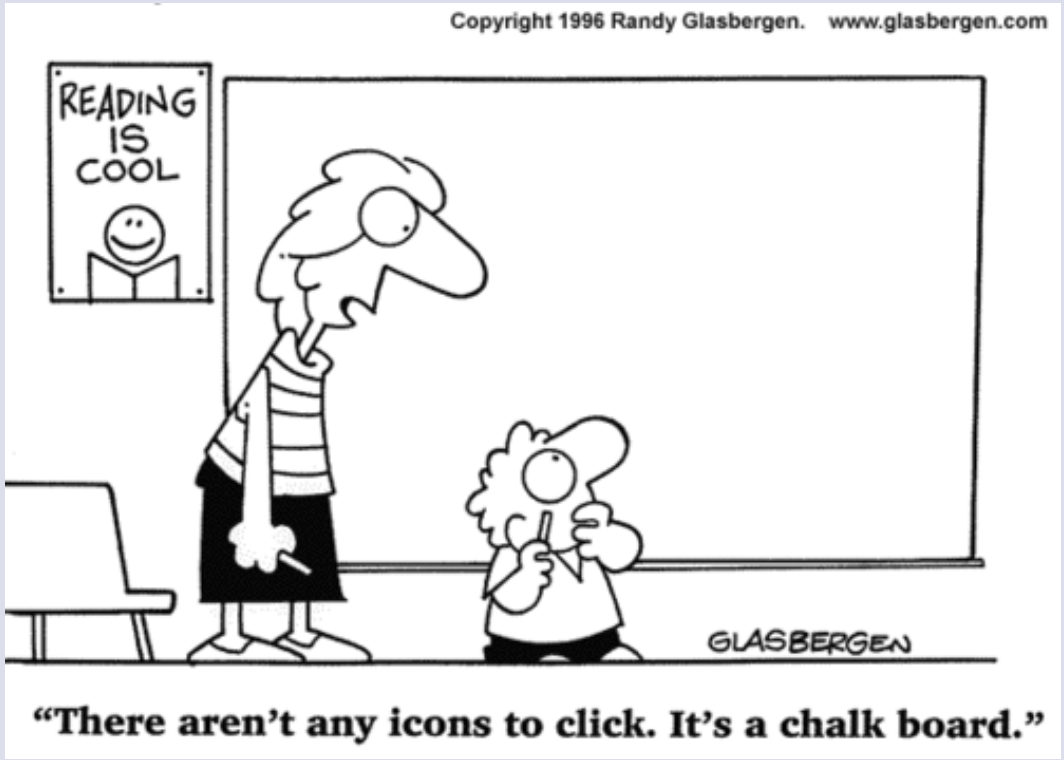
Development and application of computer- supported real, virtual and traditional laboratory work;

Attitudes and opinions as a factor in public acceptance of technology and practices;

Factors influencing human decisions in various situations.

## Research for fun.

# We know: The times are changing



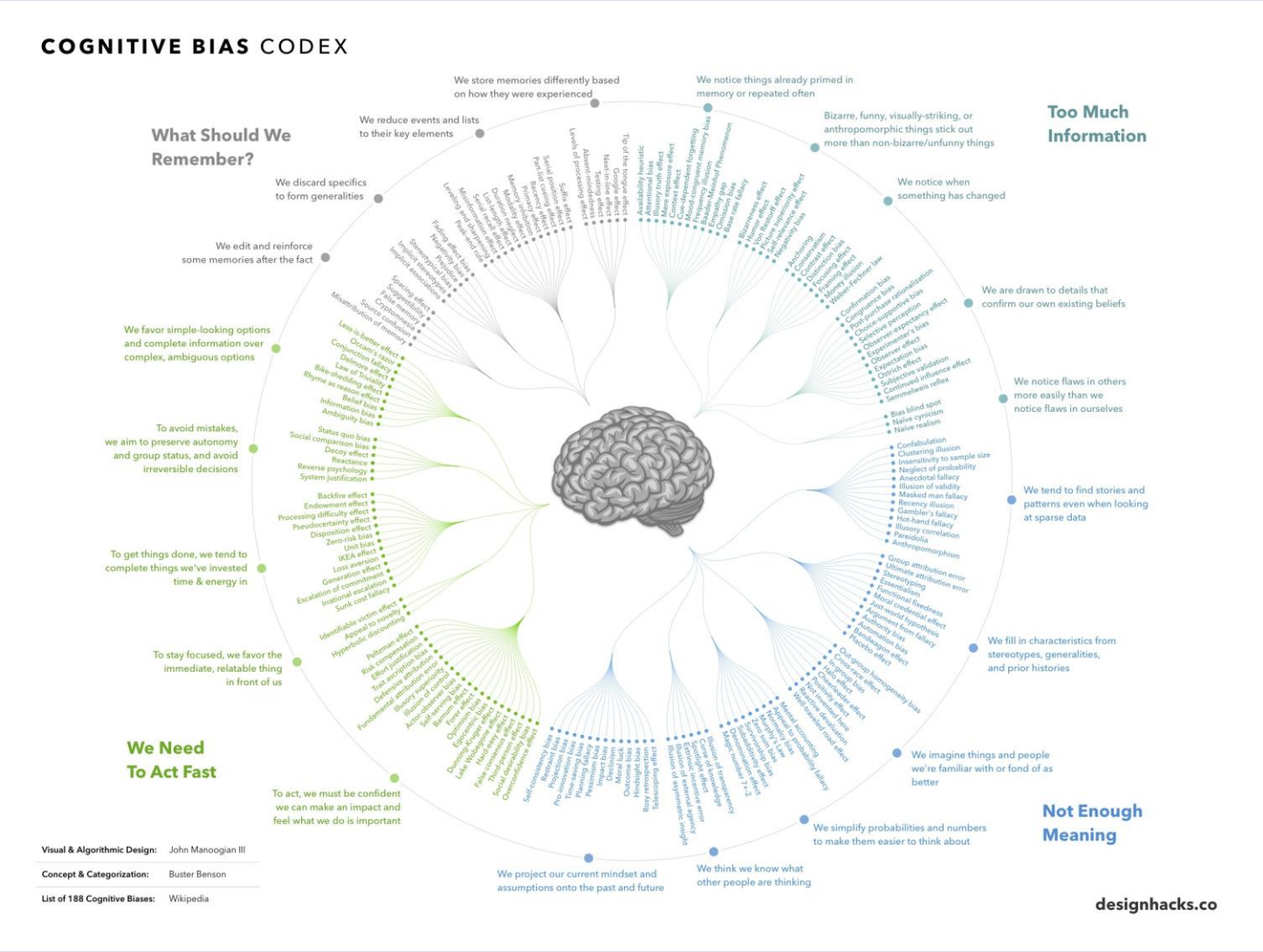

Marsel van Oosten http://www.nhm.ac.uk/visit/wpy/gallery/2014/images/new-special-award-people-s-choice/4926/facebook-update.html

# We know: Human biology did not substantially change in last millennia (Fagan, 2001; Foley, 1995).

http://becuo.com/finger-painting-hand

http://nobel.finalsite.com/page.cfm?id=21874&tab=bulletins

# We know that our cognition is biased in multiple ways



# We believe: The ICT is everywhere, so people should be digitally competent.

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## Wishfull thinking



om **Futurelab** handbook: Digital literacy across the curriculum
p://www.futurelab.org.uk/resources/documents/handbooks/digital_literacy.pdf

## Reality

Image source: https://www.groundzeroweb.com/worst-selfies-selfies-gone-wrong/

Image source: http://www.pontydysgu.org/2010/07/digital-literacies-another-viewpoint/

Image source: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digcomp-21-digital-competence-framework-citizens-eight-proficiency-levels-and-examples-use

