Vision statement

Freek Pols

Preface

Contents

1. Introduction

Dear committee member,

It is an honour and a pleasure to share my vision statement on my career at Delft University of Technology. Reflecting on my 20^{+} years in education as a teacher, my performance over the past seven years at TU Delft, and my aspirations for growth as an educator, scientist, and person has been an insightful journey.

The summary of my vision can be expressed as:

To strive for continuous growth and excellence in education, bringing out the best in both myself and others.

But even with this clear, concise and strong statement - covering one of my core values, it has been a challenge to draft a clear document in which education, research, and valorization are distinguishable components. I started as a secondary school teacher, did alongside that job a Ph.D. in physics education, and continued my career in academia with a focus on education. As a result, my research and teaching are inherently intertwined: I study what I teach, and how I teach is grounded in research (scholarly-teaching). With a drive to openly share all educational material (hence, contributing to open education), the creation of evidence-based education (education & research) and valorization (enable life long learning) are for me inseparable, though I have attempted to distinguish them in this document.

This document, written in MyST, exemplifies my innovative approach to teaching: it is one of the latest technological advancements in education and research dissemination (Cockett et al., 2024). The MyST and Jupyter projects aim to create interactive scientific publications for the web, with the ability to export content to PDF, LaTeX, and Microsoft Word. While this document is presented as a PDF, it is also available as an interactive online document. It is also the way the tool which supports the newest online interactive textbook publications, see for instance TUD's first year physics mechanics book. Moreover, the PDF version of this book is made with a bare-bone typst template which is made by me and feed back to the MyST ecology.

wat staat er in het document, volgorde.

Sincerely yours,

Freek Pols

2. Education

Reflecting on educating, I must have more than 25 years of experience with teaching. I think one of my first accounts with teaching is instructing sailing at an age of 14. When I was 16, I became an instructor in the Martial Art (Pencak Silat) that I was practicing. In hindsight, it thus seemed to be a logical step to do the minor education in my third year of the study Applied Physics and to become a secondary school teacher after my masters. I have been teaching physics in secondary school for ten years (2009-2019).

Recognizing that I probably had not yet reached my full potential and wishing to set an example for my pupils that learning is a lifelong journey, I applied for NWO Doctoral Grant for Teachers. This grant was awarded in 2014 allowing me to do a PhD. (0.4 FTE - 5 years) on teaching scientific inquiry in physics (Pols, 2023).

In 2019 I switched from secondary education to university to become the coordinator of the First Year Physics Lab Course (FYPLC) with the task to innovate this course.

In what follows is a list of courses which I taught, innovated or helped innovating.

2.1 Courses

Course code	Course Name	Year	Task
TN13010	Inleidend practicum 1	25 - now	Coordinator
TN13015	Inleidend practium 2	25 - now	Coordinator
TN1405	Inleidend practicum	19-25	Coordinator
TN2985	Introduction to experiments in physics	19 - 25	coordinator
WM0318TN	Wetenschap en argumentatieleer	22-23	Tutor
SL4301	Implementatie van onderwijs	23 - now	Guest lecturer
SL4220	Vakdidactiek basis	22 - now	Guest lecturer
SL4320	Vakdidactiek verdiepend	22 - now	Guest lecturer

Table 2.1: Courses taught

Hier een samenvatting van bovnestaande

DEF EI-NB

2.2 Curriculum

projecten verbinding math & phys boek mechanica. verbinden Q1 & Q2

2.3 Innovating lab courses

On March 1, 2019, I started my position at TU Delft as a lecturer/innovator for the physics lab courses (PLC). The assignment given by Prof. Chris Kleijn (then program director) had three objectives:

- Modernize the NP to align with 21st-century educational standards.
- Increase student motivation for the practicum.
- Focus on teaching students how to conduct research.

The PLC consists of two courses:

- **TN1405-P**: A 6-ECTS introductory practicum for first-year students.
- **TN2985**: A 2-ECTS *Introduction to Experimentation* course for minor students.

2.3.1 2019

TN1405 included:

- Python programming.
- Measurement and Uncertainty (lecture and tutorial).
- Introduction Experiments 1 & 2.
- Eight follow-up experiments focused on physics phenomena (*concept-based practica*).

TN2985 included:

- Measurement and Uncertainty.
- Introduction Experiments 1 & 2.

The assignments and lectures in TN2985 were one-on-one translations of TN1405 manual. The course was supported by two administrative staff members and a technician. Attendance tracking was manual, using physical cards.

2.3.2 Changes

TN2985

A completely new program was developed for the minor course. Students now enjoy significant flexibility, both in progressing at their own pace (for Python and report writing) and in choosing experiments. As a result, student satisfaction increased from **5.7 (2019) to 8.0 (2020) to 8.2 (2021)**.

