QDNL 3.6 – UU 24 May 2024 Quantum educationfor the younger generation

Quantum physics in class:

HOW CAN WE SUPPORT TEACHERS?

UNIVERSITY OF TWENTE.

Kirsten Stadermann

Problem

Literature

Working example

Problem

Quantum physics (QP) is difficult and still unknown for teachers.

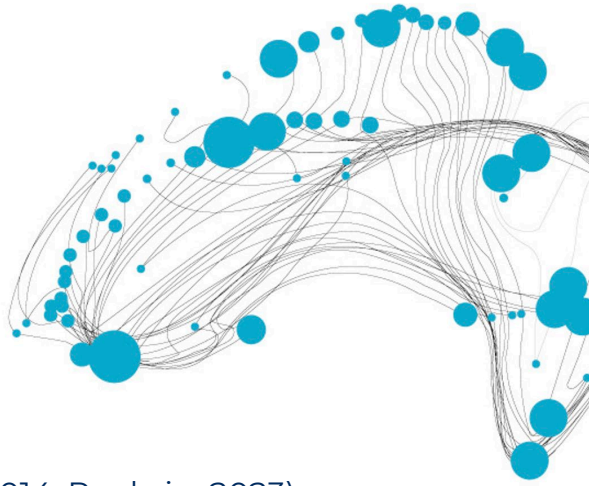
- Little background content knowledge
- Depending on textbooks
- Limited instructional strategies
- Lack of confidence (self-efficacy) in teaching QP

Lack of PCK

Physics Teacher Professional Development

COMMON MISTAKES

- Disconnection from classroom practice (Penuel et al., 2007; Loucks-Horsley et al., 2010)
- Lack of connection to teaching strategies and PCK (Etkina, 2010)
- Short-term and fragmented approach (Desimone, 2009)
- Lack of active learning (Garet et al., 2001)
- Lack of ongoing support and collaboration (Luft et al., 2014; Roehrig, 2023)
- Limited hands-on/lab experiences (Etkina, 2010)



Physics Teacher Professional Development

EFFECTIVE ONES

Effective teacher professional development programs

- Content focused
- Coherence (with teachers' needs, style, goals and school environment)
- Grounded in effective models of instruction
- Collaboration, feedback and reflection
- Active learning
- Sustained duration

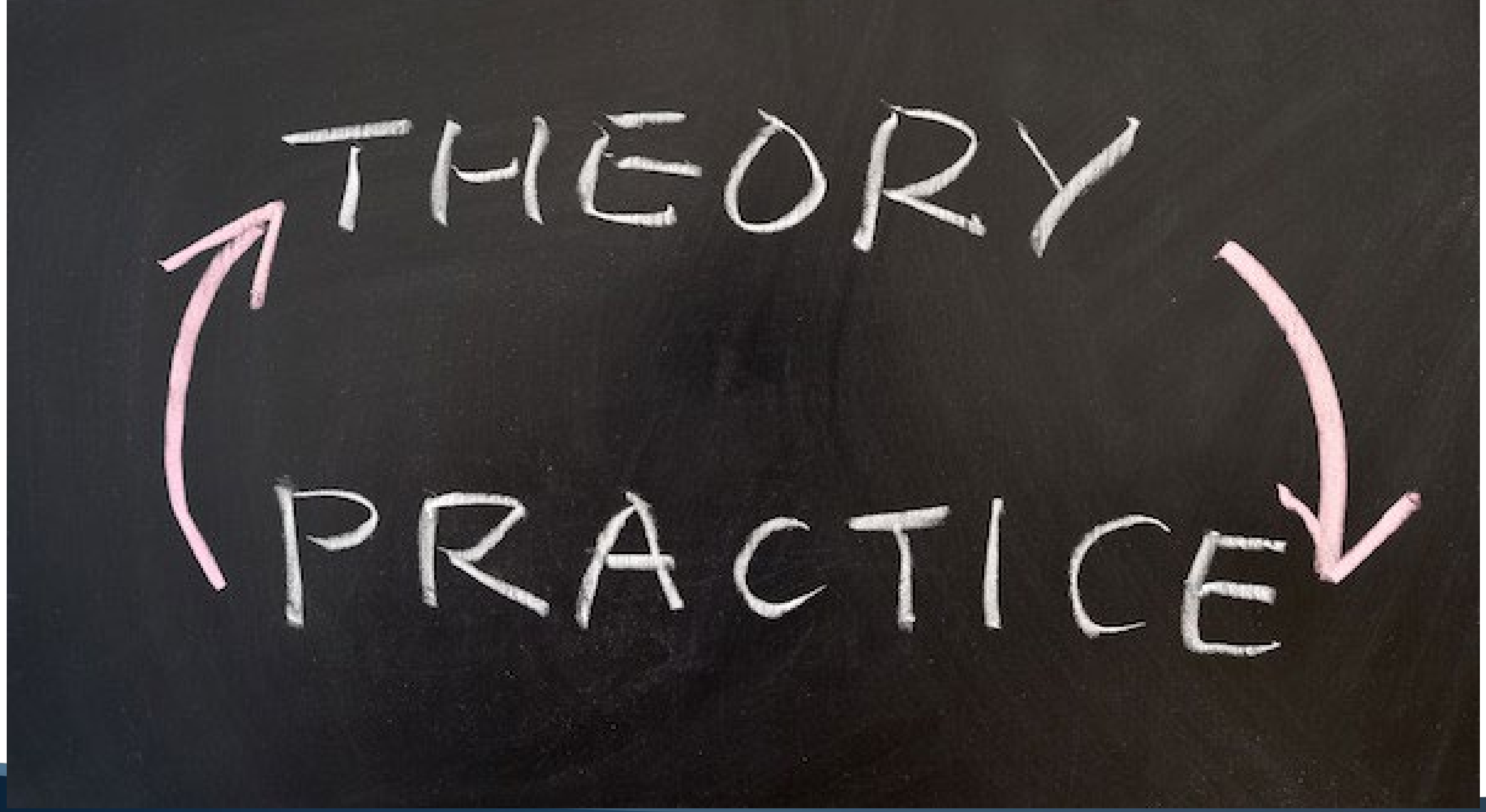
(Etkina, 2010; Luft et al., 2014; Roehrig, 2023; Darling-Hammond et al., 2017; Carli et al., 2023 ; Poortman et al., 2022; Westbroek et al., 2017)

