Introducing contemporary research topics into school science programs

Impact on students' motivation to become scientists

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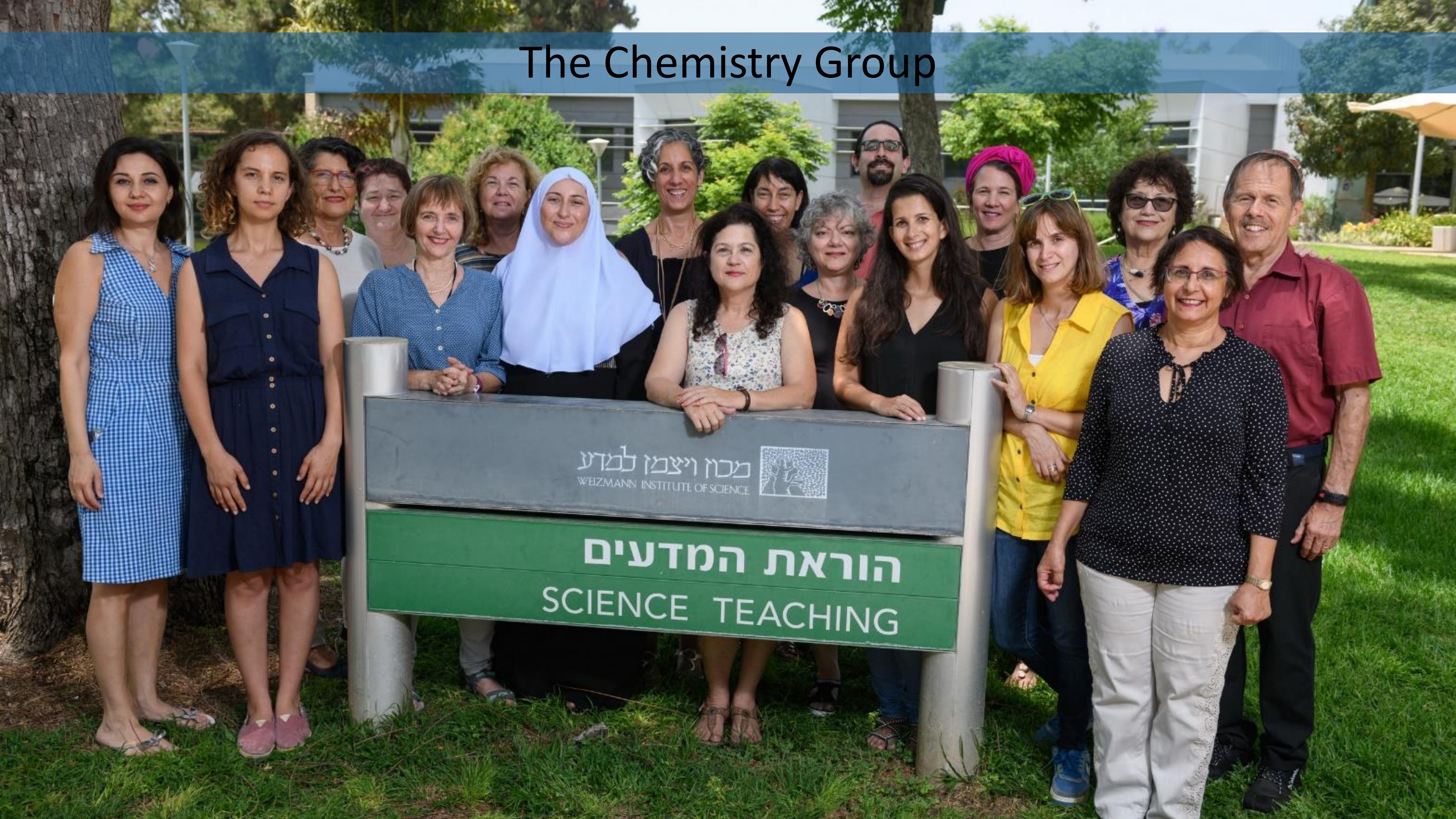
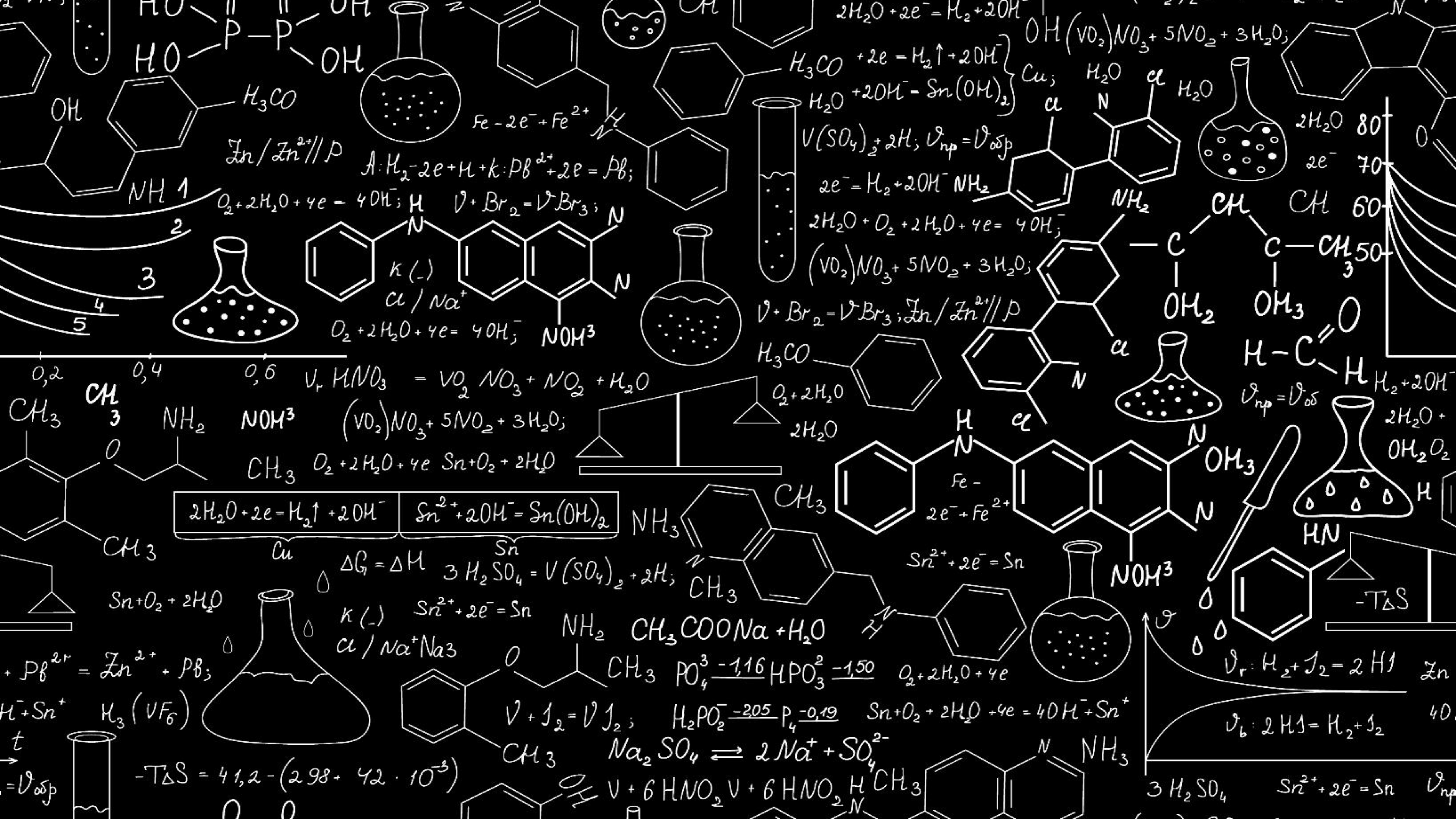
The Chemistry Group



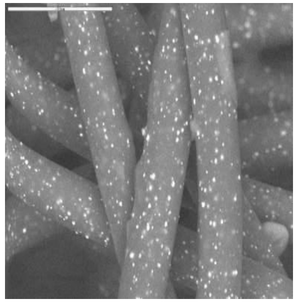
What did you learn in chemistry lessons in school?