Key Changes

- New Python, data analysis, and error propagation module with an online test.
- Attendance required only for the practicum; the rest is self-study with optional scheduled contact hours.
- Rapid feedback on the first report (within 36 hours).
- Increased freedom of choice in both experiments.

Changes to TN1405

The entire program was revised, reusing existing experiments in a modified form. The number of labs in **O2 was reduced from 8 to 3**, creating space for a **final project** where students formulate their own research question based on a chosen theme and conduct an accompanying experiment.

Key Changes

- Reduction of pre-structured labs in **O2** from **8 to 3**.
- Revision of objectives and guidelines for these labs.
- Introduction of a **final project** where students design and conduct their own research.
- Implementation of **blended learning**, with **50% of the work done at home**.
- Introduction of a **final exam** covering Python, data analysis, measurement, and uncertainty.
- Complete revision of the **practicum manual**, with links to lectures, assignments, etc.
- Revision of grading models.
- Introduction of a new practicum on determining g with **0.1% accuracy**.

2.3.3 Administrative Adjustments

2.3.3.1 Summary

Administration was previously done using a **physical card system**. This has now been fully digitized and largely automated. TAs can now independently input attendance and grades. As a result, administrative staff are now also involved in **DEF 1 & DEF 2**.

2.3.3.2 Key Changes

- **Digitization and automation** of tasks.
- **Freeing up administrative staff** for other courses.
- **Expanding digital processes** to other courses.

2.3.4 Teaching Assistants (TAs)

2.3.4.1 Summary

A **6-ECTS practicum** with around **270 students** cannot function without **TAs**. Active recruitment has been established, based on performance, engagement, and interest during the academic year. Efforts have also been made to **retain TAs longer**, partly through specialized **ITAV training**. The total number of TA hours was reduced by **scaling up**, conducting the same experiments in a **studio classroom**, and **designating one day for centralized (online) instruction**.

2.3.4.2 Key Changes

- **Active recruitment** during the academic year.
- **More targeted didactic and content training**.
- **Reduction in required TAs** through scaling and a more central role for the lecturer.

2.3.5 Scientific Contributions and Outreach

The NP has contributed to both **scientific and educational publications** and has been used to **engage prospective students**. Notable outputs include:

1. **A Physics Lab Course in Times of COVID-19** *(peer-reviewed article on adapting to home-based practicum)*
   - Read here
2. **Students' Report on an Open Inquiry** *(Physics education research paper)* Pols et al. (2021)
   - DOI: 10.1088/1361-6552/ac27f8
3. **GIREP Symposium** *(Comparison of practicum courses across four universities)*
   - Conference abstract
4. **Pre-University On-Campus Tracks** *(Engagement program for high school students)*
   - More info
5. **PRPER** *(Redesigning a first year physics lab course on the basis of the procedural and conceptual knowledge in science model)* Pols & Dekkers (2024)
6. **Phys Ed.** *(One setup for many experiments: enabling versatile student-led investigations)* Pols (2023)
7. …

2.4 Characteristics

- Innovatie
    1. niet alleen technologie centered
    2. didactiek
- Belangrijkste
    1. niet het trucje leren, maar het principe
- Courses
- Transforming education
    1. Inspiring others

3. Research

3.1 Research into the integration of argumentation in science & engineering education

Argumentation is at the core of scientific practice. It is the means by which scientists construct, justify, and communicate knowledge, ensuring that claims are rigorously tested and defended. From formulating hypotheses to interpreting data, from engaging in peer review to debating theoretical frameworks, argumentation permeates every aspect of scientific inquiry. Without it, science would not function as a self-correcting, evidence-based discipline.

The Toulmin (2003) model of argumentation has been widely used to describe this structure, emphasizing key components such as claims, warrants, and backing, which form the foundation of a cogent scientific argument. However, scientific argumentation is more than just a method of presenting findings in a scientific journal in which all elements of the Toulmin argumentation are recognizable — it is an essential cognitive process in conducting research, the crucial element in the entire scientific endeavour. A scientific investigation does not merely seek to gather data; it aims to construct a compelling and well-supported claim based on that data. This requires reasoning systematically, evaluating alternative explanations, and providing justification for methodological choices.

Scientific argumentation thus plays a fundamental role in science, especially in inquiry and in engineering design. In the process of conducting research and designing technological solution, scientists and engineers do not passively record observations or build prototypes from scratch; they actively engage in constructing an argument that supports their conclusions/solution. This involves critically assessing evidence, scrutinizing methodologies, weighing pros and cons for different solutions to each decision they have to make, and anticipating potential counterarguments.