# We abuse the term “survival of the fittest”

# We are not aware that we are surrounded by a "false reality" that does not fit our previous knowledge.

# Evidence: Because of the ICT education has changed forewer.

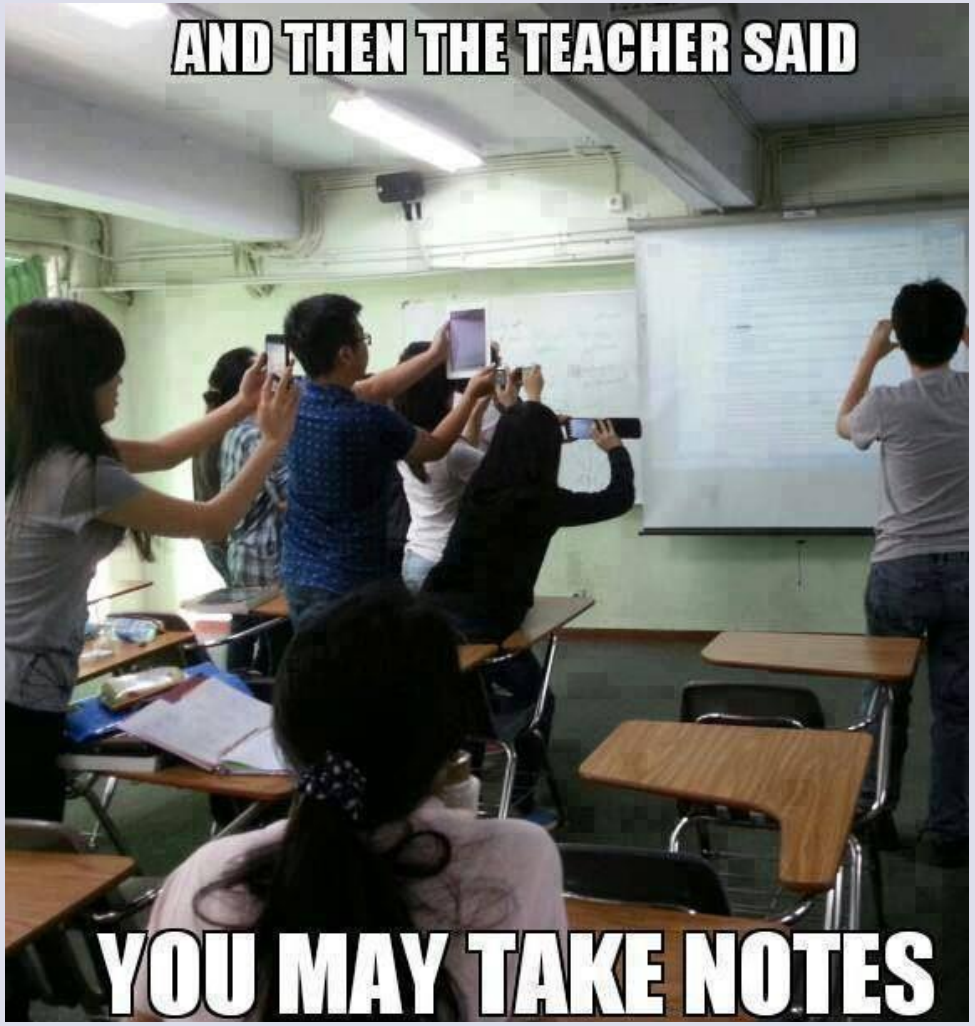
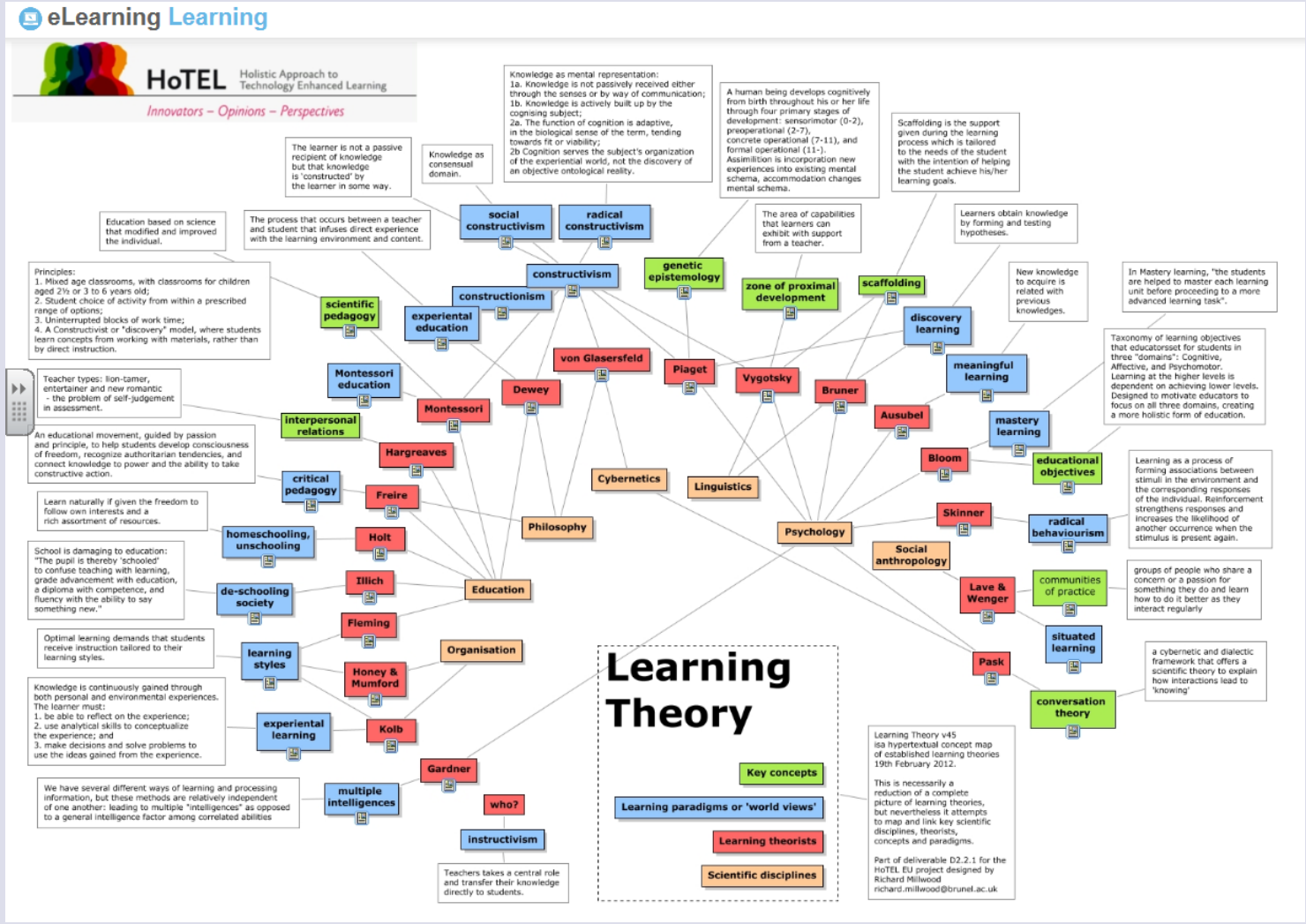



Image source: https://www.pinterest.com/pin/625367098227070330
Image source: https://www.pinterest.com/pin/4006796980677117 60

# Advice: If someone want answers, asking questions can be good starting point .

Photo: Andrej Šorgo, 2018

# Advice: provide theoretical basis of your research.
# There exists several hundreds of theories related to education




Source: http://www.elearninglearning.com/learning-theory/pedagogy/?open-article-id=3373201&article-title=how-our-learning-theories-shape-how-we-use-technology-for-learning&blog-domain=blogspot.com&blog-title=joitske-hulsebosch-elearning

# Which theories are still vivid?


http://www.horrorhomeroom.com/the-walking-dead-and-the-sympathetic-zombie/

# Cargo Cult Science (Feynman, 1974)


**Cargo Cult Science**

by RICHARD P. FEYNMAN

Some remarks on science, pseudosci
and learning how to not fool yours
Caltech's 1974 commencement addre

*In the South Seas there is a cargo cult of people. During the war they saw airplanes land with lots of good materials, and they want the same thing to happen now. So they've arranged to make things like runways, to put fires along the sides of the runways, to make a wooden hut for a man to sit in, with two wooden pieces on his head like headphones and bars of bamboo sticking out like antennas — he's the controller — and they wait for the airplanes to land. They're doing everything right. The form is perfect. It looks exactly the way it looked before. But it doesn't work. No airplanes land.*

http://militaryhistorynow.com/2014/03/05/praise-john-frum-the-bizarre-cargo-cults-of-world-war-two/

http://blog.xebialabs.com/2014/12/10/cargo-cult-devops/

http://calteches.library.caltech.edu/3043/1/CargoCult.pdf

# Cargo cult in education and popular science

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Left – Right brains (Geake, 2008)

Someone can raise percentage of brain use (Geake, 2008)

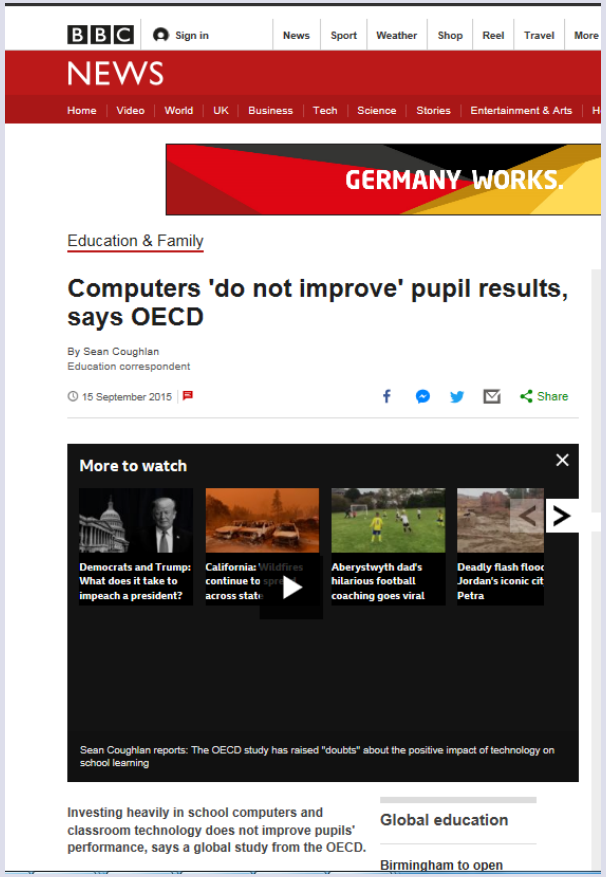
Digital natives are information literate (Šorgo et al., 2017)

On existence of Learning styles (Dembo, & Howard, 2007).

Reduction of number of students will raise outcomes (Hattie, 2015)

Giving computers to the children will improve knowledge (OECD, 2015)

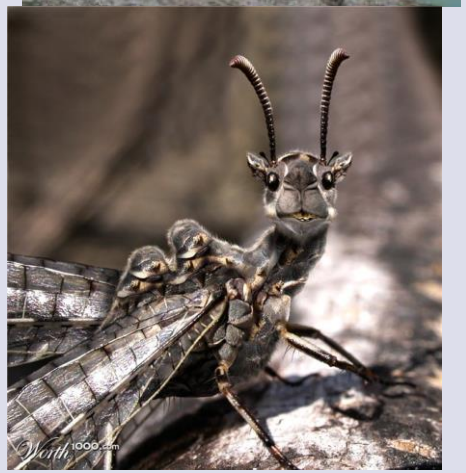
Etc.