Preconditions

Teachers will implement innovations, if they are practical:

- Instrumental (ready to use tomorrow / solving a problem)
- Congruent (with self-perception and classroom setting)
- Low cost (effort and time)

Doyle & Ponder 1977; Westbroek et al., 2017


THEORY
PRACTICE

Quantum PLN

Professional Learning Network (PLN) Planning

- Physics educators from different schools
- Once a month, 7 times, Mondays 15:00- 18:00
- Teachers define goals
- Expert facilitates and supports development, offers inspiration

How to get participants?

Getting participants

- Website
- Emails
- Personal conversations

Participants

- 9 teachers from 6 schools (pay)
- Before the first meeting: Phone call to get to know each teacher

  - 2 very experienced (> 25 years teaching, > 6 years QP)
  - 2 unexperienced (never had taught QP)
  - 5 teachers experienced but want to improve their teaching

Activities

1	Introduction, exchange, inventory of wishes
2	
3	
4	
5	
6	
7	

The protagonists

Activities

1	Introduction, exchange, inventory of wishes
2	Testing quantum experiments
3	
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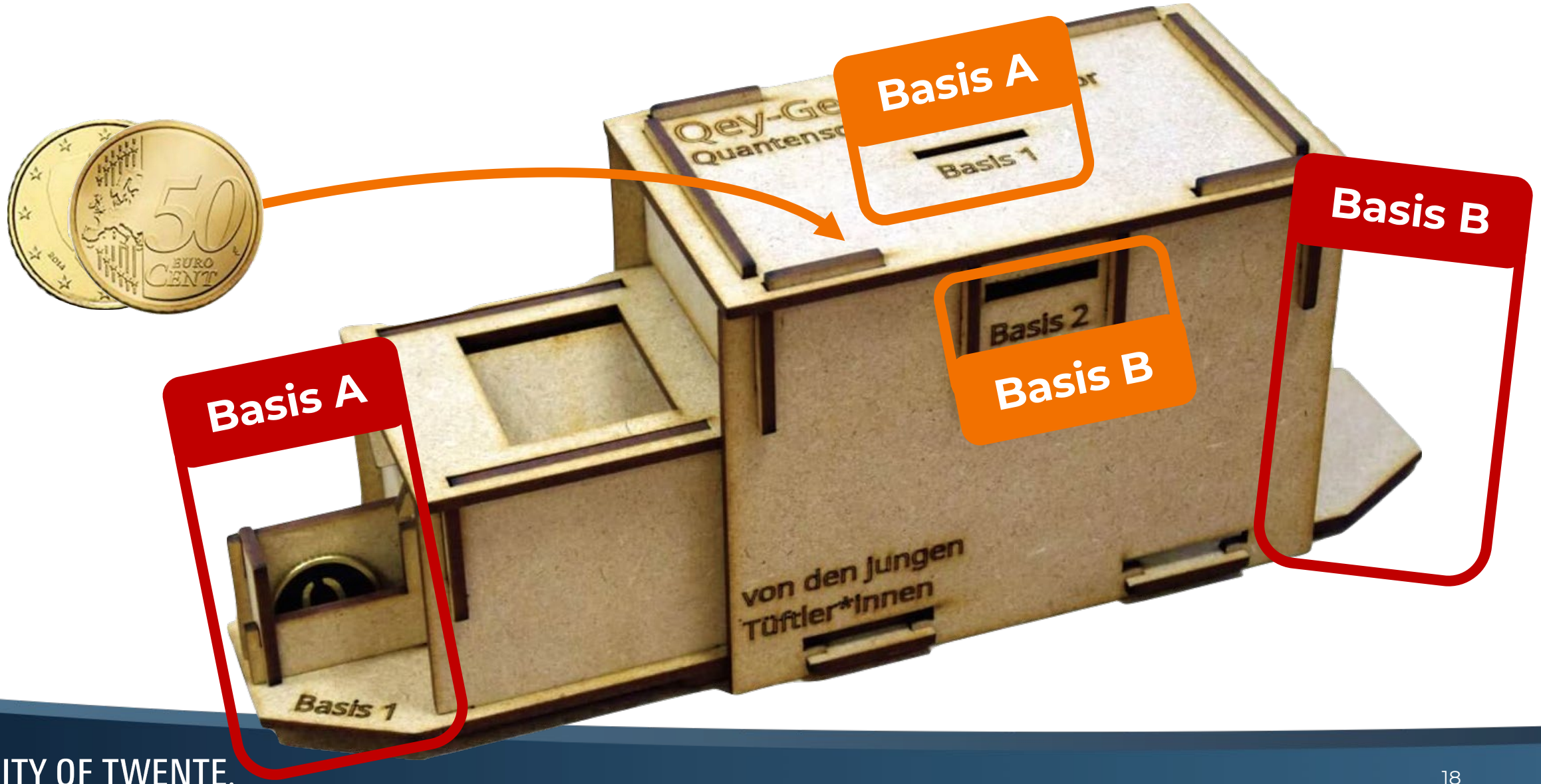
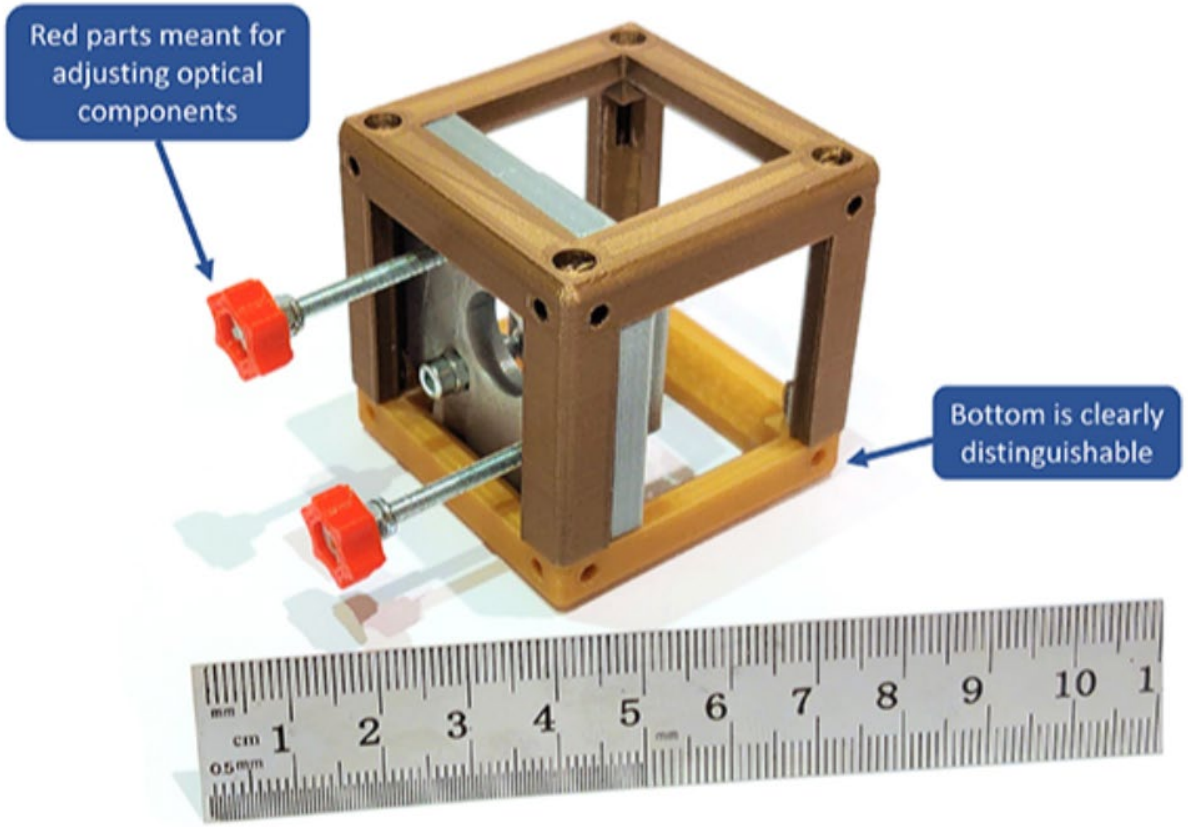
Quantum-eigenschappen van een foton