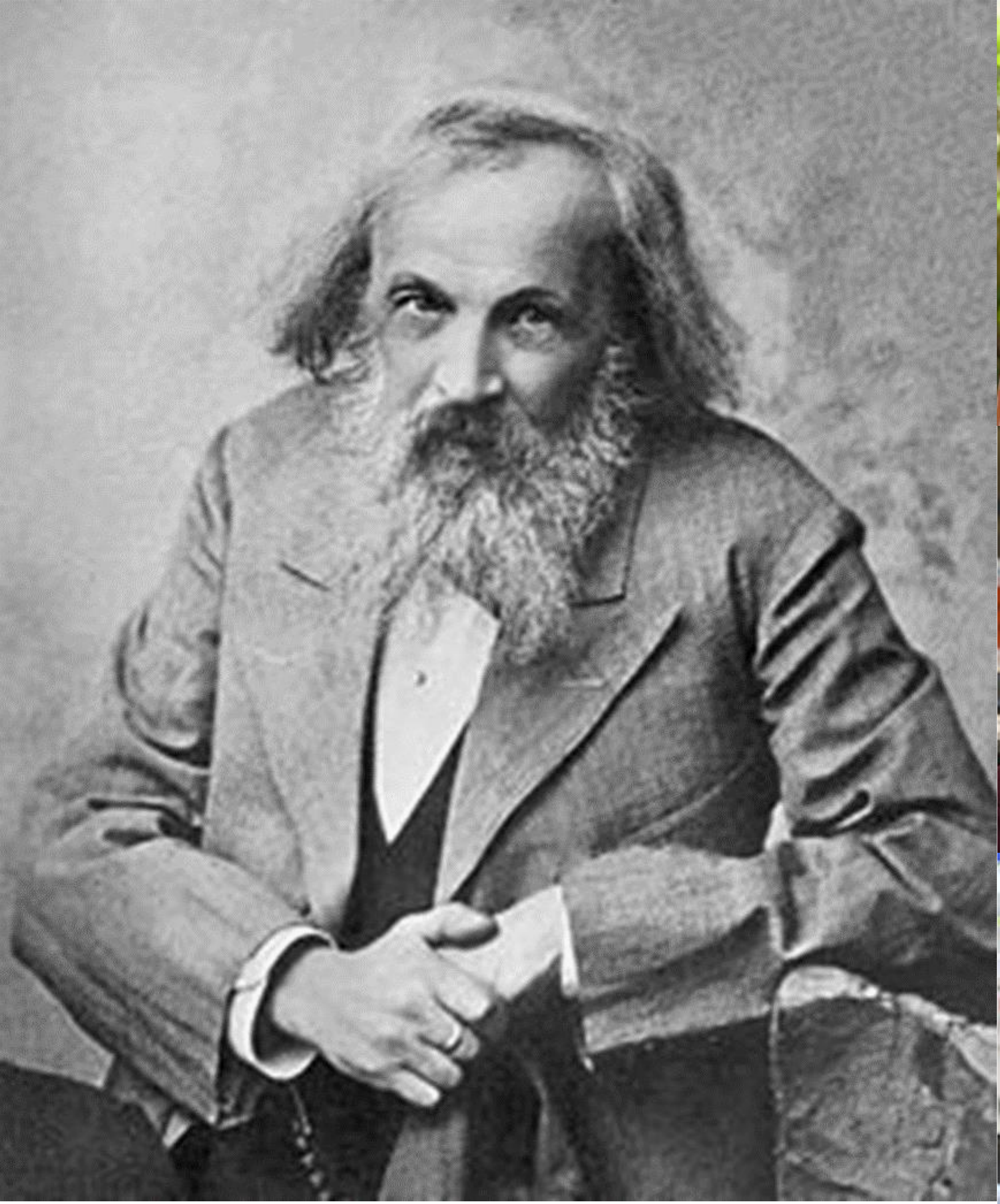


2H2O + 2e⁻ = H2 + 2OH⁻
(VO2)NO3 + 5NO2 + 3H2O;
H3CO
+2e = H2↑ + 2OH⁻
H2O +2OH⁻ = Sn(OH)2
Cu;
Fe - 2e⁻ + Fe2+
Zn/Zn2+//P
A: H2 - 2e + H + K: Pb2+ + 2e = Pb;
V(SO4)2 + 2H; Vnp = Vобр
2e⁻ = H2 + 2OH⁻ NH2
O2 + 2H2O + 4e = 4OH⁻;
V + Br2 = VBr3;
2H2O + O2 + 2H2O + 4e = 4OH⁻;
K(-)
Cl / Na+
O2 + 2H2O + 4e = 4OH⁻;
NOH3
V + Br2 = VBr3; Zn/Zn2+//P
0,2
0,4
0,6
Vr HNO3 = VO2 NO3 + NO2 + H2O
CH3
NH2
NOH3
(VO2)NO3 + 5NO2 + 3H2O;
O2 + 2H2O + 4e Sn + O2 + 2H2O
2H2O + 2e = H2↑ + 2OH⁻
Sn2+ + 2OH⁻ = Sn(OH)2
Cu
Sn
ΔG = ΔH
3 H2SO4 = V(SO4)2 + 2H;
Sn2+ + 2e⁻ = Sn
Sn + O2 + 2H2O
K(-)
Cl / Na+ Na3
CH3COONa + H2O
PO4 3 -1,16 HPO3 2 -1,50
O2 + 2H2O + 4e
Zn2+ + Pb;
H3(VF6)
V + I2 = VI2;
H2PO2 -205 P4 -0,19
Sn + O2 + 2H2O + 4e = 4OH⁻ + Sn+
Na2SO4 ⇄ 2Na+ + SO4 2-
-TΔS = 41,2 - (298 · 42 · 10⁻³)
V + 6 HNO2 V + 6 HNO2
3 H2SO4
Sn2+ + 2e⁻ = Sn
Vr: H2 + I2 = 2HI
Vb: 2HI = H2 + I2
Vnp = Vоб
-TΔS
H2 + 2OH⁻
2H2O
OH2O2
80
70
60
50

Chemistry is continually being developed through research

- Organic chemistry
- Solid state
- Bio-chemistry, biomaterials
- Colloids and nanochemistry
- Medicinal chemistry
- Catalysis
- Analytical chemistry
- Sustainability, global challenges
- Computational chemistry





Dmitri Mendeleev, 1834-1907

Why should we bridge this gap?

(Blonder & Dinur, 2011; Hutchinson, Bodner, and Bryan, 2011; Blonder & Sakhnini, 2012; Delgado, Stevens, Shin, and Krajcik, 2015)