# School system is killing creativity (Ken Robinson, TED talk)


http://www.youtube.com/watch?v=zDZFcDGpL4U

# SSI problem: People do not like ideas about genetically modified organisms

http://www.worth1000.com/contests/3695/contest

# 1st cluster of research: connections between knowledge, opinions and acceptability of GMO‘s

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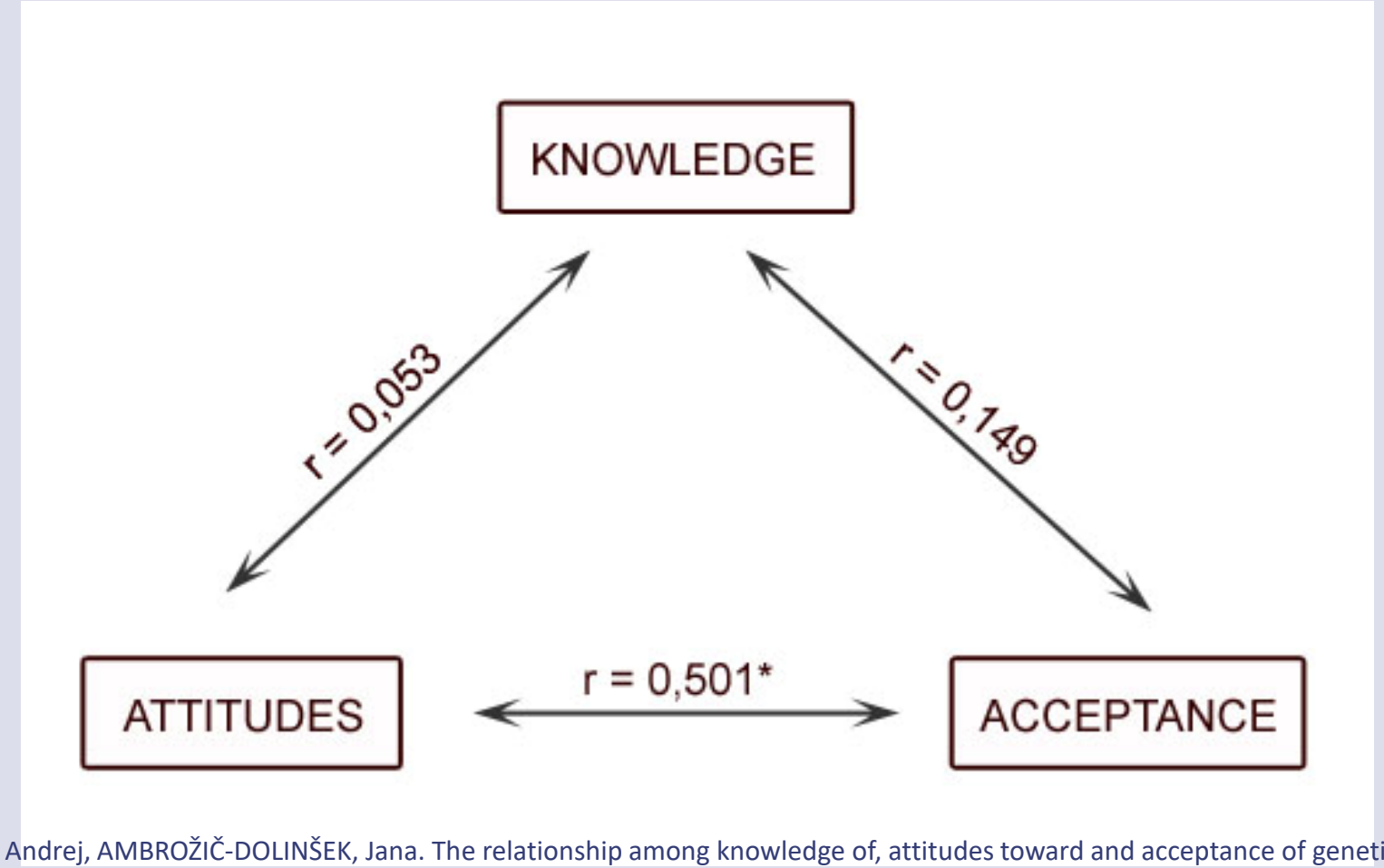
ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana. The relationship among knowledge of, attitudes toward and acceptance of genetically modified organisms (GMOs) among Slovenian teachers. *Electron. J. Biotechnol.*, oct. 2009, vol. 12, no. 3, str. 1-13. http://dx.doi.org/10.2225/vol12-issue4-fulltext-1, doi: 10.2225/vol12-issue4-fulltext-1. [COBISS.SI-ID 17230088],

AMBROŽIČ-DOLINŠEK, Jana, ŠORGO, Andrej. Odnos študentov razrednega pouka do gensko spremenjenih organizmov (GSO) = Opinion about genetically modified organisms (GMOs) among students of elementary education. *Acta biol. slov.*. [Tiskana izd.], 2009, vol. 52, št. 2, str. 21-31. [COBISS.SI-ID 17374728]

ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana. Knowlege of, attitudes toward, and acceptance of genetically modified organisms among prospective teachers of biology, home economics, and grade school in Slovenia. *Biochemistry and molecular biology education*. [Print ed.], 2010, vol. 38, no. 3, str. 141-150. http://dx.doi.org/10.1002/bmb.20377, doi: 10.1002/bmb.20377. [COBISS.SI-ID 17617416],

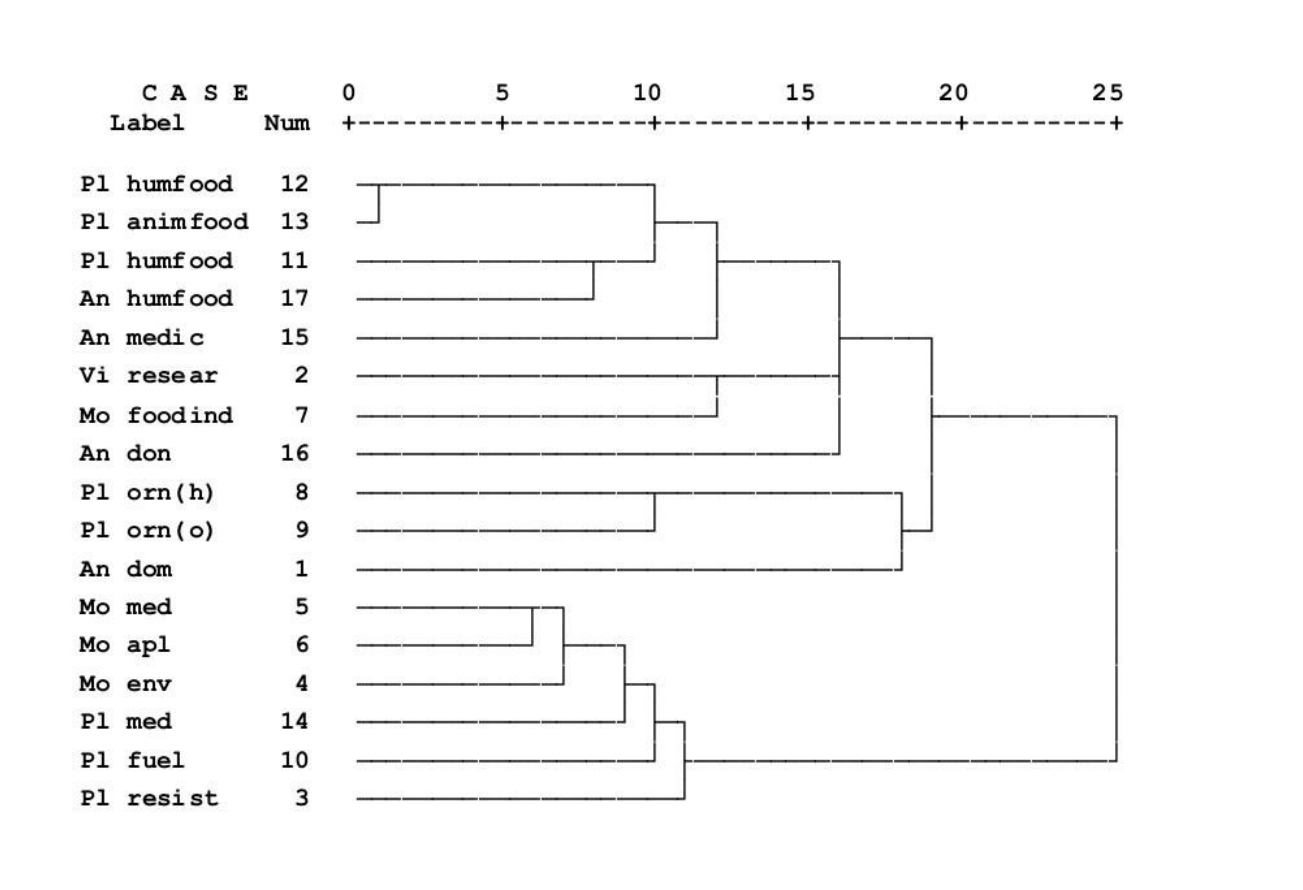
AMBROŽIČ-DOLINŠEK, Jana, ŠORGO, Andrej. The importance of education of future elementary teachers about modern biotechnology issues = Pomen izobraževanja bodočih učiteljev razrednega pouka o biotehnologiji. *Acta biol. slov.*. [Tiskana izd.], 2011, vol. 54, št. 2, str. 85-92. [COBISS.SI-ID 18848264]

# Myth: you can influence something simply by adding knowledge about GMOs




ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana. The relationship among knowledge of, attitudes toward and acceptance of genetically modified organisms (GMOs) among Slovenian teachers. *Electron. J. Biotechnol.*, oct. 2009, vol. 12, no. 3, str. 1-13. http://dx.doi.org/10.2225/vol12-issue4-fulltext-1, doi: 10.2225/vol12-issue4-fulltext-1. [COBISS.SI-ID 17230088],

# RQ: Can you treat GMOs as one item? (e. g. in Eurobarometer 2010)




ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana. Knowlege of, attitudes toward, and acceptance of genetically modified organisms among prospective teachers of biology, home economics, and grade school in Slovenia. *Biochemistry and molecular biology education*. [Print ed.], 2010, vol. 38, no. 3, str. 141-150. http://dx.doi.org/10.1002/bmb.20377, doi: 10.1002/bmb.20377. [COBISS.SI-ID 17617416],

# 2nd Cluster: What about emotions?

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Year 2009

564 questionnaires: 341 (60.5%) secondary school;
223 (39.5%) higher education.