In education, fostering argumentation skills is crucial for developing students' ability to engage in scientific reasoning. Research shows that many students view scientific inquiry as a mechanical process of following procedures rather than as a means of constructing and defending knowledge. By integrating argumentation into science curricula, educators can shift students' perspectives, helping them understand that science is about producing the most reliable and defensible answers to research questions, rather than merely completing experiments.

3.1.1 Integration of argumentation and scientific inquiry

Enabling students to engage in basic scientific research is an important component of the curriculum in secondary and higher education [REF]. However, literature indicates that meaningfully implementing this (developing research skills and knowledge in students) is only minimally successful [REF]. In my PhD research, we have taken steps to address this issue (Pols, 2023). We have demonstrated that, on the one hand, argumentation is an indispensable but underemphasized aspect of education in scientific research. On the other hand, a focus on argumentation (viewing research as the construction of a scientifically convincing claim) leads students to develop a need for research knowledge, as they recognize that only the best answer to the research question suffices [REF].

By defining 'research' as the construction of the most convincing possible answer to a given question, it is no longer sufficient for a student to merely apply the correct theory and perform methodologically sound procedures. The development of such routines remains important, but the didactics must also ensure that the student is continuously aware of the nature and purpose of the research activity. This means that the student makes decisions and choices that are rationally justifiable, as they lead to optimally valid and reliable research outcomes within the given contextual constraints. This perspective on a 'research learning trajectory' requires the development of didactics that span from students' first encounter with scientific research to full-fledged independent physical research.

At the end of the dissertation, a large theoretical model is developed (see figure below), which appears to be useful for further integrating argumentation and research. The presented model links the Toulmin argumentation model (Toulmin, 2003) with the Procedural and Conceptual Knowledge in Science (PACKS) model (Millar et al., 1994). While the Toulmin model describes the elements of an argumentation structure, the PACKS model outlines the different types of knowledge required to define the content of those elements. This theoretical model needs further elaboration and substantiation. This will be achieved through a theoretical literature review, in which:

1. the necessity of integrating argumentation and research will be further argued,
2. the theoretical model will be expanded, and
3. its practical implementation (along with the associated implications for education) will be developed.

Various follow-up studies have been proposed in the dissertation that require further elaboration:

- If research knowledge is developed in physics education, to what extent is this knowledge relevant in other subjects, and how can we facilitate this knowledge transfer?
- What knowledge do teachers actually need, and how can we optimally train them to teach research skills? In collaboration with TUD's teacher education program, particularly within master's research projects, various studies are and will be conducted to address these questions.

Learning how to conduct a thorough research project is important, but convincingly conveying the study into a publication (in any form) has proven to be challenging [REF]. This requires a deep understanding of the scientific purpose of research and its dissemination (a strong connection to argumentation), and the development of creativity and a sense of language. With the advent of large artificial language models such as ChatGPT, writing and writing education seem to be placed in an entirely new perspective [REF]. In this practice-oriented study, we aim to connect with research on the use of ChatGPT as a meaningful coach in writing reports [REF].

Funding for ongoing research is being sought through one of the NRO calls for long-term research, see for example here. The research on writing education is included in the Comenius grant application.

3.1.2 Integration of argumentation in engineering design

Engineering Design (ED), the systematic and creative process of devising and constructing solutions for a specific problem, is a key component in STEM education (Council;, 2012; Vossen, 2019) and is integrated in the intended learning outcomes of all Dutch secondary science subjects (SLO, 2020). ED is mainly meant to:

- develop conceptual knowledge, strengthening (theoretical) subject matter taught through direct instruction (Stammes, 2021);
- develop design and research practices, learning how an iterative process of thinking and tinkering may yield a prototype that solves the problem and suits the needs (Cunningham, 2009; Fan & Yu, 2017; Kolodner et al., 2003).

Engaging secondary school students in ED can enhance their real-world problem solving skills (Fortus et al., 2005), foster interest in engineering careers (Reynolds et al., 2009), and provide illustrative preparation of and lay foundational groundwork for tertiary engineering education. Although it plays a central role in science curricula (Council;, 2012; Feder et al., 2009; Pieters, 2022) and has a (potential) function in education, the teaching and learning of ED is problematic in various ways and the development of pedagogical approaches for ED fails to match EDs importance (Van Dooren, 2020). Students – at all levels – often struggle with ED when prerequisite design knowledge is not identified and developed timely. They tend to focus exclusively on the first idea that comes to mind without considering alternatives – known as design fixation (Jansson & Smith, 1991). Once the design is fully developed and a prototype built, the design choices are justified in retrospect (post hoc), only because assessment procedures demand it. Proper ED, however, requires that conscious, deliberate choices are made throughout the design process in order to justify the design (Kuijk, 2024). Instead, as an expert design teacher stated: "We seem to teach our students how to come up with rationales for their designs on the spot."