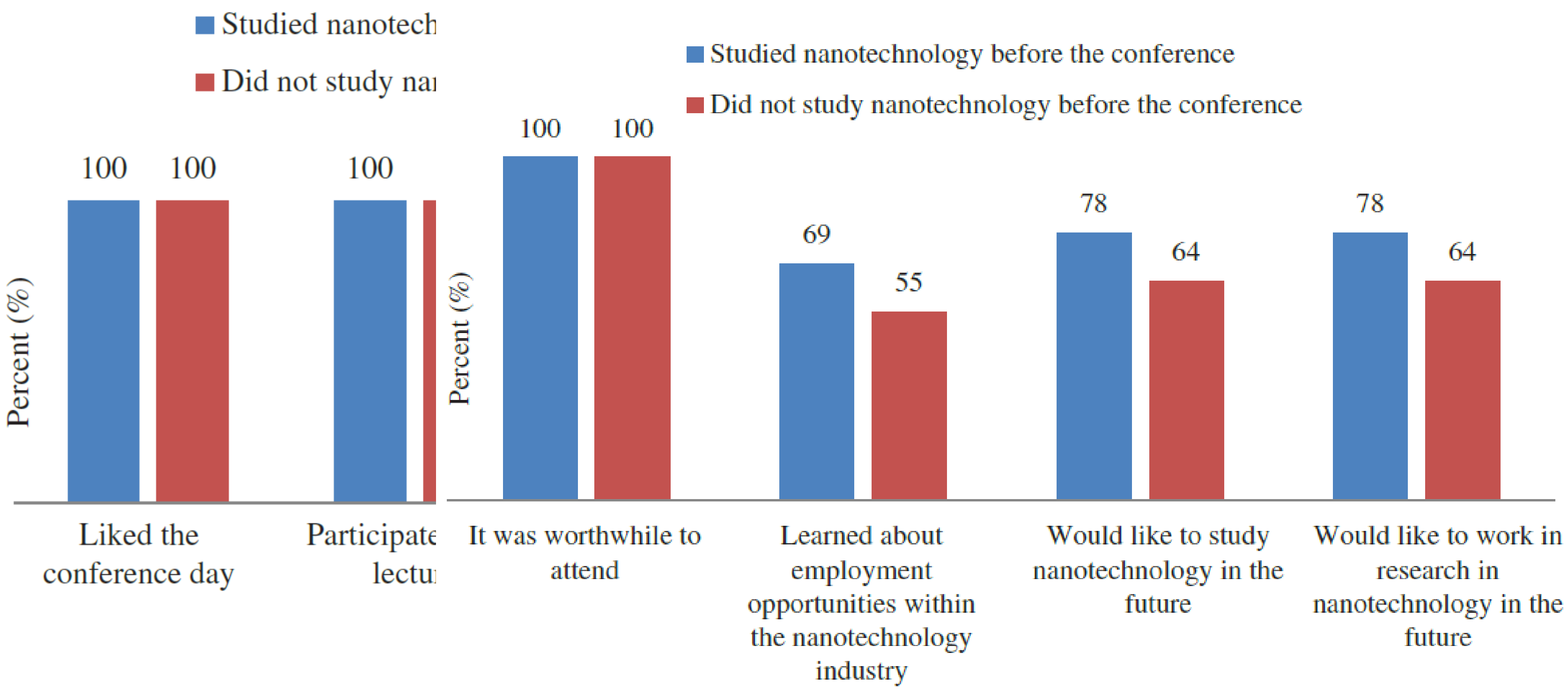
How can we bridge this gap?

Blonder, Rap, & Benny, (2020). Research visits as nuclei for school programs. In Parchmann, Simon, & Apotheker (Eds.). *Engaging Learners with Chemistry: projects to stimulate interest and participation* (pp. 135-153). Royal Chemistry Society.

Stamer, David, Höffler, Schwarzer, & Parchmann. (2021) Authentic insights into science: scientific videos used in out-of-school learning environments. *International Journal of Science Education* 43:6, pages 868-887.

Blonder, R., & Sakhnini, S. (2015). The making of nanotechnology: exposing high-school students to behind-the-scenes of nanotechnology by inviting them to a nanotechnology conference. *Nanotechnology Reviews, 4(*1), 103-116.

Participate in a scientific conference



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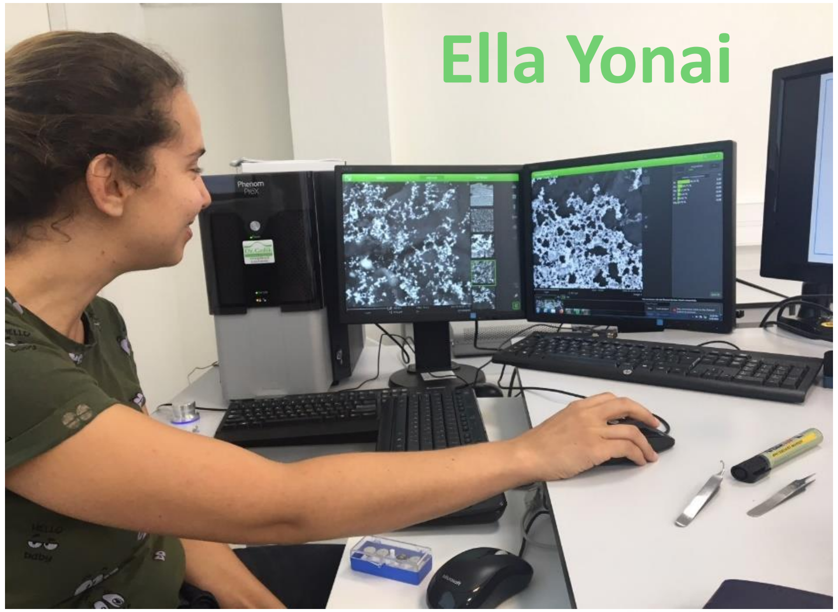
Outreach activities: The example of the Scanning Electron Microscope (SEM)



- A method for characterization for scientific research (Smith & Oatley, 1955)

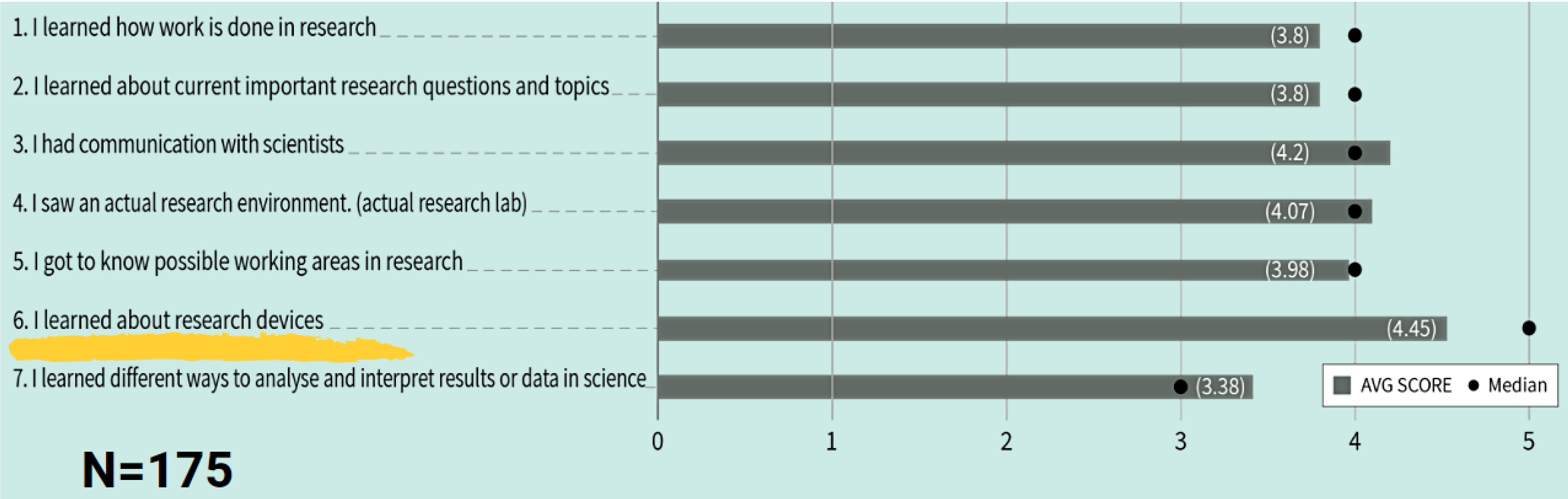
- SEM has the ability to reach a nanoscale (10^{-9}m) resolution - Imaging
- EDS abilities - Element identification

- Characterization methods (such as a SEM) is a fertile concept to discuss contemporary nanoscale science and hold a discussion with scientists