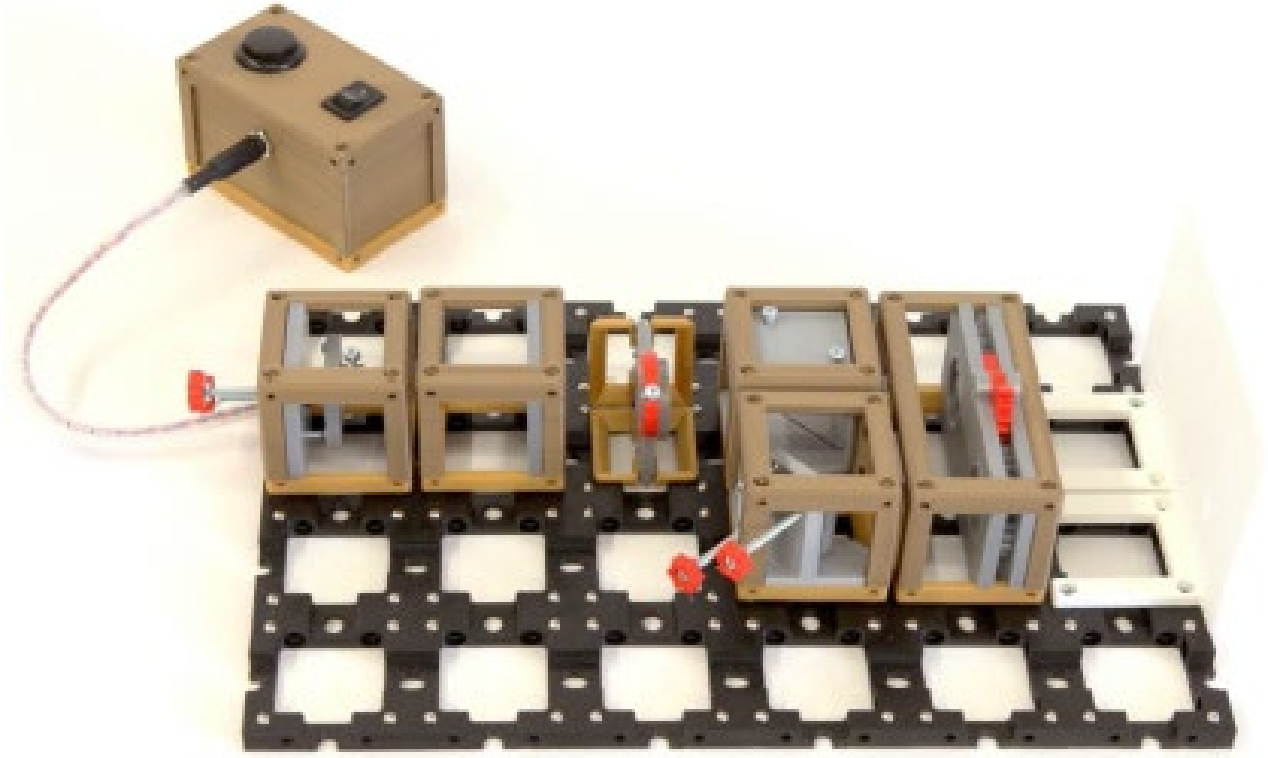
3d-printed experimental setup

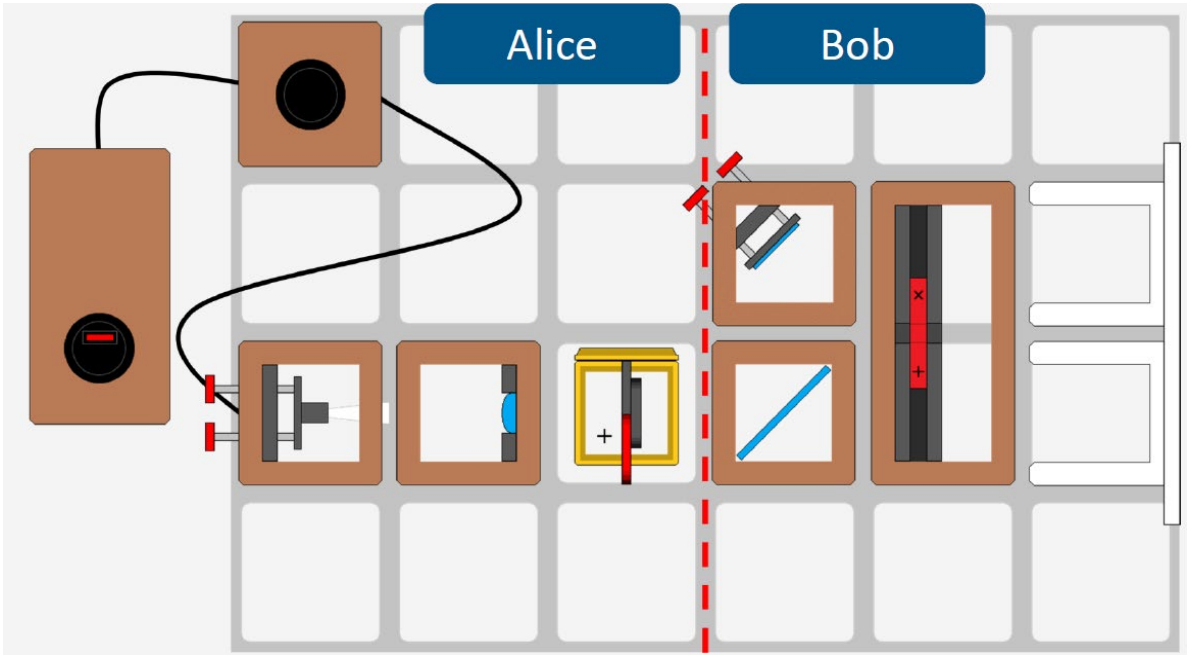


Haverkamp, N., Pusch, A., Heusler, S., & Gregor, M. (2022). A simple modular kit for various wave optic experiments using 3D printed cubes for education. *Physics Education*, *57*(2), 025019.

Cryptography (BB84-protocol)

Even more ‘real’ but still a simulation you can play with.





Niels Haverkamp, Alexander Pusch https://physikkommunizieren.de/3d-druck/o3q-optic-cubes-bb84/