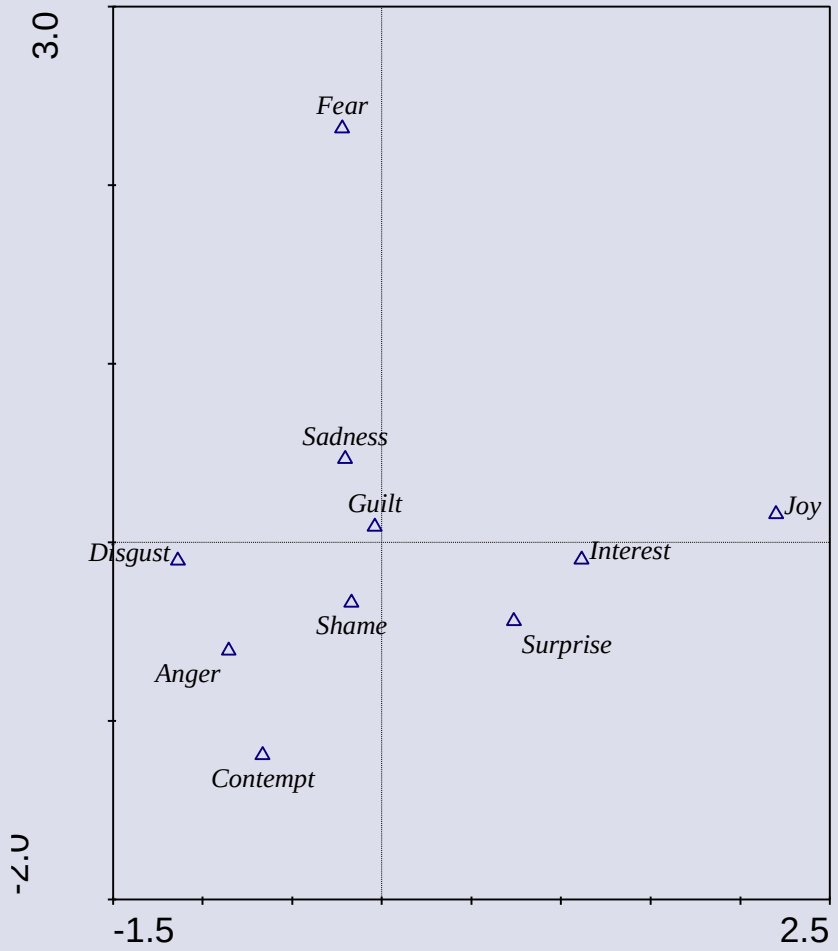
10 basic emotions (Izard)

ŠORGO, Andrej, AMBROŽIČ-DOLINŠEK, Jana, TOMAŽIČ, Iztok, JANŽEKOVIČ, Franc. Emotions expressed toward genetically modified organisms among secondary school students and pre-service teachers. *J. Balt. sci. educ.*, 2011, vol. 10, no. 1, str. 53-64. [COBISS.SI-ID 18312456],

# GMOs are most often connected with fear and disgust.

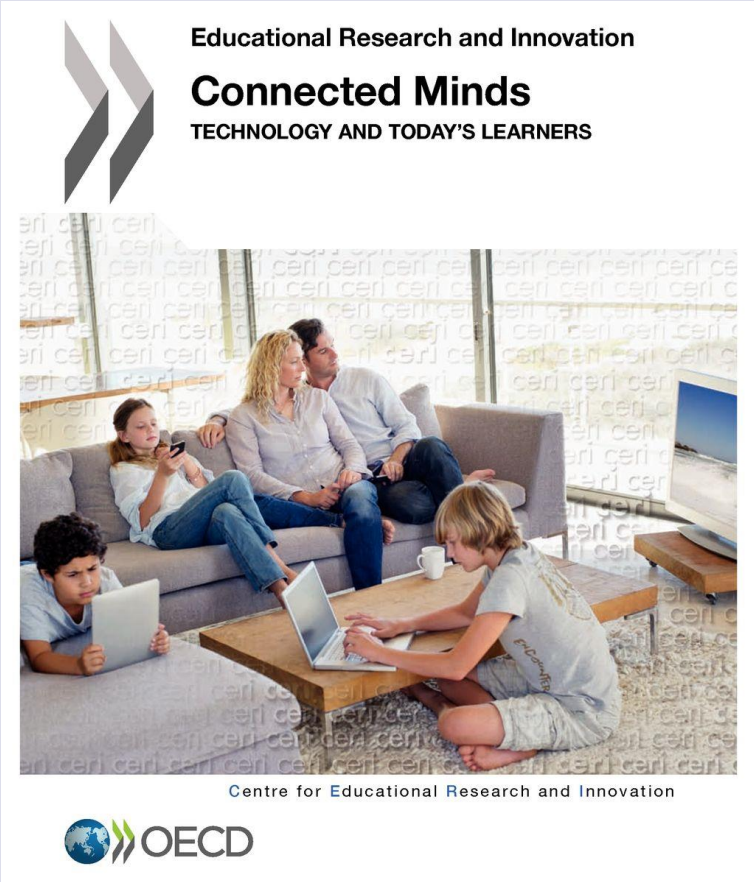
https://geneticliteracyproject.org/wp-content/uploads/2016/08/frankenfood-4-12-18-1.jpg

# Only interest and surprise are emotions connected with all types of GMOs.



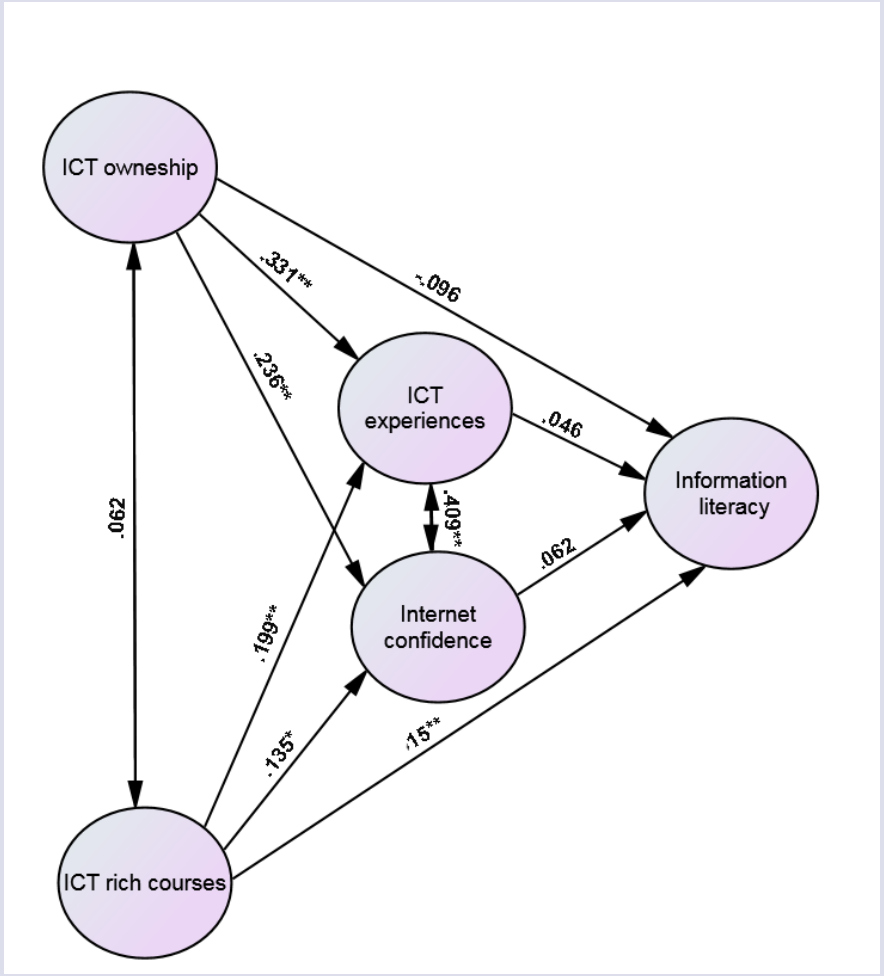

Šorgo, A., Dolinšek, J. A., Tomažič, I., & Janžekovič, F. (2011). Emotions expressed toward genetically modified organisms among secondary school students and pre-service teachers. *Journal of Baltic Science Education*, *10*(1).