Phenom ProX Desktop SEM

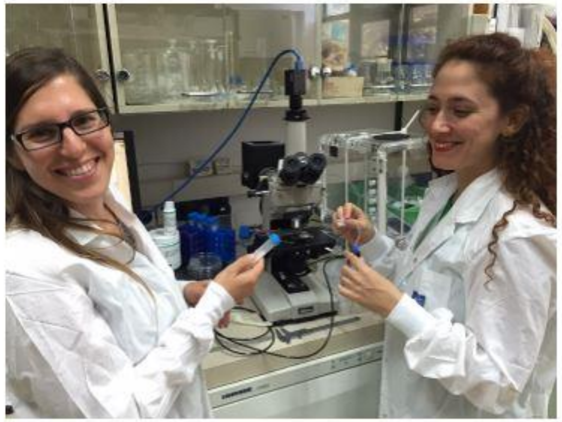
- The high-performance desktop SEM
- Magnification range up to 150,000x
- Fully integrated EDS solution
- Optional SED

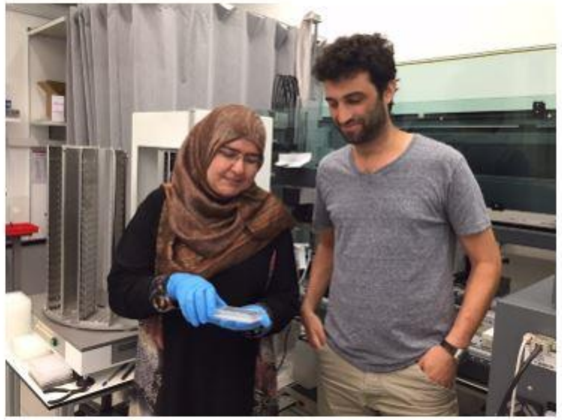
The influence of the SEM activity:
Perceived authenticity



N=175

Joining a research lab → Job Shadow






SciCar

Addressing Attractivness of
Science **Car**eer Awareness

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European Commission

TWINNING

Blonder, R., Rap, S. & Benny, N. (2020). Research visits as nuclei for school programs. In I., Parchmann, S. Simon, & J. Apotheker (Eds.). *Engaging Learners with Chemistry: projects to stimulate interest and participation* (pp. 135-153). Royal Chemistry Society. doi: 10.1039/9781788016087

Job Shadow @ Weizmann

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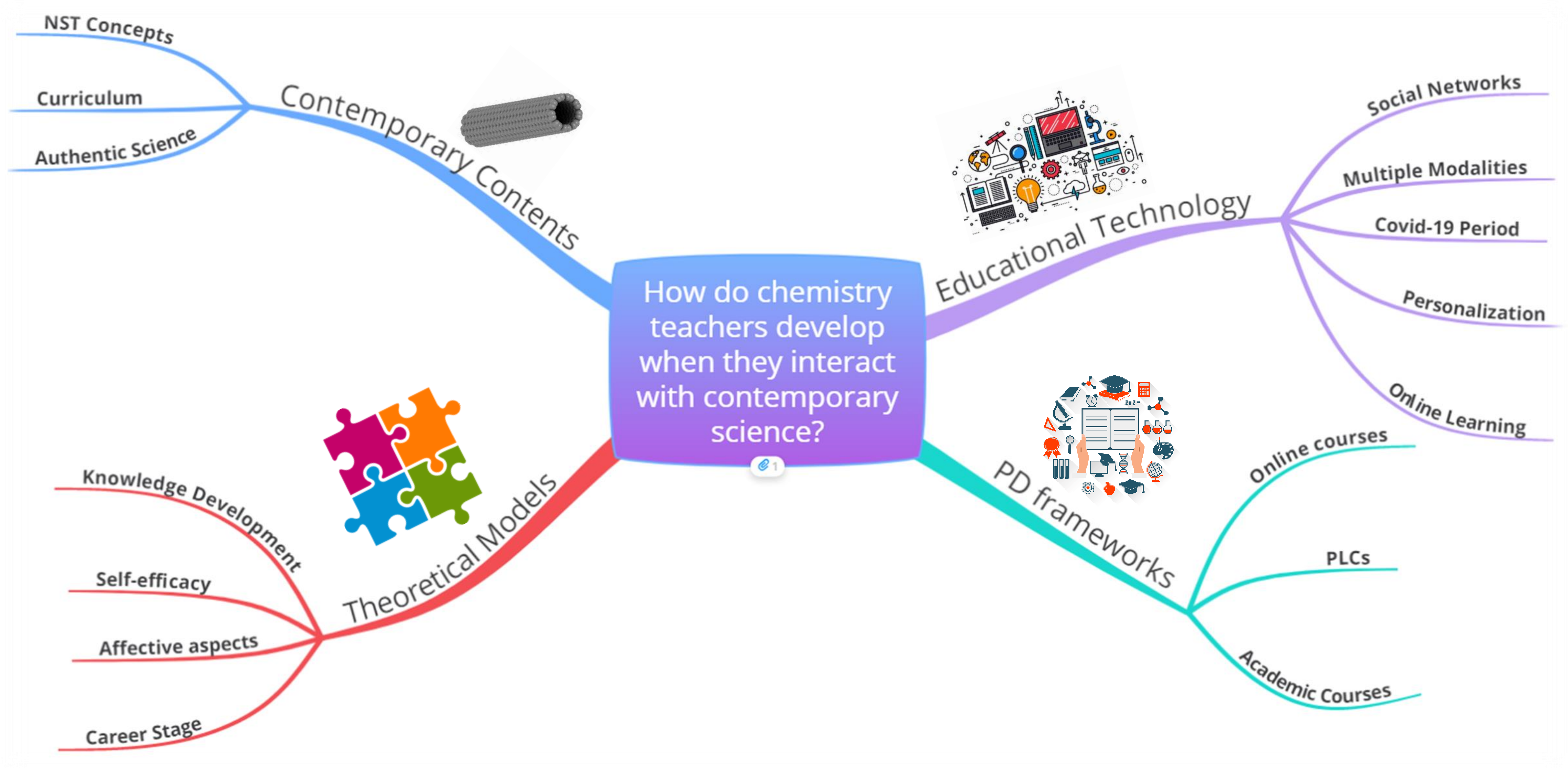
TWINNING

Can formal education bridge the gap?