One of the main problems is that ED is often taught by educators with limited design experience (pre-tertiary level) or by design experts (tertiary level) who frequently lack pedagogical training or possess only implicit understanding of the practices and knowledge they apply (Lawson, 2006; Van Dooren, 2020). This dichotomy hinders effective teaching, leading some teachers to skip ED altogether, or to present it as an undifferentiated whole, rather than addressing specific aspects before applying them in an integrated manner (Stammes, 2021). Hence, for teaching ED at all levels a theoretical framework is essential for elucidating the intricacies of engineering design, explicating the requisite knowledge, and optimizing instructional approaches. In the related field of teaching scientific inquiry, a sequenced, argumentation focused (knowing what, knowing how, and knowing why) approach yielded an enhanced understanding of scientific practice and encourages students to develop personal reasons for adhering to scientific criteria (Pols, 2023). We see opportunities for extending this approach to ED pedagogy and 'uncover' the yet unexplored area of integrating argumentation and ED.

ED, although often seen as particularly a creative discipline, should be considered a knowledge based activity, where more pertinent knowledge leads to better solutions. As in scientific inquiry, we believe that it should be possible to create a procedural and conceptual knowledge in science (PACKS) model that distinguishes different knowledge types that inform the decisions taken in various stages (Millar et al., 1994). Unravelling the knowledge types allows to teach these in (mere) isolation -reducing and focussing the cognitive demand- before integrating these. These knowledge types include the idea that only the best solution (in the given circumstances) suffices, and understandings of what characterizes solutions that engineers regard as 'best', what understandings contribute to that evaluation, and how those solutions can be produced. Without these understandings, students may regard ED as 'find a solution to the design problem, any solution will do' prevents students from adopting and adhering to the norms and standards designers apply in their work.

These knowledge types are not yet identified for ED and thus need an elaborate theoretical framework that elucidates the intricacies of engineering design. Using the central questions:

- What are the understandings required to successfully design, conduct, and evaluate an engineering design?
- What are the characteristics of a valid, reliable, sufficiently specific, and detailed assessment of students' understanding in engineering design?

we aim to construct a theoretical framework, (PACKED-model) that links the various knowledge types to the stages of the design process. We aim to derive a tentative set of knowledge types using literature- and field studies. Using these knowledge types, we will derive so-called field-dependent elements (Toulmin, 2003), which are the standards for judging the soundness, validity, cogency or strength of arguments. To propose, validate and test an approach to derive the presence and attainment level for these understandings, we adapt the modified Delphi approach (Hsu & Sandford, 2007) as used in Pols et al. (2022). Subsequently, using the central question:

- How does the theoretical framework and a focus on argumentation facilitate teachers to design ED teaching-materials? we will involve secondary school pre-service teachers in our teacher-education program and in-service teachers in a professional learning community (DuFour, 2004) to use the theoretical construct and derive design principles to design teaching materials and test these in their own practices. Using education design research (Akker et al., 2006), we investigate the teacher's use of the framework and its facilitation in designing lessons. The developed materials will be arranged in a coherent teaching-learning sequence, where we emphasizes throughout the need for integrating argumentation and ED: each and every design decisions should be justifiable in light of producing the best available solution within certain practical constraints (finance, time, knowledge). Using the central question:
- What does integrating argumentation in teaching engineering design contribute to student understanding, critical attitude, and use of argumentation in ED?

3.2 Open Education

iets over nieuwe wereld van OE, en de vele vraagstukken die er zijn. d eprojecten die er lopen, zowel op TUD als met twente. Ontwikkeling en onderzoek hand in hand.

3.3 Supervising

As a faculty member in Applied Physics with a research focus on physics education, my work bridges the gap between fundamental physics and the scholarship of teaching and learning. My research aims especially on enhancing physics education by integrating inquiry learning, argumentation, and conceptual understanding into instructional practices.

One of the challenges in this field is the limited availability of large-scale funding opportunities that support the hiring of PhD students. Unlike traditional applied physics research, physics education research does not typically fall within the scope of major research grants that provide long-term funding for doctoral candidates. There are research grants for education, but these foremost are focussed on education in general -

resulting in a very divers field of applicants and reviewers (not aware of the issue in a specific educational domain). Despite these constraints, I have actively pursued funding opportunities and have been committed to supervising and mentoring researchers in this domain.