# Myth: Digital natives (Prensky 2001) are because of heavy use of technologies information literate.




http://www.oecd-ilibrary.org/education/connected-minds_9789264111011-en

# Finding: Only good designed ICT rich courses were predictors of Information Literacy




Šorgo, Boh, Bartol in Dolničar. Attributes of digital natives as predictors of information literacy in higher education. British Journal of Educational Technology , 2017.

# Myth: longer daily use of digital tools is reflected in higher information literacy.

- students who were **online longer** had **lower IL knowledge** but a **higher opinion** of it.
- (The results confirm the **Dunning-Krueger effect**, whereby unskilled individuals overestimate their abilities, while skilled individuals underestimate their achievements. )
- **Solution:** students should be explicitly taught IL skills and corresponding behavior.

Dolenc, K., & Šorgo, A. (2020). Information literacy capabilities of lower secondary school students in Slovenia. *The Journal of Educational Research*, *113*(5), 335-342.

# Theory: Behavioral intentions are predictor of actual behavior

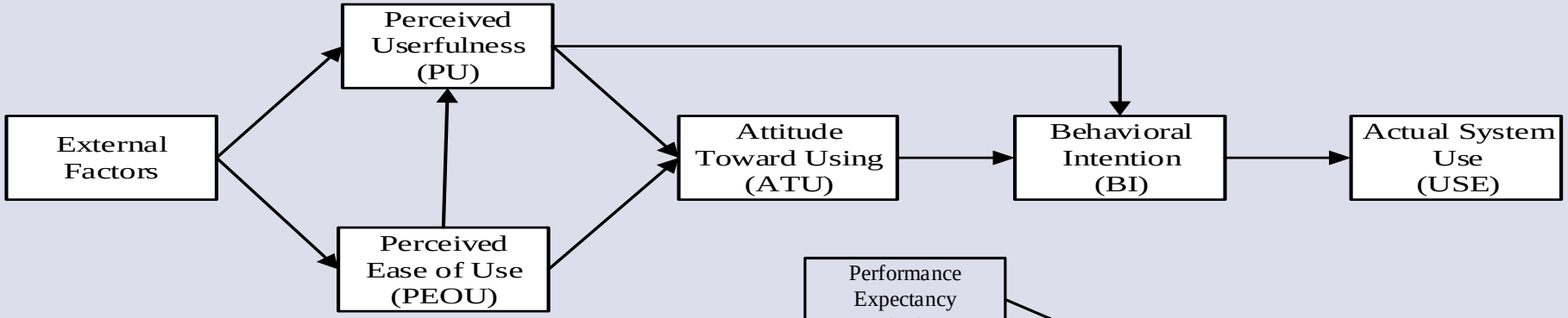



*Figure 1: Technology Acceptance Model (TAM)*

(Davis, Bagozzi, & Warshaw, 1989)

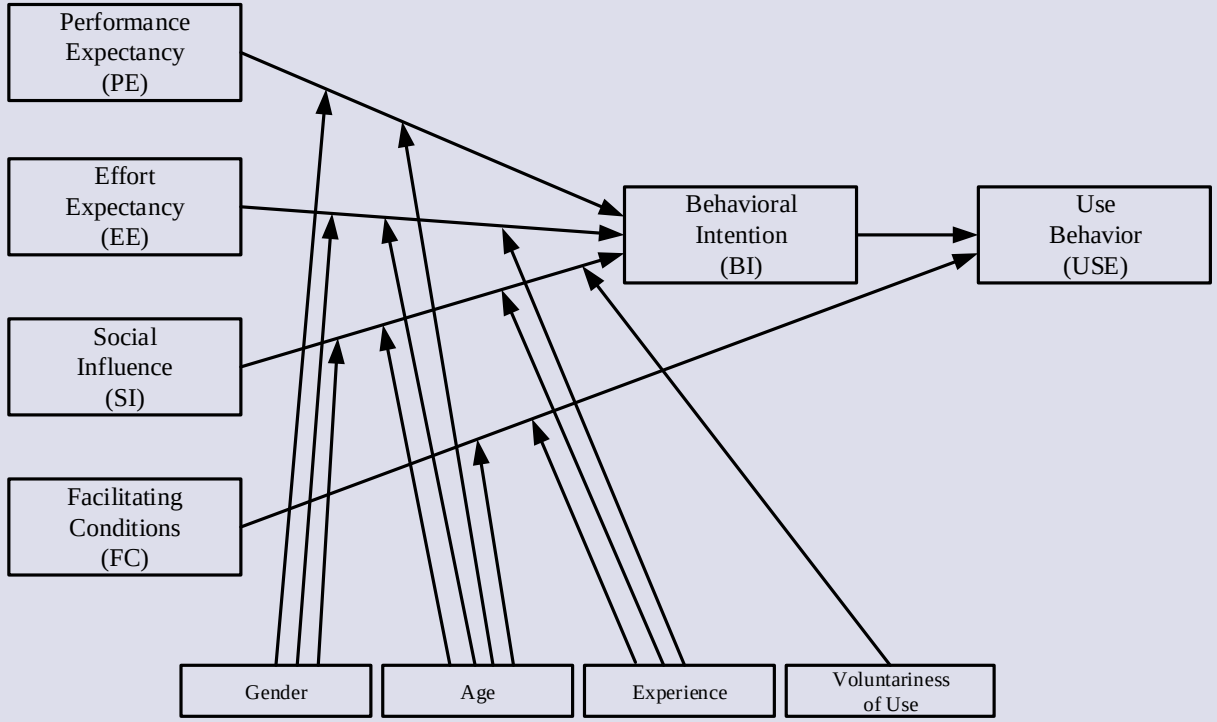
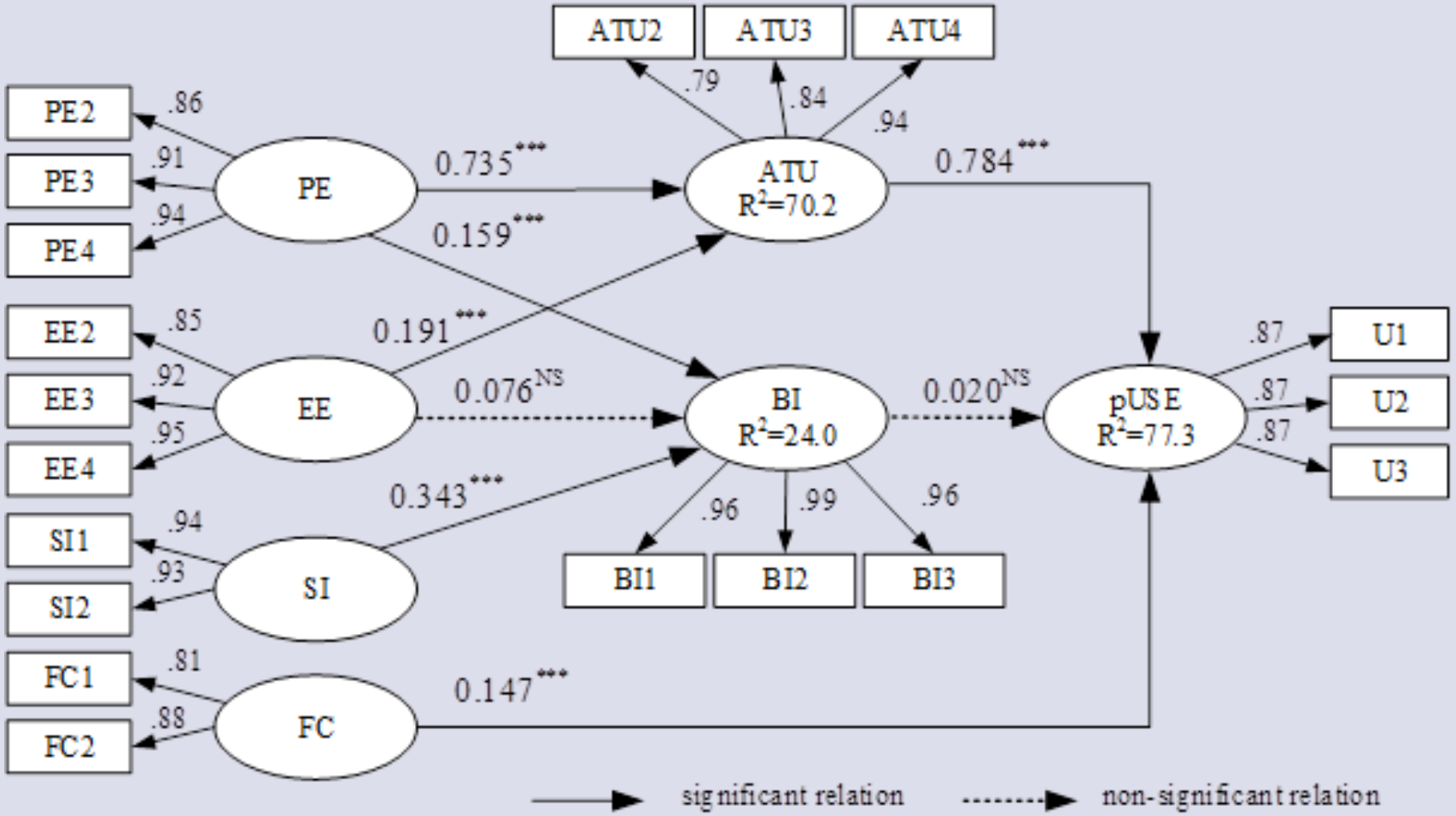



*Figure 2: Unified Theory of Acceptance and Use of Technology (UTAUT)*(Venkatesh et al., 2003)

# Intentions are not necesary predictors of a habit (Šumak and Šorgo, 2016)




Šumak, B., & Šorgo, A. (2016). The acceptance and use of interactive whiteboards among teachers: Differences in UTAUT determinants between pre-and post-adopters. *Computers in Human Behavior*, *64*, 602-620.