The Blonder's Research Group

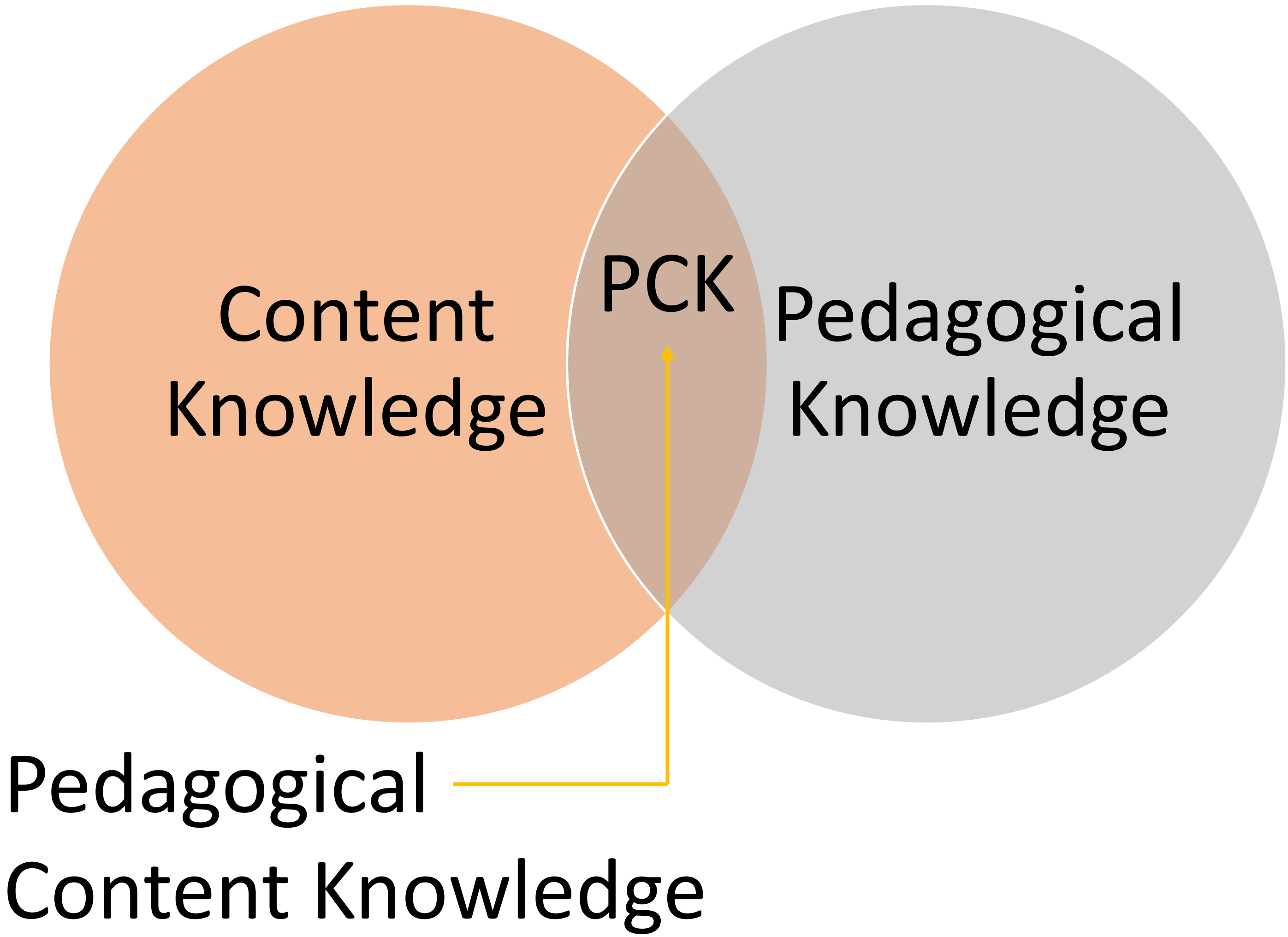


The McKinsey report: Barber, M., & Mourshed, M. (2007). *How the world's best-performing school systems come out on top.*

1. The quality of an education system cannot exceed the quality of its teachers
2. The only way to improve outcomes is by improving instruction

Teachers have a central role

Teachers’ knowledge is complex



Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Courses for teachers: Updating their Content Knowledge (CK)

The Story of Nanomaterials in Modern Technology: An Advanced Course for Chemistry Teachers

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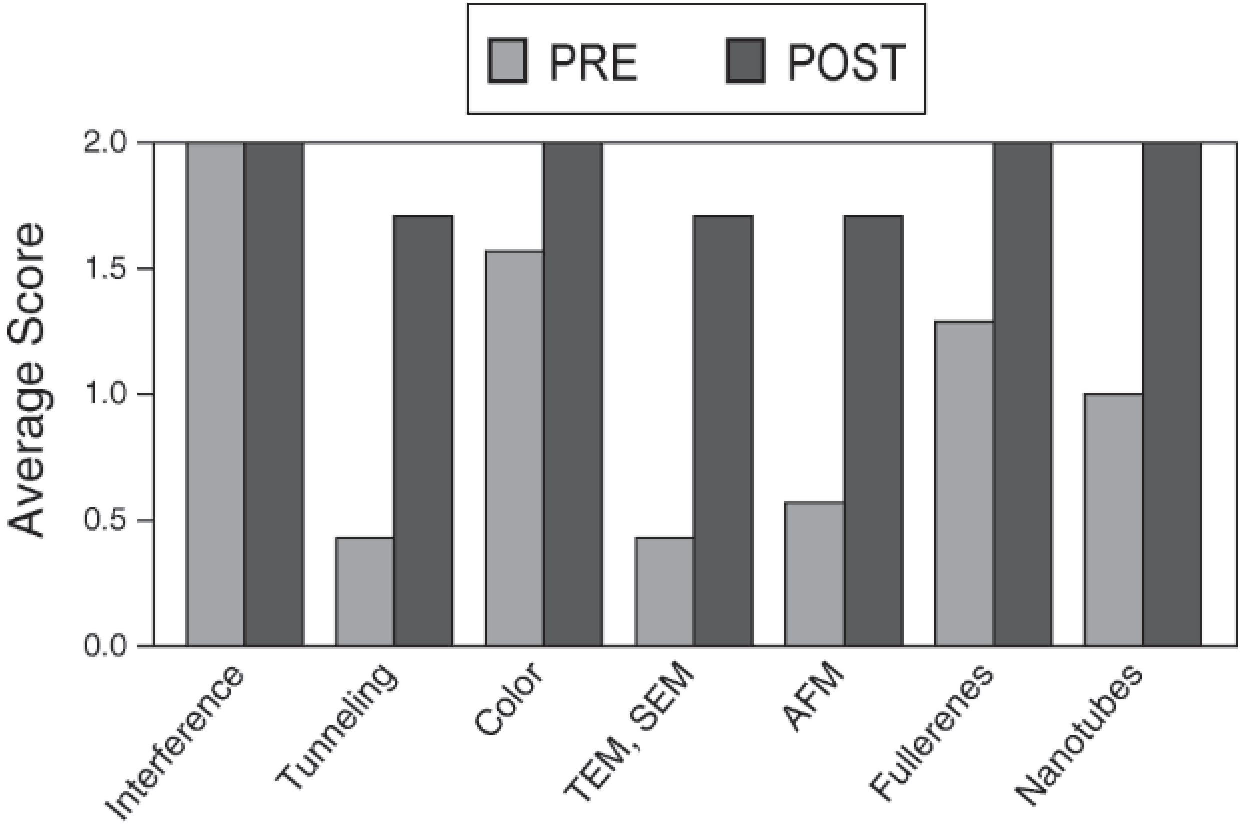
Blonder, R. (2011). The story of nanomaterials in modern technology: An advanced course for chemistry teachers. *Journal of Chemical Education, 88*, 49-52. https://doi.org/10.1021/ed100614f

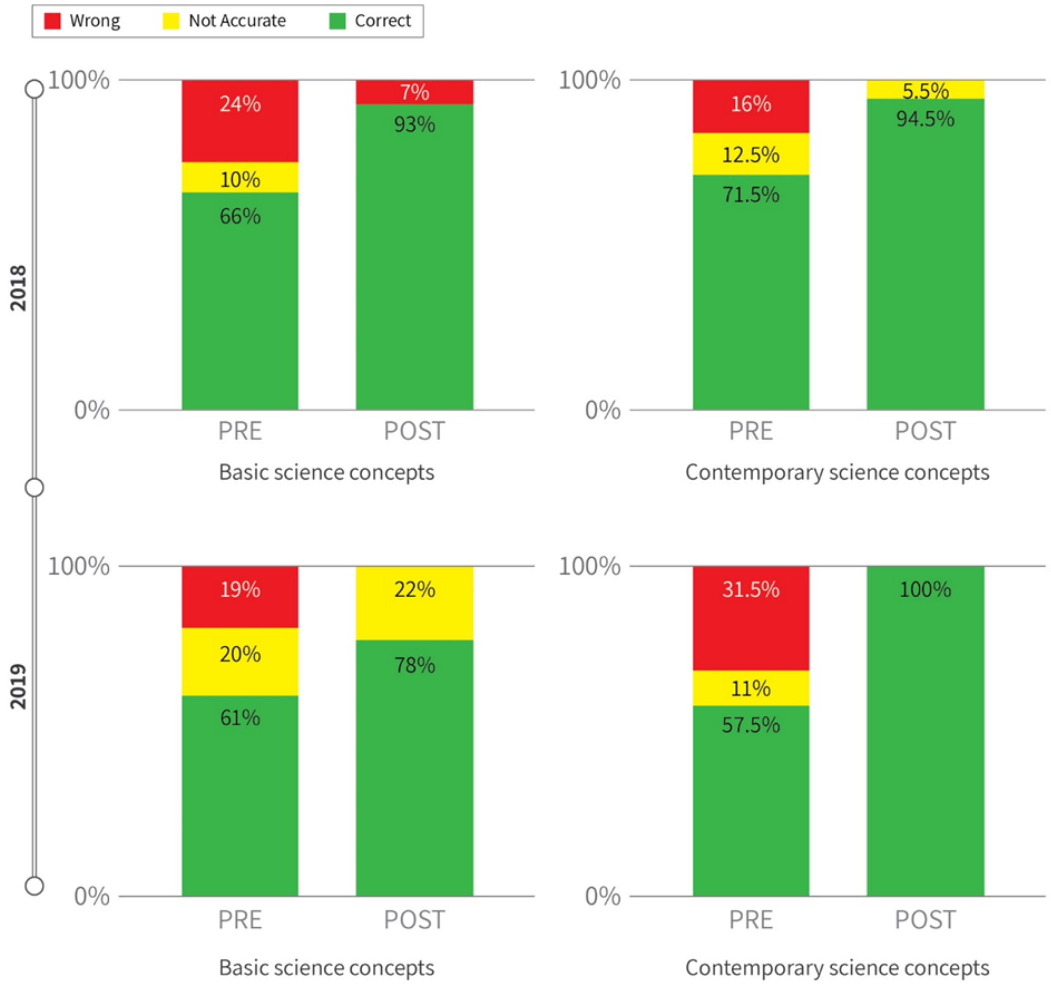
Teachers improved their CK of contemporary science (nanotechnology)