In addition to my own research endeavors, I (try to) play a role in supporting assistant/associate professors (Wim Bouwman, Cees Haringa, Jessica Bickel, Rolf Hut) and colleagues (Pleun Hermsen, Margreet Docter, Rutger Ockhorst) who wish to investigate their own teaching practices. As well as students of the students association who wanted to do a study on the use of genAI in the educational program (Johann Beyers & Jesse van der Veen). Moreover, several papers have been written with students (Lennard Duynkerke, Jels Van Arragon, Kevin Van Prooijen, Luuk Van Der Goot, Nils Zwinkels, Seth Bulcke, Lisanne Oosterlaan, Fleur Collenteur, Marjolein v. Braak, Floris Dirkzwager, Koen van Uffelen, Amy Tarling & Xan Perk) on their projects done in the first year physics lab course, allowing them to gain some experience in the publishing process. Through educational grants, which often focus on curriculum innovation rather than dedicated research positions, I help guide and supervise projects that lead to meaningful educational advancements. These grants provide faculty members the opportunity to develop and implement educational innovations, and I contribute by offering expertise, mentoring, and collaborative support to ensure their success.

My leadership in this area strengthens the faculty's commitment to high-quality physics education and enhances our collective ability to contribute to the field. By fostering an environment where research-based teaching improvements are systematically explored and documented, I am actively shaping the future of physics education both within our faculty and beyond.

3.4 Review

I have been actively involved in review work for scientific journals (PRPER), professional journals (phys. ed.), conference proposals and proceedings (GIREP), and Dutch research proposals (SoTL & NRO klein) & TUD OESF. Furthermore, for the NRO's Scholarship of Teaching and Learning, I lead a TUD review committee to support teacher who … After following a training at the Institute of Physics, and reviewing for IoP's physics education, I became an IoP's trusted reviewer.

Figure 3.1: Certificate of IoP's trusted reviewer

4. Impact, valorization, leadership, organization

https://openbadgefactory.com/v1/assertion/64fea635ba085cb1e5189c1550424b0167786130

For some, it is straightforward to distinguish between Impact, valorization, leadership, organization. However, in my case, these dimensions are inherently intertwined due to the nature of my work. My research in physics education, teaching, and the dissemination of both research findings and educational materials create impact, shows leadership, …

Consequently, rather than structuring this chapter strictly along these four traditional themes, I adopt a thematic approach in which these elements naturally emerge. This structure better reflects the reality of my work, where research informs teaching, teaching generates new research questions, and dissemination—whether through academic publications or educational resources—creates impact that extends beyond the immediate academic community.

4.1 Teach the teacher

Arduino Inquiry Docenten opleiders doceren (HU / HR) Python Jupyter book -> myst Vertalen van onderzoek naar onderwijs Edudag, cursussen, teachbooks..

4.2 Open pedagogy

- verschil open education en open pegagogy
- SdF
- Python
- teachbooks en OIT, ontwikkelaar / tester MyST.
- OER / OCW nieuw platform.
- ILM

4.3 Pre-unviersity

SoTL Delft Impuls Open Leermaterialen programma

5. Appendices

5.1 Courses

2019-now

TN1405: Inleidend practicum (coordinator)

The first year physics lab course (6ECTS ∼240 students) aims at introducing students to the basics of experimental physics.

TN2985: Introduction to experiments in physics(coordinator)

This course (2ECTS ∼40 students) introduces students how opted for the minor in physics to the basics of experimental physics.

2023&2024 WM0318 Wetenschaps- & argumentatieleer (lecturer)

This course introduces the students to the philosophy of science (Nature of Science). In various sessions they discuss their standpoints regarding statements that are introduced in articles. They thereby explore their own views on the nature of science.

2022-Now SL4310 Vakdidactiek verdieping (guest lecturer ICT)

In this lecture I introduce the students to the use of four different ICT tools which can be used in the classroom.

SL4220 Vakdidactiek basis Natuurkunde/Scheikunde (guest lecturer practicum)

In this lecture I teach the basics of the pedagogy of practical work.

2023- SL4301 Implementatie van onderwijs (guest lecturer practicum Online textbooks & escaperooms)

In this course students are introduced to relevant ideas and materials that they can use in their own teaching practices. I introduce them to the use of escaperooms and the use of open online interactive books.

5.2 Supervision

20XX Master Thesis Diana

2024 Master Thesis Farah Kidwai: De SGO met perspectiefvragen - Een ontwerponderzoek naar het bevorderen van micro-macro denken in de scheikunde begripspracticumles

2025 Stage

5.3 Research output

A detailed list of scientific publications with abstracts is available here.

2024

- Redesigning a first year physics lab course on the basis of the procedural and conceptual knowledge in science model.

Physical Review Physics Education Research, 20(1), 010117.
Pols, C.F.J., & Dekkers, P.J.J.M.

2023

- Integrating argumentation in physics inquiry: A design and evaluation study.