# Europe needs more Scientists and STEM educators:

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*Europe Needs More Scientists* (Gago et al., 2004),

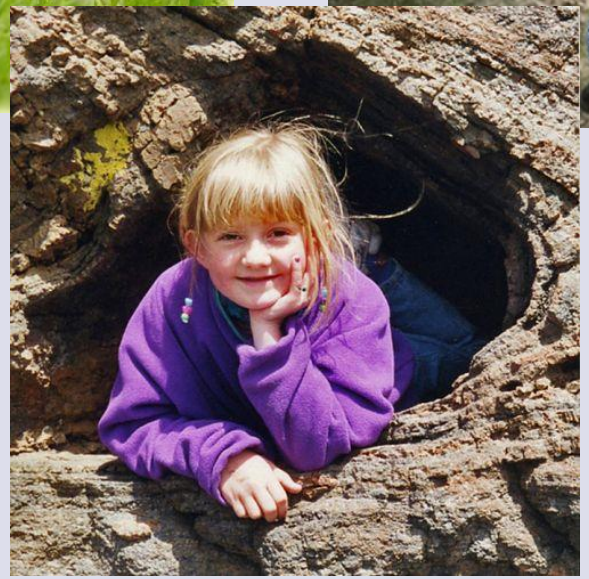
*Science Education Now: A Renewed Pedagogy for the Future of Europe* (EU, 2007),

*Evolution of Student Interest in Science and Technology Studies: Policy Report* (OECD, 2006),

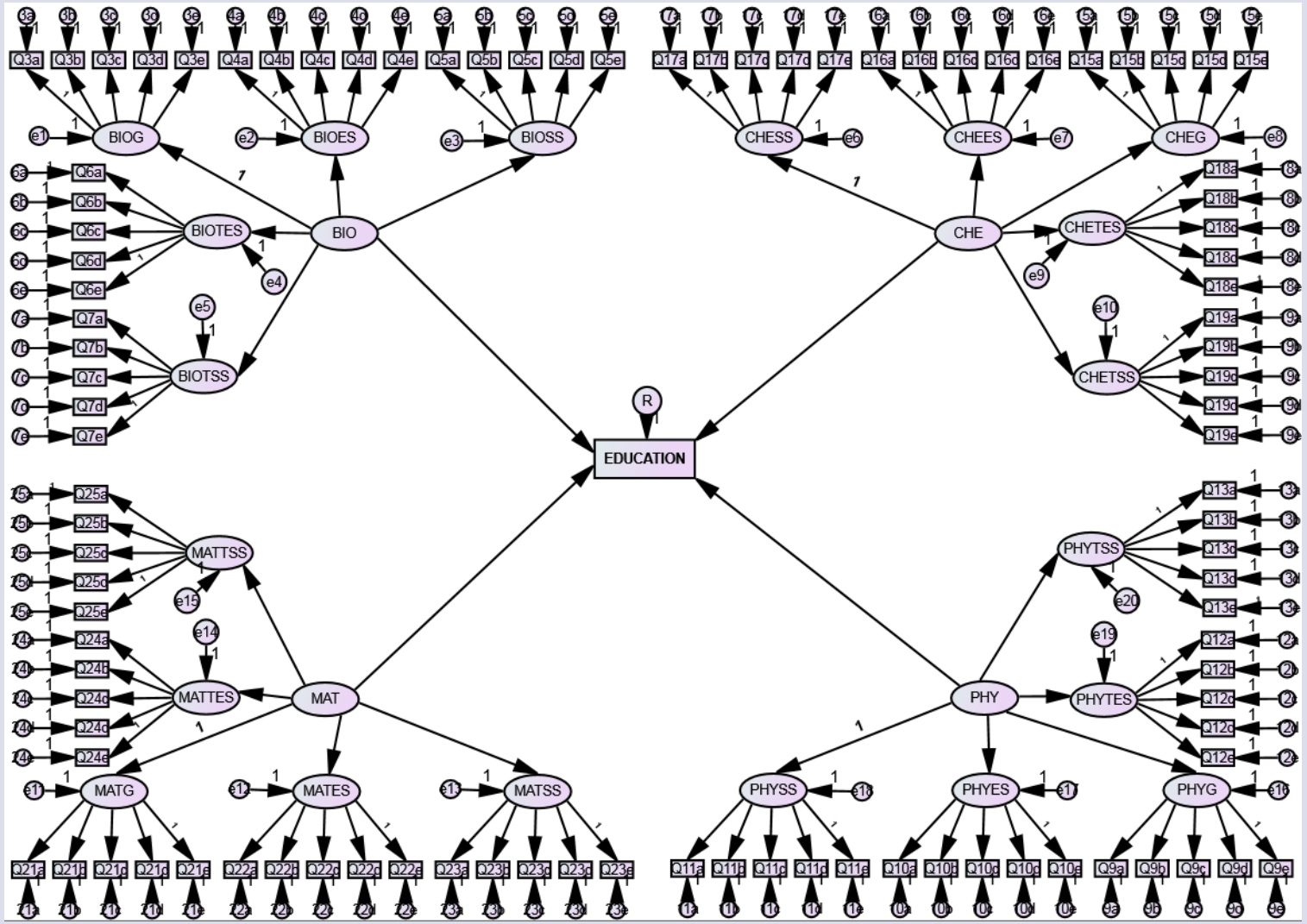
*Science Education in Europe: Critical reflections* (Osborne & Dillon, 2008),

*Education at a Glance 2015: OECD Indicators (OECD, 2015);*

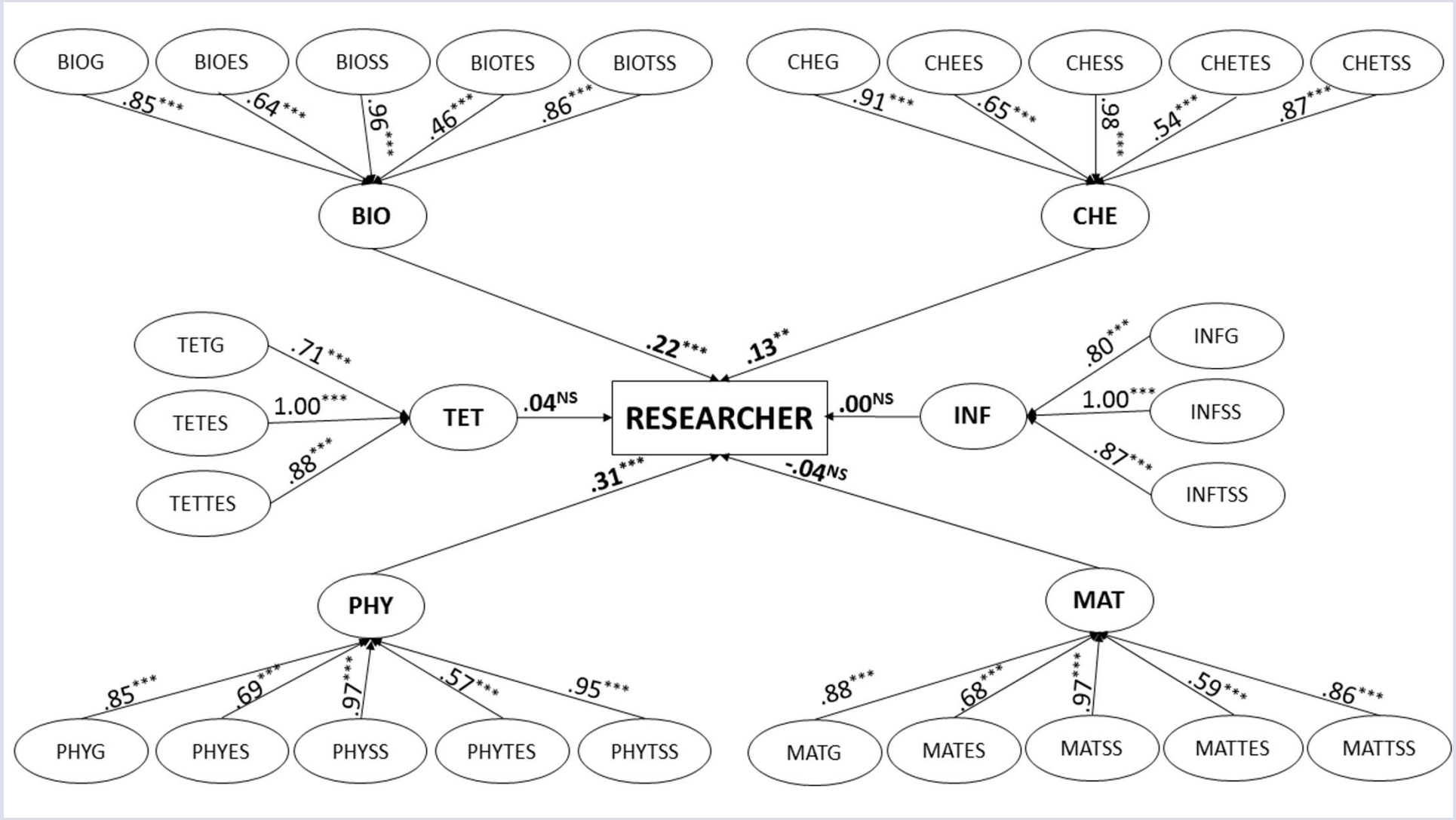
# Myth: work in classrooms can help in building interest in STEM disciplines