Blonder, R. (2011). The story of nanomaterials in modern technology: An advanced course for chemistry teachers. *Journal of Chemical Education, 88*, 49-52. https://doi.org/10.1021/ed100614f

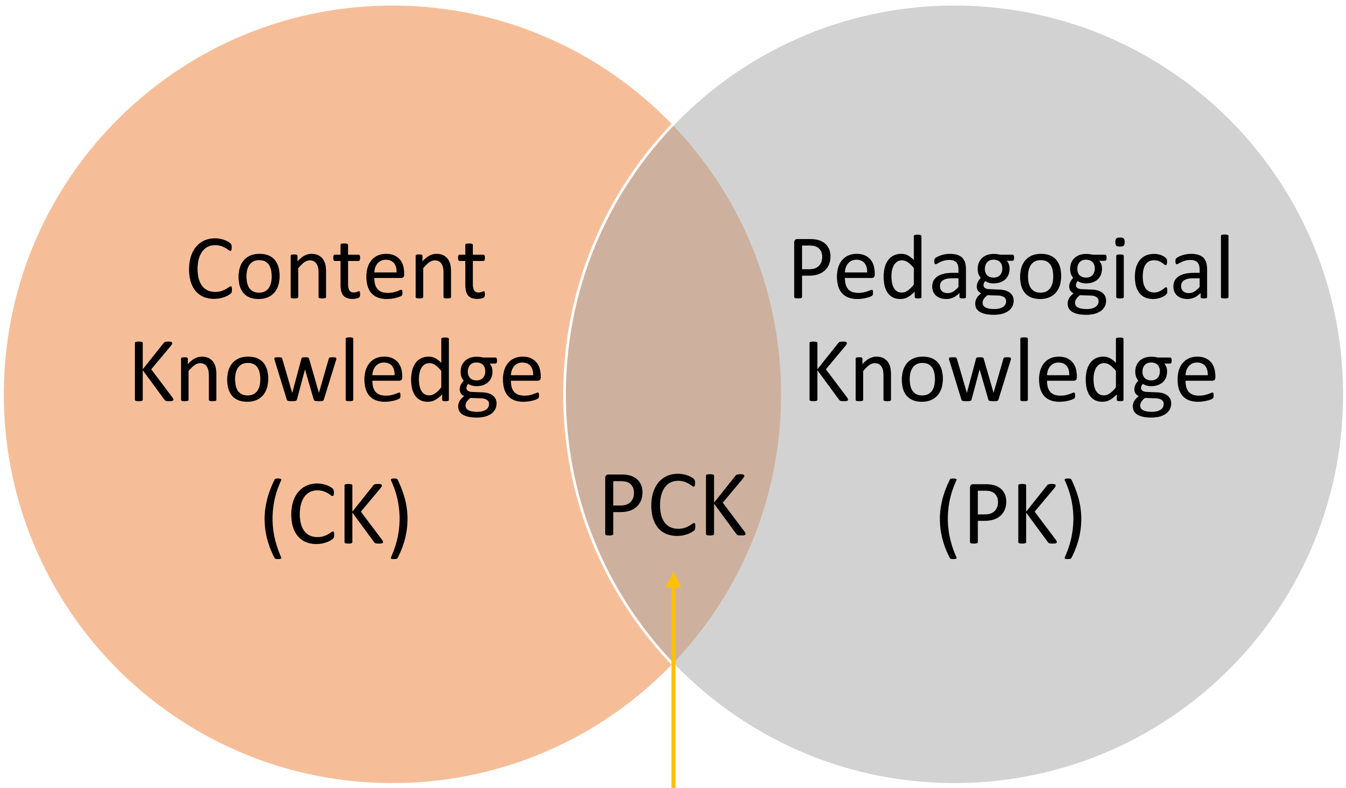
Feldman-Maggor, Y., Tuvi-Arad, I., & Blonder, R. (2022). Development and Evaluation of an Online Course on Nanotechnology for the Professional Development of Chemistry Teachers. *International Journal of Science Education*

Teachers improved their CK of contemporary science (Electron Microscopy)



Yonai & Blonder (submitted). A Scanning Electron Microscope (SEM) course for teachers: Exploring teachers' roles in an authentic science environment. *Journal of Science Teacher Education.*