Physical Review Physics Education Research, 19(2), 020170.
Pols, C.F.J., Dekkers, P.J.J.M., & de Vries, M.J.

2022

- ‘Would you dare to jump?’ Fostering a scientific approach to secondary physics inquiry.

International Journal of Science Education, 44(9), 1481-1505.
Pols, C.F.J., Dekkers, P.J.J.M., & De Vries, M.J.

- Defining and assessing understandings of evidence with the assessment rubric for physics inquiry: Towards integration of argumentation and inquiry.

Physical Review Physics Education Research, 18(1), 010111.
Pols, C.F.J., Dekkers, P.J.J.M., & De Vries, M.J.

2021

- What do they know? Investigating students’ ability to analyse experimental data in secondary physics education.

International Journal of Science Education, 43(2), 274-297.
Pols, C.F.J., Dekkers, P.J.J.M., & De Vries, M.J.

5.4 Educational papers (international)

A detailed list of educational publications with abstracts is available here.

2024

- Elements of proper conclusions.

Physics Education, 60(1), 015009.
Pols, F.

- The Vitruvian Man: An Introduction to Measurement and Data Analysis.

The Physics Teacher, 62(5), 356-359.
Pols, F.

- The scientific graphic organizer for lab work.

The Physics Teacher, 62(1), 20-21.
Pols, F.

- A hands-on activity to introduce the structure of NV-center quantum bits in diamond.

Physics Education, 59(4), 045017.
Ockhorst, R., Koopman, L., & Pols, F.

2023

- One setup for many experiments: enabling versatile student-led investigations.

Physics Education, 59(1), 015007.
Pols, F.

- Collaborative data collection: shifting focus on meaning making during practical work.

Physics Education, 58(2), 023001.
Pols, F., & Diepenbroek, P.

2021

- Students’ report on an open inquiry.

Physics Education, 56(6), 063007.
Pols, F., Duynkerke, L., Van Arragon, J., Van Prooijen, K., Van Der Goot, L., & Bera, B.

- What's inside the pink box? A nature of science activity for teachers and students.

Physics Education, 56(4), 045004.
Pols, F.

- The sound of music: determining Young's modulus using a guitar string.

Physics Education, 56(3), 035027.
Pols, F.

2020

- Teaching a hands-on course during corona lockdown: from problems to opportunities.

Physics Education, 55(6), 065022.
Hut, R.W., Pols, C.F.J., & Verschuur, D.J.

- A pandemic-resilient open-inquiry physical science lab course which leverages the Maker movement.

Electronic Journal for Research in Science & Mathematics Education, 24(3).
Bradbury, F.R., & Pols, C.F.J.

- A Physics Lab Course in Times of COVID-19.

Electronic Journal for Research in Science & Mathematics Education, 24(2), 172-178.
Pols, F.

2019

- Introducing argumentation in inquiry—a combination of five exemplary activities.

Physics Education, 54(5), 055014.
Pols, F., Dekkers, P., & de Vries, M.

5.5 Educational papers (national)

A detailed list of Dutch publications with abstracts is available here.

2024

- Practicum, wat hebben we (ervan) geleerd?

NVOX 49(10), 22-23
Pols, C.F.J. & van den Berg, E. & Dekkers, P.J.J.M.

- Eenvoudig online boeken maken met Jupyter Book

NVOX 49(8), 22-23
Pols, C.F.J. & Idema, T.

- Leren onderzoeken

NVOX 49(6), 50-51
Pols, C.F.J.

2023

- De radioactiviteit van fruit

NVOX 48 (8), 52-53.
Pols, C.F.J., Zwinkels, N., Bulcke, S.

- Melk in je koffie

NVOX 48 (5), 12-14. Mooldijk, A. & Pols, C.F.J.

- De natuurkunde van Spiderman

NVOX 48 (4), 34-35.
Pols, C.F.J.

2022

- Proeven (v/a)an vroeger.

NVOX 47 (10), 286-286.
Pols, C.F.J.

2021

- Practica bij de valbeweging.

NVOX 46 (10), 34-35.
Pols, C.F.J.

- Kritisch? Ik?! Ontwikkeling van een kritische houding in een leerlijn onderzoeken

NTvN
Pols, C.F.J.

2020

- Bouw een demoproef.

NVOX 45 (10), 58-59.
Pols, C.F.J., Hut, R.W., Oosterlaan, L., van Braak, M., Collenteur, F.

- Practicum, net even anders

NVOX 45 (8), 438-439.
Pols, C.F.J.

2019

- De Scientific Graphic Organizer

NVOX 44 (8), 410-411.
Pols, C.F.J.

- De mens van Vetruvius

NVOX 44 (6), 286-286.
Pols, C.F.J.