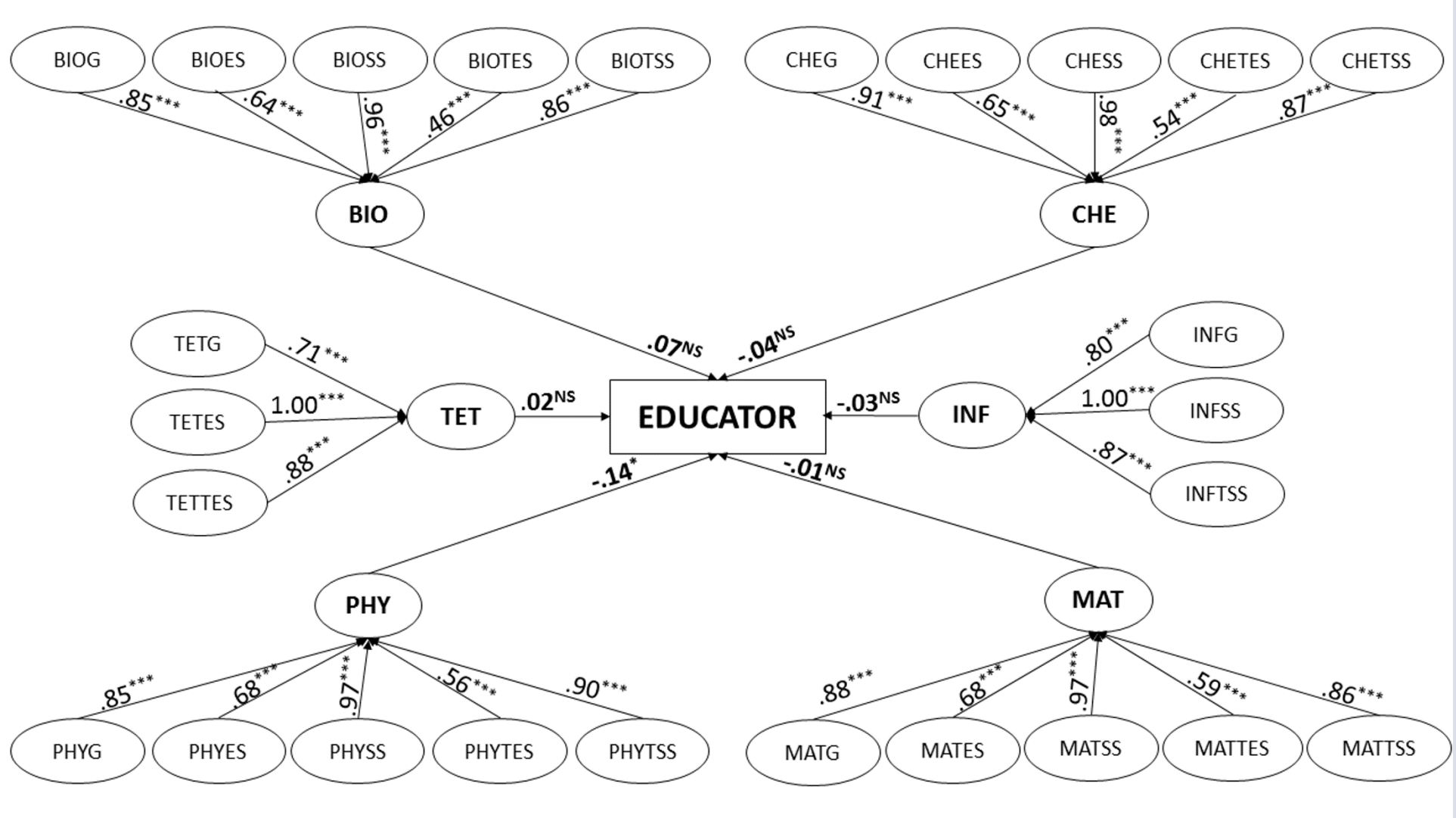
# Basic model: (Šorgo et al., JRST, 2018)



# Influence of STEM subjects on aspiration to become a researcher (Šorgo et al., 2018)



# Influence of STEM subjects on aspiration to become educator (Šorgo et al., 2018)

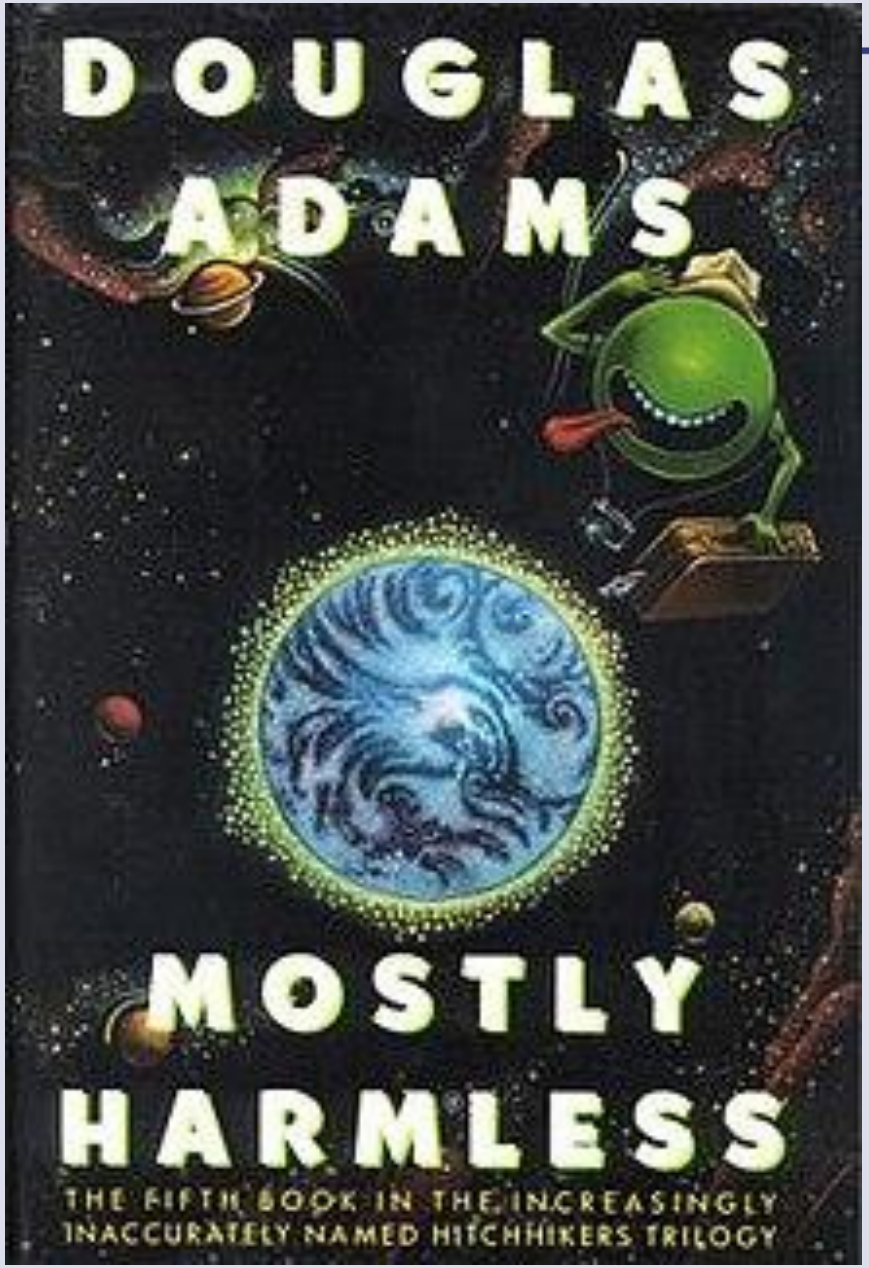


# Correlation between aspirations to work in science and aspirations to work in education is:

$$r = -0.03;\ p = 0.964$$

# Conclusion

Contents and classroom experiences of STEM subjects in elementary and secondary school are mostly harmless for career aspirations of students.

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# Breaking news: most recently published