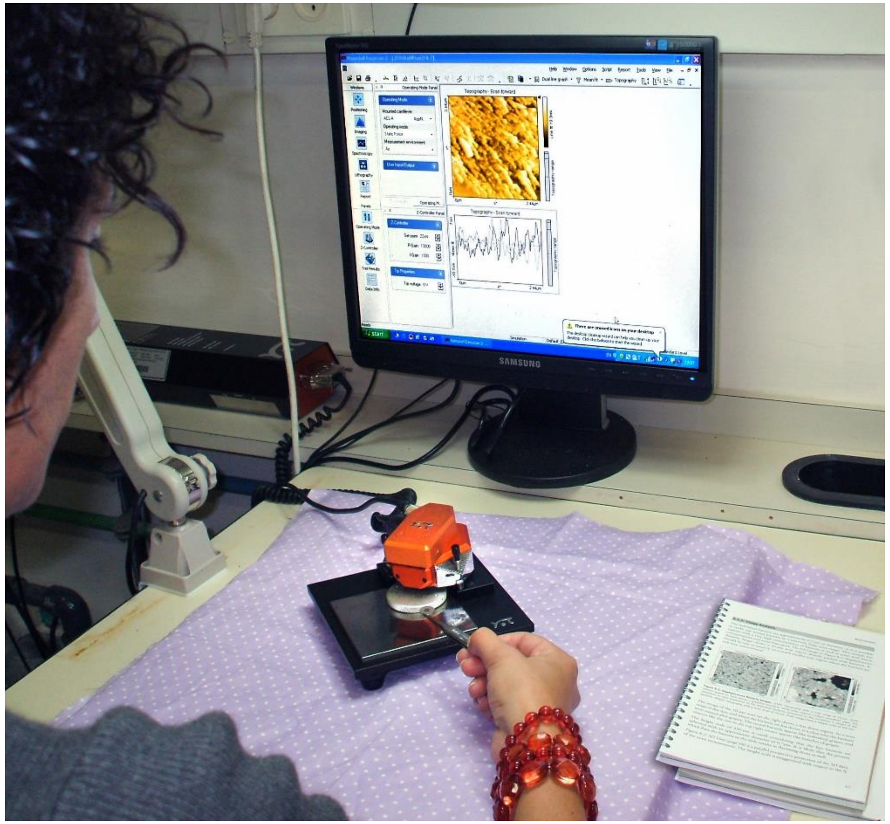
CK is not enough…

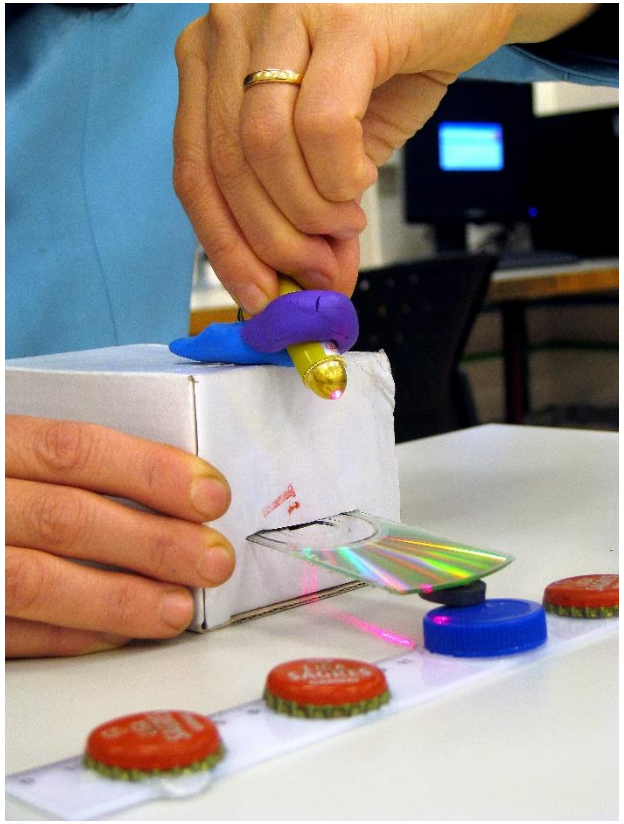


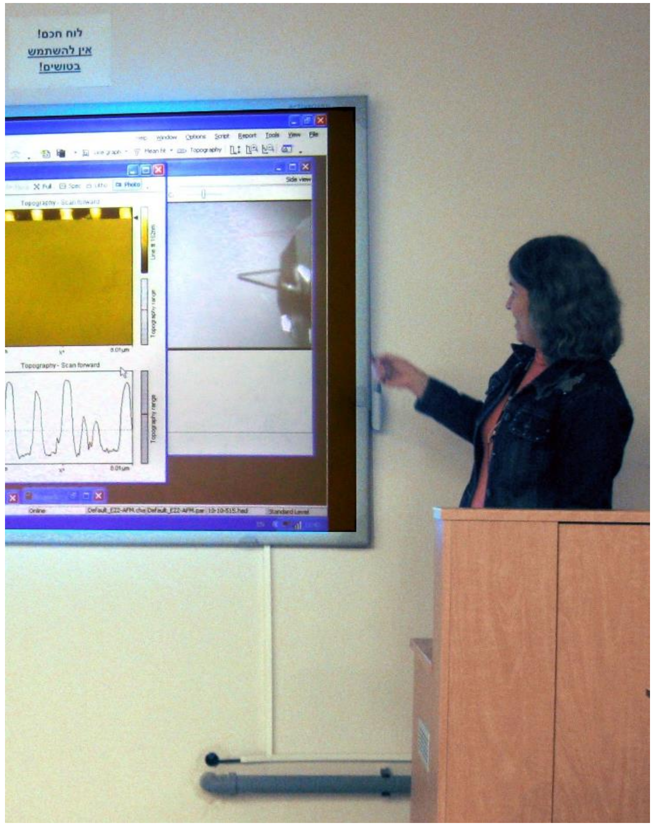
Pedagogical
Content Knowledge

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Teachers need to develop PCK to bring contemporary chemistry to class





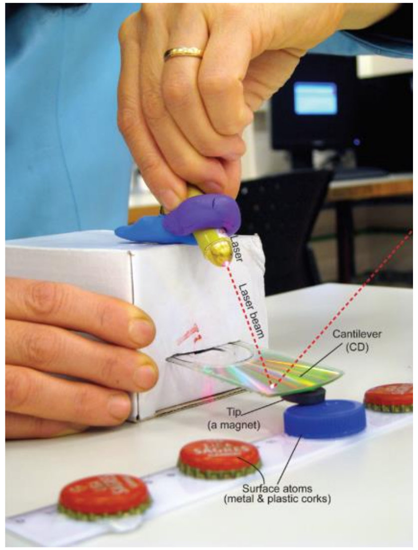


Planinšič, G., & Kovač, P. (2008). Nano goes to school: A teaching model of the atomic force microscope. *Physics Education, 43, 37-45.*

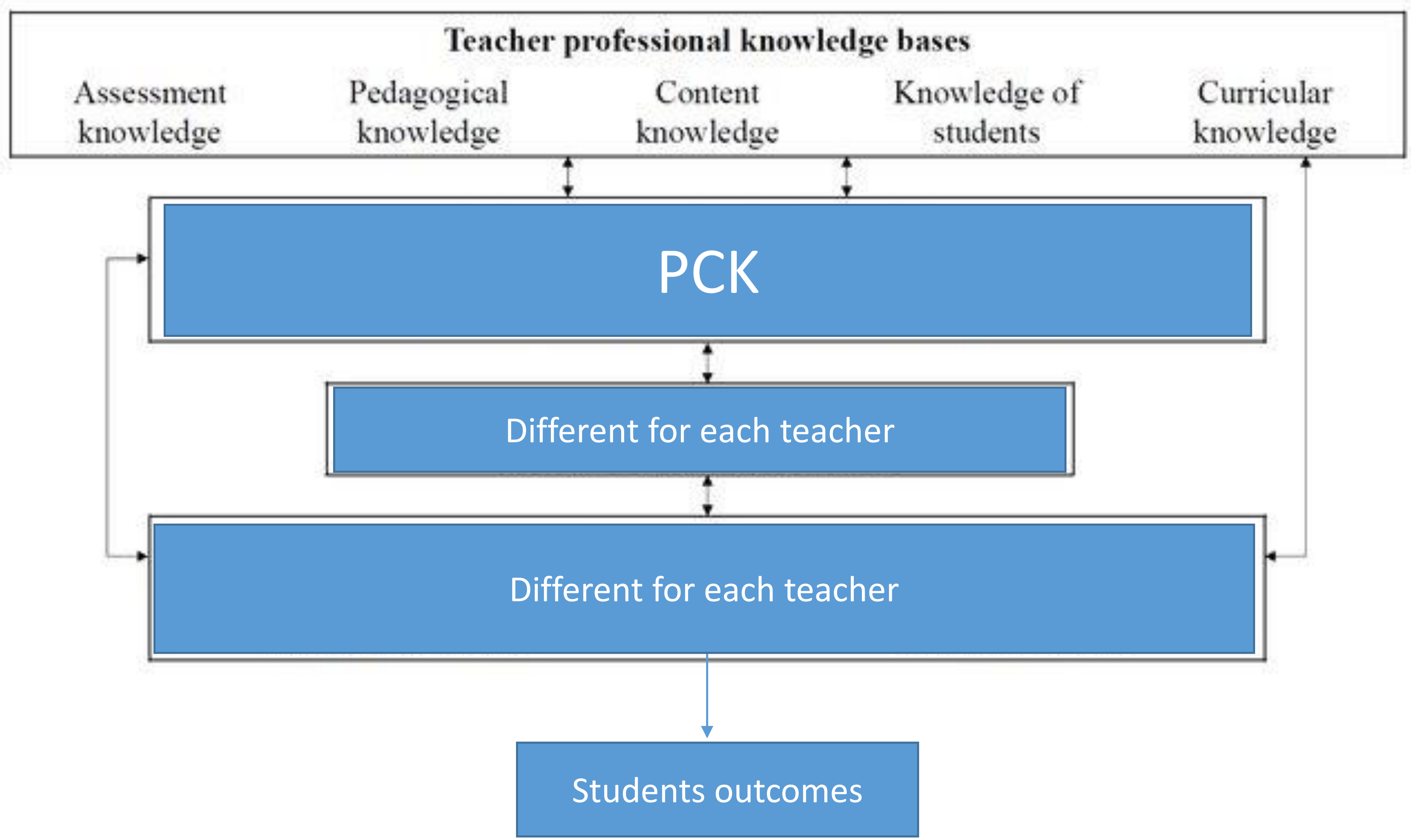
Blonder, R. (2010). The influence of a teaching model in nanotechnology on chemistry teachers' knowledge and their teaching attitudes. *Journal of Nano Education, 2, 67-75.*