Activities

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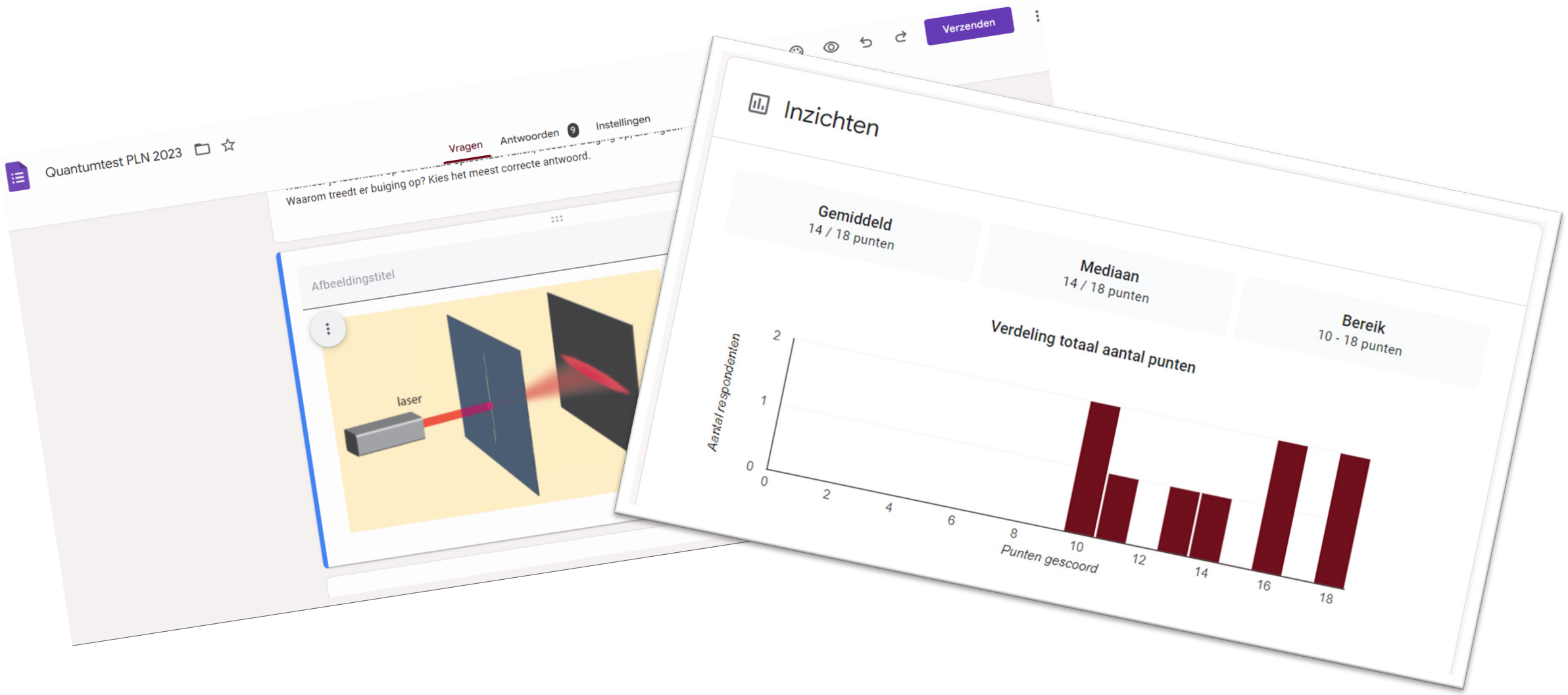
Quantumtest PLN 2023
Vragen
Antwoorden 9
Instellingen
Verzenden
Waarom treedt er buiging op? Kies het meest correcte antwoord.
Afbeeldingstitel
laser
Inzichten
Gemiddeld
14 / 18 punten
Mediaan
14 / 18 punten
Bereik
10 - 18 punten
Verdeling totaal aantal punten
Aantal respondenten
Punten gescoord
0
1
2
0
2
4
6
8
10
12
14
16
18

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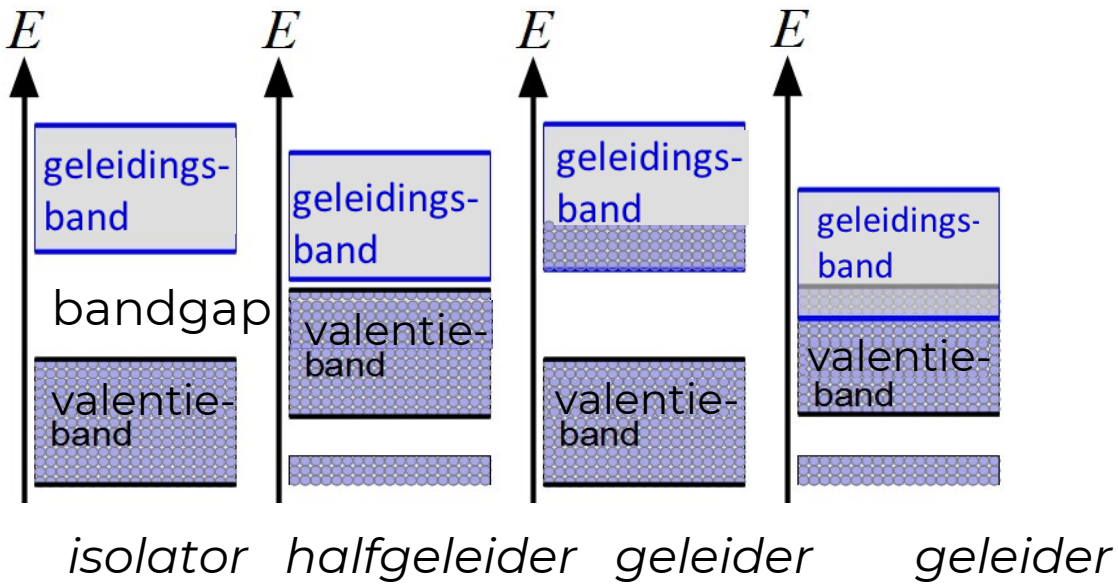
Isolator - halfgeleider - geleider