- Leren onderzoeken: een praktische aanpak in klas 4.

NVOX 44 (2), 98-99.
Pols, C.F.J.

- Leerlingen leren onderzoeken

Nederlands Tijdschrift voor Natuurkunde, 84 (11), 45-47.
Pols, C.F.J.

- De hellingproef: Een practicum over het ontbinden van krachten in componenten

NVOX, 47 (8), 442-443.
Pols, C.F.J. (2019).

2018

- Beweging in stop-motion

NVOX, 43 (5), 244-245.
Pols, C.F.J.

2017

- Snaartheorie in de praktijk

NVOX, 42 (2), 72-73.
Pols, C.F.J. (2017).
- Technisch ontwerpen in 4V.

NVOX, 42 (1), 40-41.
Pols, C.F.J. (2017).

2016

- Een leerlingpracticum quantummechanica voor minder dan € 30,-

NVOX, 41 (3), 132-133
Pols, C.F.J. & Nelk, J.P.
- Een foto of grafiek zegt meer dan 1000 woorden

NVOX, 41 (2), 68-69.
Pols, C.F.J.

2014

- Een versnelling langs een helling

NVOX, 40 (4), 178-179
Pols, C.F.J.

5.6 Books & Chapters

- ShowdeFysica 3: Natuurkunde laat je zien (2023)

NVON
Frederik, I., van den Berg, E., , Dekkers, P., Pols, F., Sonneveld, W., Spaan, W., van Veen, N., Staderman, K.
- Show de Fysica 2: Natuurkunde laat je zien (2017)

NVON
Frederik, I., van den Berg, E., te Brinke, L., Dekkers, P., Pols, F., Sonneveld, W., Spaan, W., van Veen, N., van Woerkom, M.
- Show the physics (2024)

NVON & TUD
Pols, F. & Dekkers, P.J.J.M.
- Maker education in the applied physics bachelor programme at Delft University of Technology (2023).

Chapter in Klapwijk, M., Gu, J., Yang, Q., & de Vries, M. J. Maker Education Meets Technology Education: Reflections on good practices.
Brill
Pols, F., & Hut, R.
- Leerstofdomeinen: Technische automatisering (2017)

Chapter in Kortland, K., Mooldijk, A. Poorthuis, H., Handboek natuurkundedidactiek, 206-211.
Epsilon
Mooldijk, A. & Pols, C.F.J.

5.7 Conferences, workshops & trainings

https://polslab.tnw.tudelft.nl/index.php?page=Conferences

2025

- Integration of argumentation as prerequisite for effective practical work

A presentation on the integration of argumentation and practical work at the ESERA conference, Copenhagen, DK
Pols, C.F.J. & Dekkers, P.J.J.M.

- We've got 99 demonstrations and so much fun!

A workshop on physics demonstrations at the GIREP conference, Leiden, NL
Pols, C.F.J. & van Veen, N.

- Towards Open Physics Education: Teaching with Jupyter (Note)Books

A presentation on teaching with Jupyter Books at the GIREP conference, Leiden, NL
Pols, C.F.J.

- Opening up Classroomdemonstrations

A workshop on physics demonstrations at the AAPT Winter Meeting, Saint Louis, USA
Pols, C.F.J.

- The Scientific Graphic Organizer for lab work

A posterpresentation on the SGO at the AAPT Winter Meeting, Saint Louis, USA
Pols, C.F.J.

- Teaching Scientific Inquiry

A presentation on my dissertation at the AAPT Winter Meeting, Saint Louis, USA
Pols, C.F.J.

2024

- Jupyter Books

A teacher professionalization training (betasteunpunt, TU Delft) on the making of Jupyter Books.
Pols, C.F.J., van Woudenberg, T.

- Python in teaching

A teacher professionalization training (betasteunpunt, TU Delft) on Python, introducing (physics) teachers to Python programming
Pols, C.F.J.

- Show de Fysica

Several physics demonstrations showed at the WND conference, Noordwijkerhout, The Netherlands.
Pols, C.F.J., Dekkers, P.J.J.M., Frederik, I., Sonneveld, W. et. al.

- Creating magical, meaningful moments with demonstrations

At the 7th of November, I gave a workshop on the use of physics demonstrations at the education day of TU Delft.
Pols, C.F.J.

- Python in Teaching event

At the 14th of March, we have held a Python in Teaching event at Delft University of Technology. Several teachers presented their approach to Python teaching
Pols, C.F.J.

- Opening up classroom demonstration experiments

A poster presentation at the 12th International Conference on Physics Teaching in Engineering Education PTEE on our project in which we are opening up our classroom demonstration experiments to students.
Pols, C.F.J. & Haaksman, R.H.