A three-stage model for development of teachers' contemporary knowledge

1) Contemporary contents
2) Tutorial that emphasizes pedagogy
3) Adaptation to education



Mamlok-Naaman, R., Blonder, R., & Hofstein, A. (2010). Providing chemistry teachers with opportunities to enhance their knowledge in contemporary scientific areas: A three-stage model. *Chemistry Education Research and Practice, 11, 241-252.*



Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: results of the thinking from the PCK summit. In A. Berry, P. J. Friedrichsen, & J. J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education (pp. 28–42). Routledge.*

The Importance of and the need for personalization learning for teachers

Blodner, R., & Vescio, V. (2022). Professional Learning Communities across science teachers' careers: The importance of differentiating learning. In J. A. Luft & M. G. Jones (Eds.), *Handbook of Research on Science Teacher Education (pp. 300-312). Taylor & Francis Books.*

How can we practically personalize teachers learning? They differ in many aspects…

students	philosophy	beliefs
knowledge	seniority	context

Research Practice Partnership

The teachers -

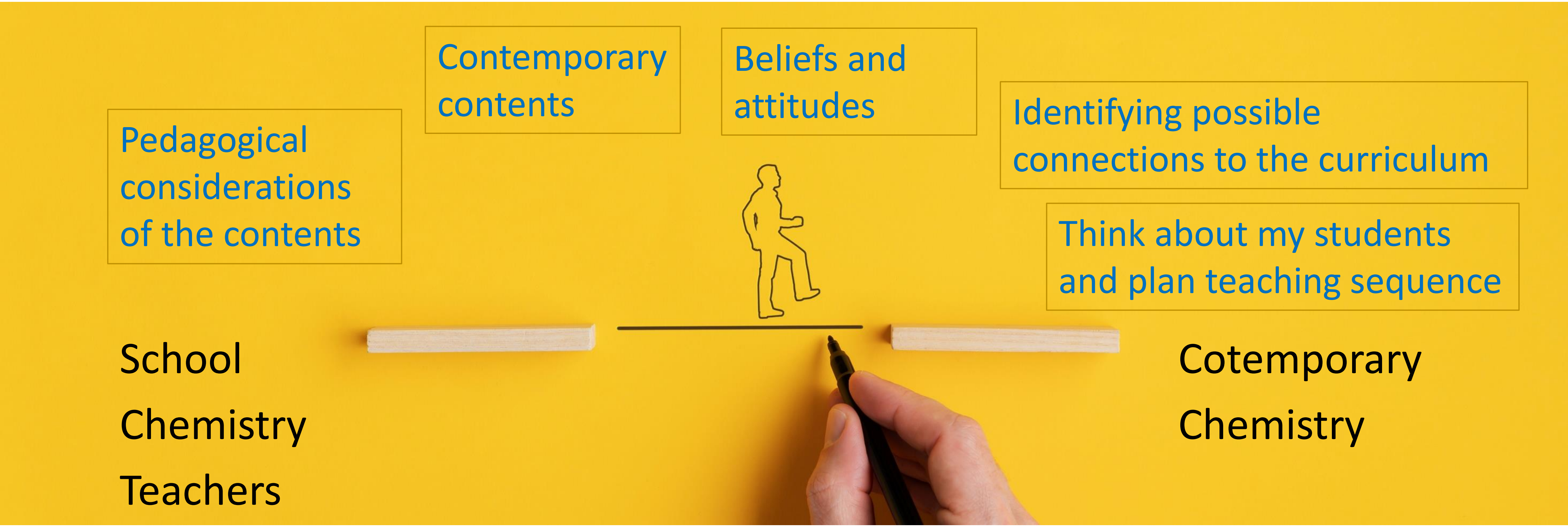
- Designed nanotechnology unit for their own students
- Implement the unit and
- Measured its influence on their students
- Wrote a report about the process

After 5 years -

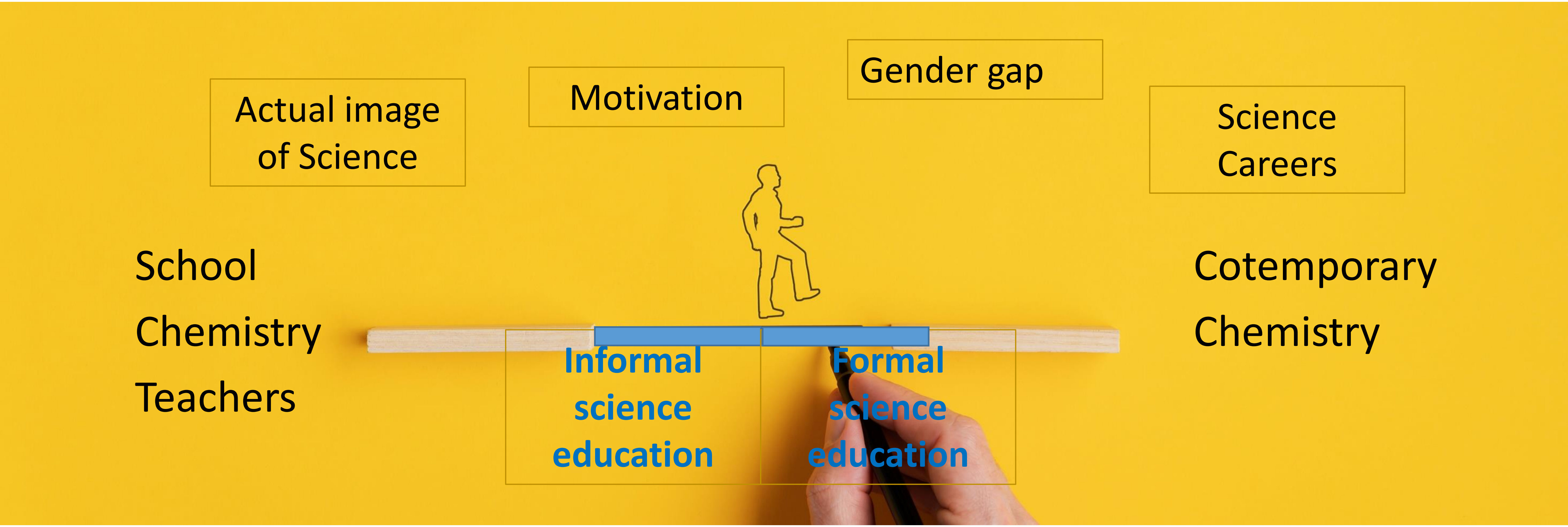
- The change was sustainable
- Verity of teaching approaches transferred to their teaching of chemistry.

Blonder, R., & Mamlok-Naaman, R. (2016). Learning about teaching the extracurricular topic of nanotechnology as a vehicle for achieving a sustainable change in science education. *International Journal of Science and Mathematics Education, 1-28. https://doi.org/10.1007/s10763-014-9579-0*

Impact of teachers’ knowledge & beliefs



Bridging the gap



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