Isolator:
valentieband vol, geleidingsband leeg, band gap groot

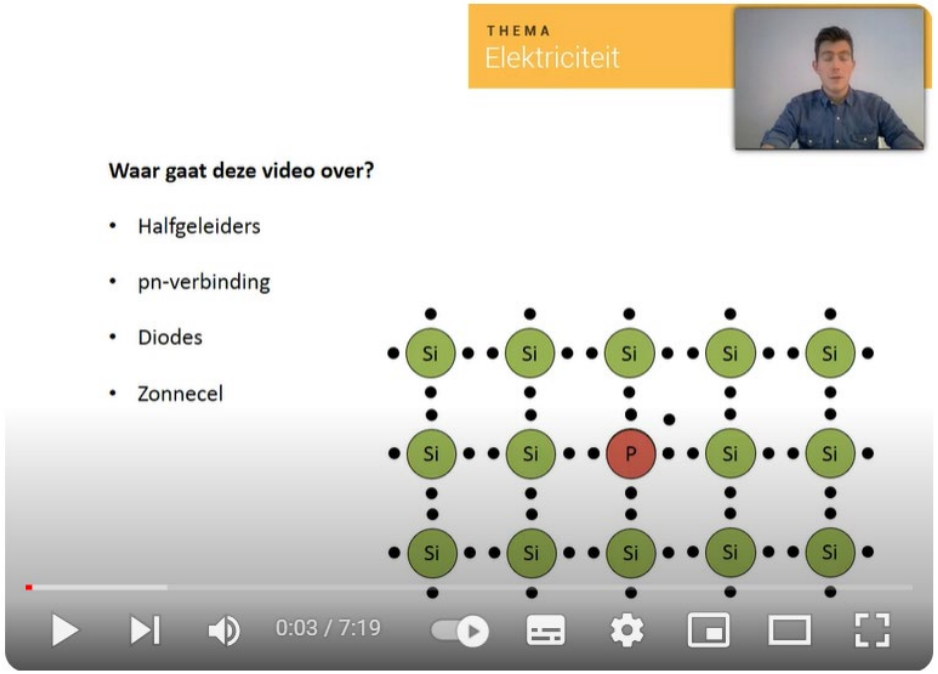
Halfgeleider:
valentieband vol, geleidingsband leeg, band gap klein

Geleider:
valentieband vol, geleidingsband deels gevuld, of
overlap valentieband en geleidingsband

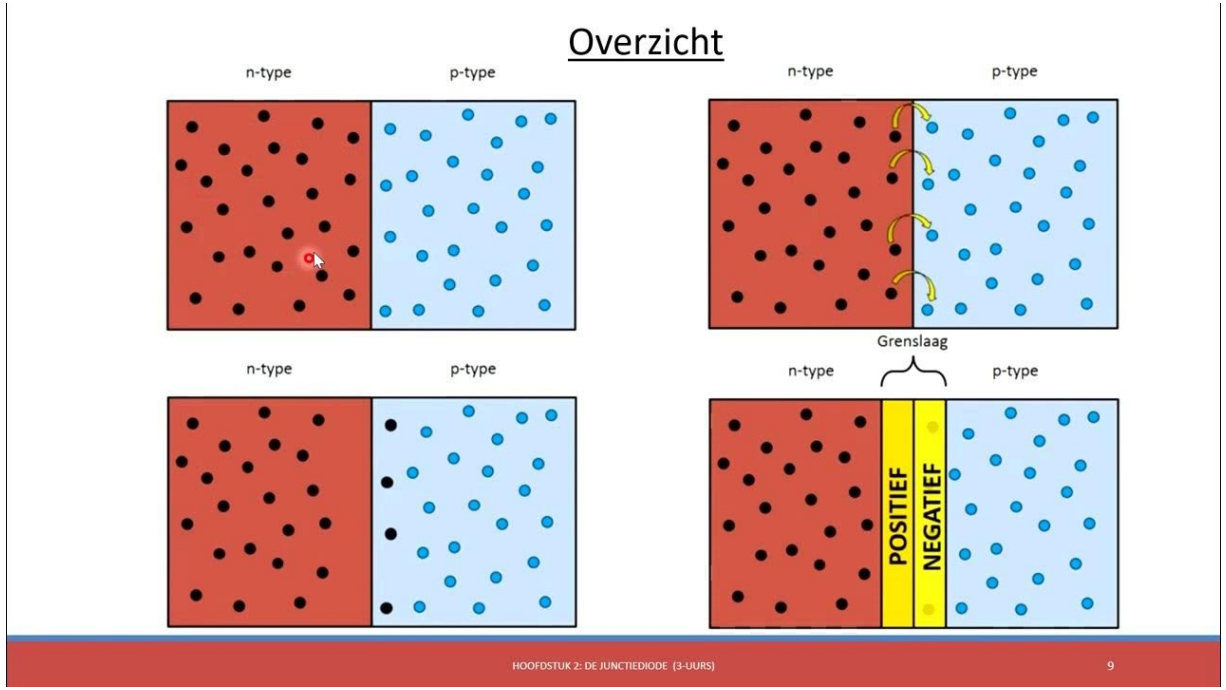


Elektrische geleiding is alleen in *deels* gevulde banden mogelijk.