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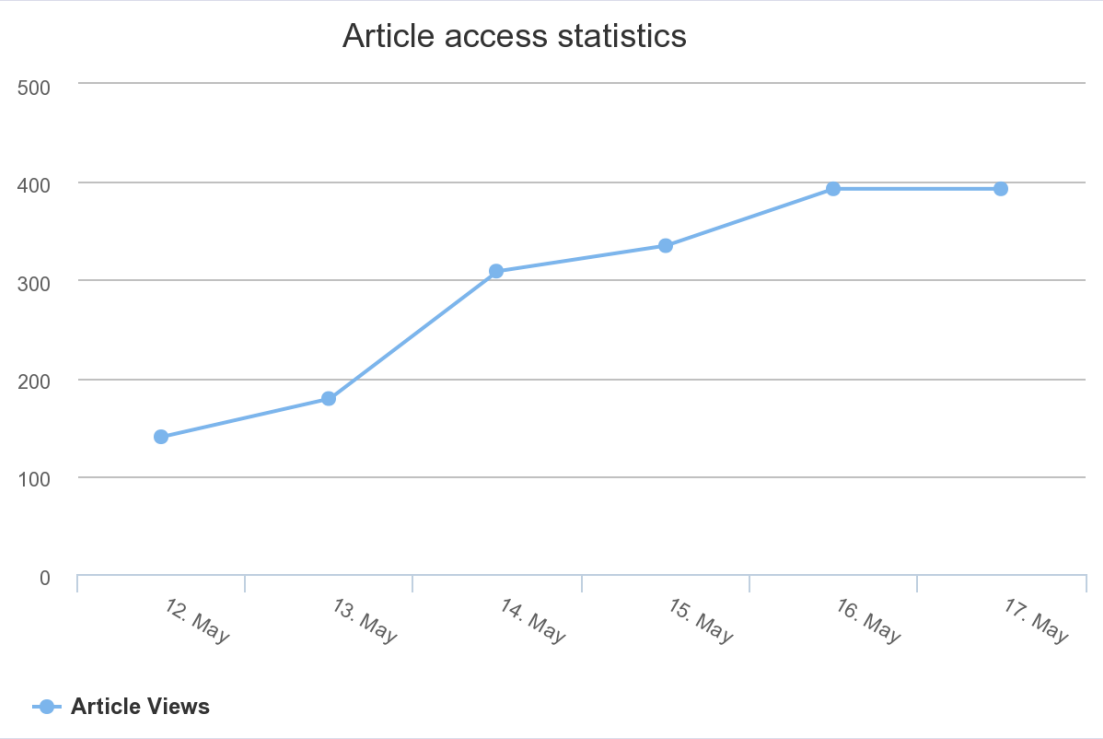
Kletečki N, Hruševar D, Mitić B, Šorgo A. Plants Are Not Boring, School Botany Is. *Education Sciences*. 2023; 13(5):489. https://doi.org/10.3390/educsci13050489



# How to avoid “cargo cult” research. Tips made by ChatGPT.

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Here are some practical tips for young researchers to help them avoid falling into the trap of "cargo cult" research and embrace a more rigorous scientific approach:

1. **Understand the scientific method**: Familiarize yourself with the principles of the scientific method, including formulating hypotheses, designing experiments, collecting data, analyzing results, and drawing conclusions. This foundation will guide your research and ensure a systematic and evidence-based approach.
2. **Emphasize critical thinking**: Cultivate a skeptical mindset and develop your critical thinking skills. Question assumptions, evaluate evidence objectively, and consider alternative explanations for your observations. Avoid confirmation bias by actively seeking evidence that challenges your hypotheses.
3. **Formulate testable hypotheses**: Clearly define your research questions and formulate hypotheses that are specific, testable, and falsifiable. This will guide your experimental design and allow you to draw meaningful conclusions from your data.
4. **Design robust experiments**: Take the time to design experiments carefully, ensuring they are well-controlled, appropriately powered, and capable of addressing your research questions. Consider potential confounding factors and control for them to minimize bias.
5. **Collect and analyze reliable data**: Employ rigorous data collection methods and ensure the quality and integrity of your data. Use appropriate statistical analysis techniques to draw valid conclusions from your data and consider consulting with a statistician if needed.

# How to avoid “cargo cult” research. Tips made by ChatGPT.

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1. **Engage in peer review**: Seek feedback and engage in discussions with your peers and mentors. Peer review provides valuable insights, helps identify potential flaws in your methodology or reasoning, and improves the overall quality of your research.
2. **Be transparent and reproducible**: Clearly document your methods, procedures, and data analysis steps. Make your data and methodologies openly available whenever possible to enable reproducibility and scrutiny from the scientific community.
3. **Stay up-to-date with the literature**: Continuously read and stay informed about the latest research in your field. This helps you build a solid foundation of knowledge, avoid reinventing the wheel, and ensures your work is contributing to the existing body of knowledge.
4. **Seek collaboration and mentorship**: Collaborate with experienced researchers and seek guidance from mentors who can provide valuable insights and help you navigate the research process effectively. Their expertise can assist in avoiding common pitfalls and improving the quality of your work.
5. **Embrace intellectual honesty**: Be open to revising your hypotheses and changing your conclusions based on the evidence. Accept that negative results are valuable contributions to scientific knowledge. Avoid clinging to preconceived ideas or selectively reporting only data that supports your initial assumptions.

By following these guidelines, young researchers can foster a more rigorous and scientific approach to their work, reducing the risk of engaging in "cargo cult" research practices and contributing to the advancement of knowledge in their respective fields.

# A suggestion: Since sooner or later many will use AI, read this work beforehand

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Sorgo, A., Vavdi, M., Cigler, U., & Kralj, M. (2015). Opportunity makes the cheater: High school students and academic dishonesty. *CEPS Journal*, *5*(4), 67-87.

https://files.eric.ed.gov/fulltext/EJ1128951.pdf

# Suggestions:

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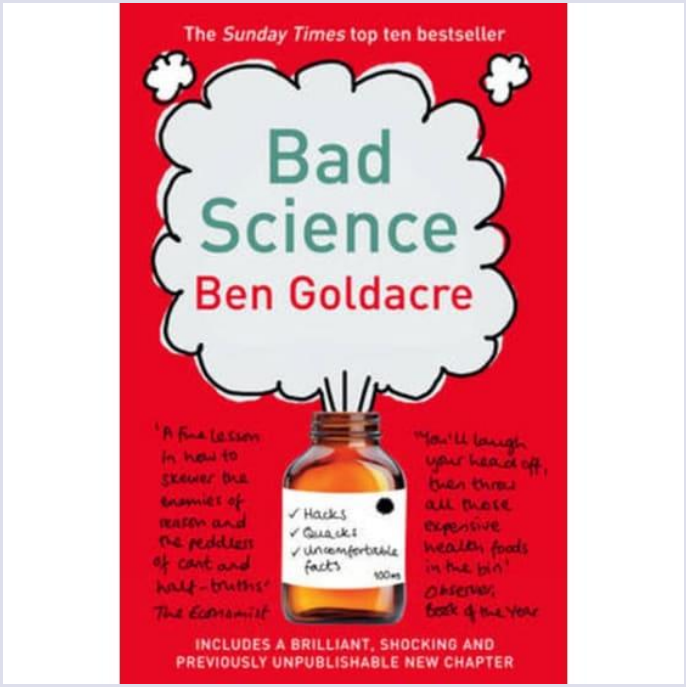
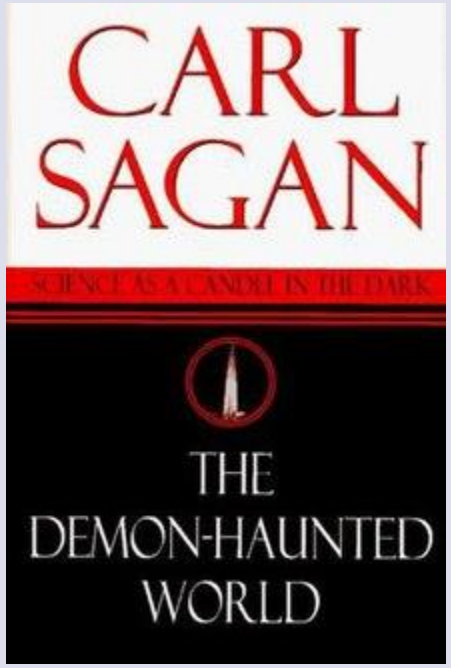
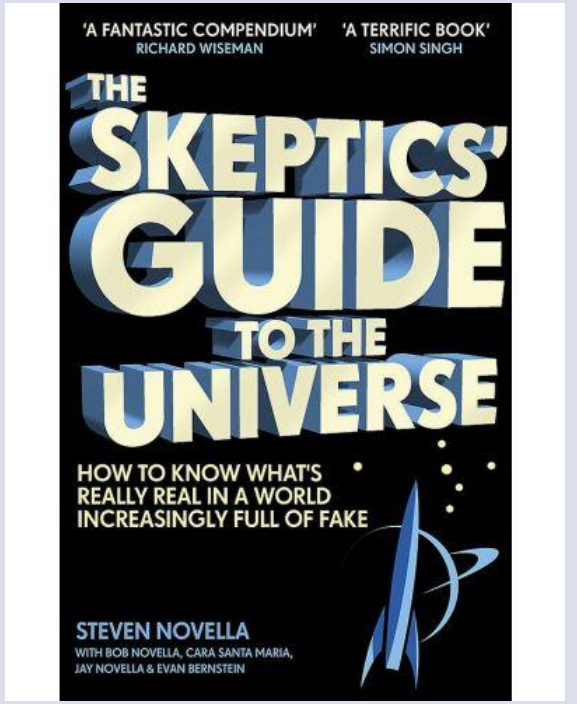
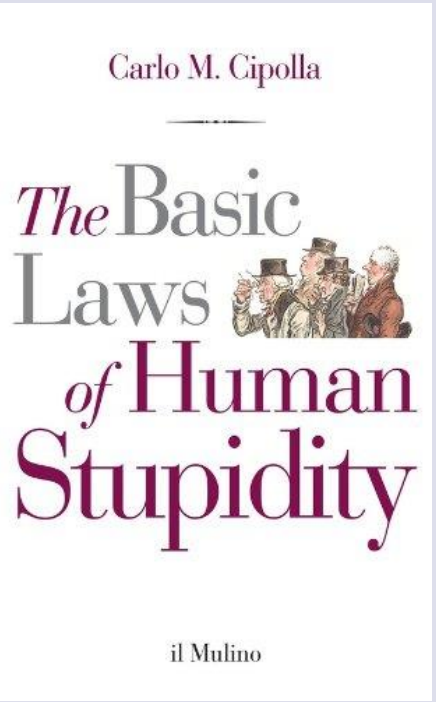
- Become a curious sceptic who realises that brains are not made to search for truth, but to solve problems.
- Read, read, and read,
- Not be afraid to enter hell of statistics trying to understand it.



# Thank you

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