Halfgeleiders en pn-verbindingen

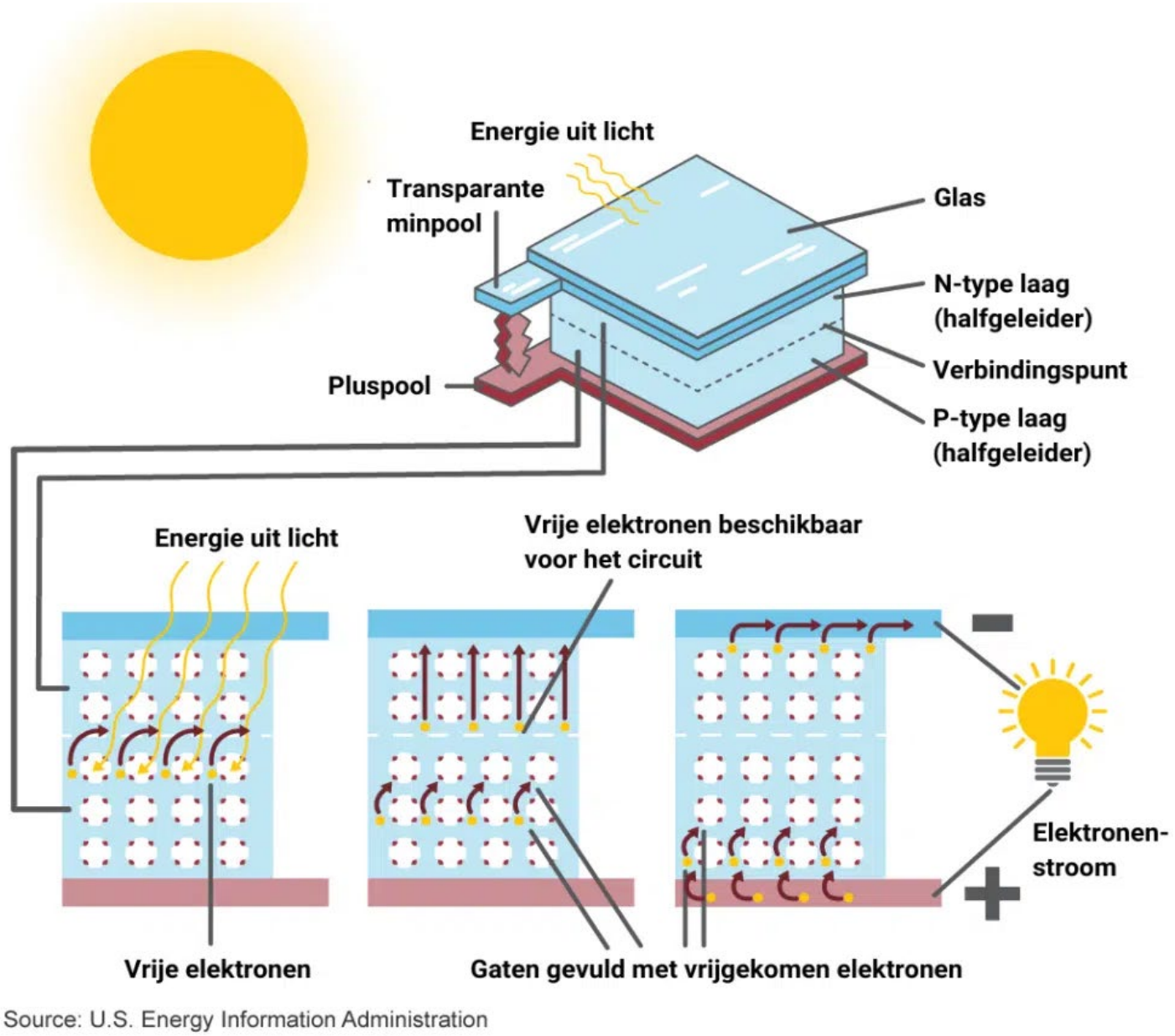


https://www.youtube.com/watch?v=Xhu7NzRpgCU&ab_channel=JeroenBruijstens



https://www.youtube.com/watch?v=_hun1hCl1mA&ab_channel=ThomasGoossens

zonnecel



Source: U.S. Energy Information Administration

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7	

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	Visiting Q-lab with own students, supervised by 6 UT assistants
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HOE WERKT HET EXPERIMENT?

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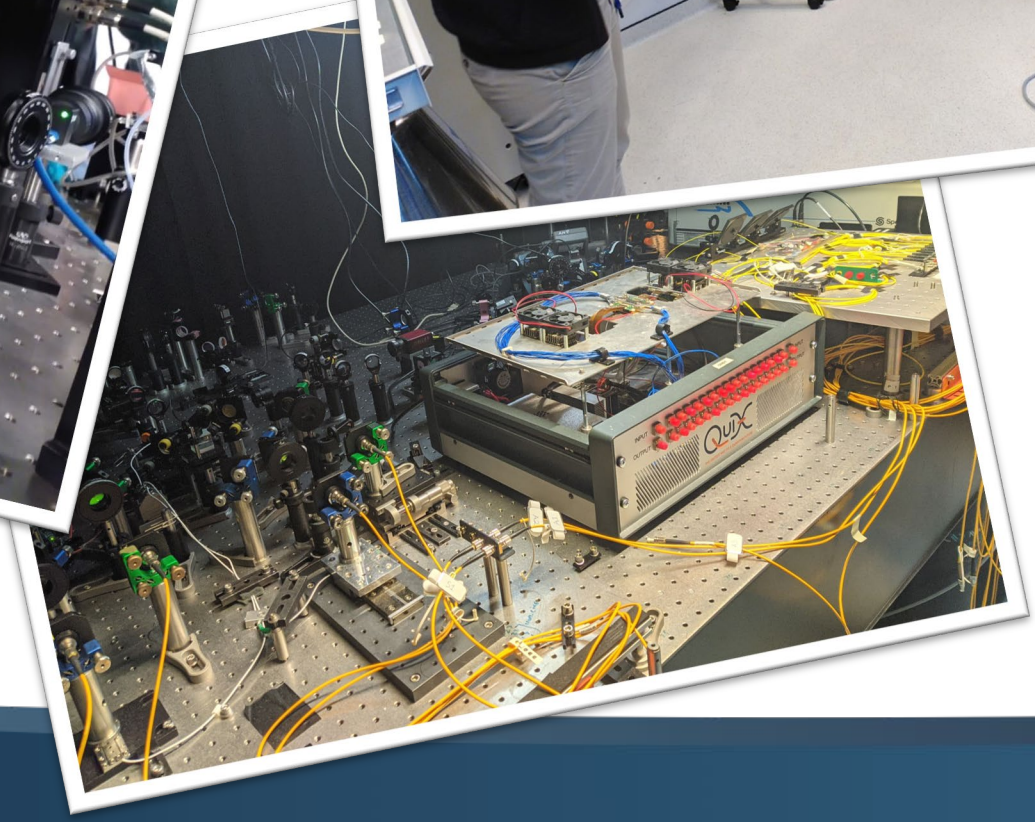
6	Collaborating on our own teaching materials, comparing different textbooks
	Visiting Q-lab with own students, supervised by 6 UT assistants
7	Visiting the quantum optics laboratory and semiconductor department



Evaluation

What teachers say they value most

- Flexibility/ variation of the program (3x)
- Content knowledge (“I see more connections.”) (5x)
- Useful and attractive teaching materials (5x)
- Discussing new exam topics (5x)
- Historical background/ stories of QP (4x)
- Develop teaching materials together (4x)
- Building network / intervision (4 x)
- Being inspired by enthusiastic teachers and researchers (2x)

Evaluation

What teachers say they will use in their lessons

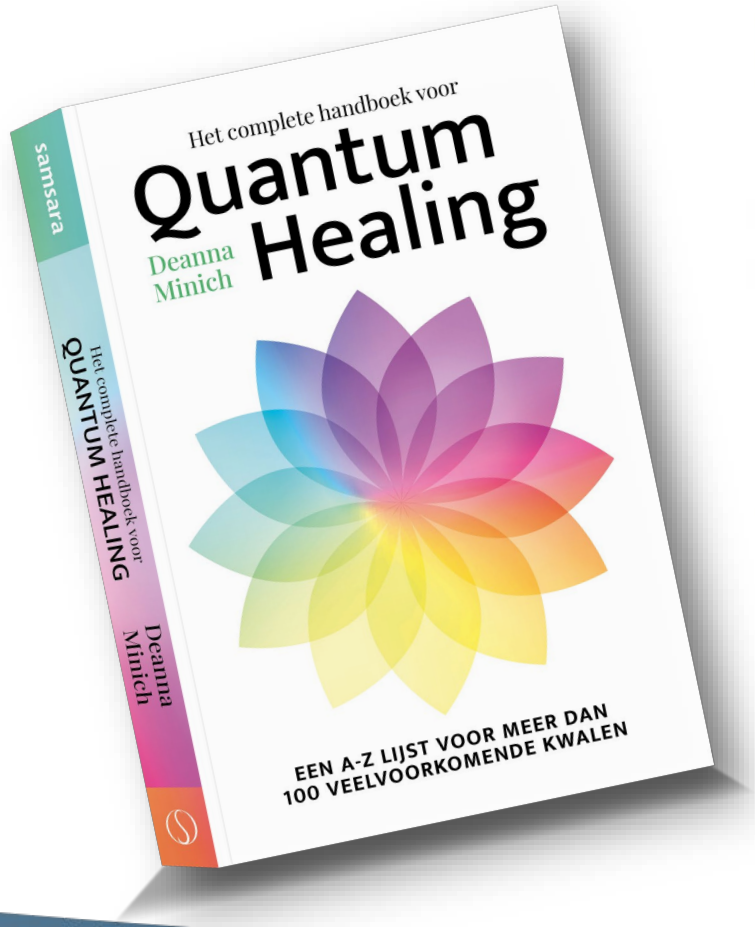
- New ways of presenting/explaining (6x)
- Useful and attractive teaching materials (4x)
- Feeling of competence (3x)
- Student practicals (3x)
- Historical background/ stories of QP (2x)
- Examples from applications/research (2x)
- Fundamental/philosophical topics (2x)

Evaluation

What teachers want

- Come back next year (8x)
- A session on entanglement (5x)
- More about semiconductors (4x)
- Discussing fundaments of QP
- Clearer homework
- Discussing different

Questions?


samsara
Het complete handboek voor
Quantum Healing
Deanna Minich
EEN A-Z LIJST VOOR MEER DAN 100 VEELVOORKOMENDE KWALEN


VORRATSPACK 60 CAPS
finish
POWERBALL
QUANTUM
KRAFTVOLLE REINIGUNG & GLANZ
60 ALL IN 1 CAPS
FRESH
SCHNELL-AUFLÖSEND
FETTLÖSE-KRAFT


Blu-ray Disc
QUANTUM OF SOLACE
007

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