- Redesign of a first year physics lab course

A presentation at the 12th International Conference on Physics Teaching in Engineering Education PTEE on the recent redesign of the First Year Physics Lab Course at TU Delft.
Pols, C.F.J.

- Enhancing a critical attitude in experimental physics

A workshop at the 12th International Conference on Physics Teaching in Engineering Education PTEE on increasing students' critical attitude towards experimental physics.
Pols, C.F.J.

2023

- The Pedagogy of Lab Work: Unleashing the potential of lab activities

A workshop on the pedagogy of university lab work at the education day of TU Delft.
Pols, C.F.J.

- Python4All @ TU Delft

A presentation and discussion session on how we teach introductory Python at TU Delft.
Pols, C.F.J.

- Python4All

A roundtable discussion on the introduction of Python to first year students at the CDIO conference, Trondheim
Pols, C.F.J., Steele, G.A.

- Development of the mental model of wave – particle as basis for wave-particle duality

Preliminary results of an investigation on students' understanding of waves/particles presented at the GIREP conference, Kosice
Ockhorst, R. & Pols, C.F.J.

- Introducing quantum physics concepts through lesson materials on quantum technology

Teaching materials on QM presented as poster at the GIREP conference, Kosice
Ockhorst, R., Koopman, L. & Pols, C.F.J.

- Show de Fysica

Several physics demonstrations showed at the WND conference, Noordwijkerhout, The Netherlands.
Pols, C.F.J., Dekkers, P.J.J.M., Frederik, I., Sonneveld, W. et. al.

2022

- Show de Fysica.

Several physics demonstrations showed at the WND conference, Noordwijkerhout, The Netherlands.
Pols, C.F.J., Dekkers, P.J.J.M., Frederik, I., Sonneveld, W. et. al.

- An introduction to the Assessment Rubric for Physics Inquiry.

Paper on ARPI presented at the GIREP conference, Ljubljana, Slovenia.
Pols, C.F.J. & Dekkers. P.J.J.M.

- The scientific graphic organizer for practical work.

Poster on the use of the SGO presented at the GIREP conference, Ljubljana, Slovenia.
Pols, C.F.J. & Diepenbroek, P.

- Towards inquiry: Redesign of a first year physics lab course.

Presentation of the transformation of the FYPLC at the GIREP conference, Ljubljana, Slovenia.
Pols, C.F.J.

- The pedagogy of practical work

Workshop for teacher educators at the Hogeschool Rotterdam
Pols, C.F.J.

2021

- Differences and similarities in approaches to physics LAB-courses.

Symposium (chair) at the online GIREP World Conference on Physics Education, Hanoi, Vietnam.
Pols, C.F.J., Lewandowski, H.J., Logman, P.S.W.M. & F.R.Bradbury.

- Development of a teaching sequence on physics inquiry.

Paper on the TLS presented at the online GIREP World Conference on Physics Education, Hanoi, Vietnam.
Pols, C.F.J., Dekkers, P.J.J.M., & de Vries, M.J.

- From producers to consumers: fostering students' scientific approach to practical work.

Paper on an introductory inquiry activity presented at the Online GIREP conference, Mino, Braga, Portugal.
Pols, C.F.J., P.J.J.M. Dekkers, M.J. de Vries.

- Using the Assessment Rubric for Physics Inquiry for open inquiries in a multidisciplinary lab course.

Online Physics Education Research Conference 2021.
F.R. Bradbury & Pols, C.F.J.

- Assessing a flipped-lab course consisting of open-inquiry projects using Arduinos.

AAPT Online Summer Meeting 2021.
F.R. Bradbury & Pols, C.F.J.

- Constraints in Physics Lab Courses: the Good, the Bad, and the Pandemic.

Invited speaker at APS March Meeting.
Bradbury, F.R. & Pols, C.F.J.

2020

- Open-inquiry experiments using sensors controlled by Arduinos in a pandemic-resilient lab course.

Poster presentation at Physics Education Research Conference
Bradbury, F.R., Pols, C.F.J. & Vlaanderen, C.L.

- Teaching Scientific Inquiry

Workshop for teacher educators at the Hogeschool Utrecht
Pols, C.F.J.

2019

- Using cogency to foster the use of concepts of evidence in physics experiments.

Paper presented at NARST, Baltimore, USA.
Pols, C.F.J., P.J.J.M. Dekkers & M.J. de Vries

2018

- Data-analysis in practical work, what do students know?.

Paper presented at the GIREP conference, San Sebastian, Spain.
Pols, C.F.J. & Dekkers, P.J.J.M.

5.8 Grants & Applications

Year	Title	Call	Main applicant	Accepted
2014	The interactive whiteboard as intervention during practical work in physics class to increase students learning	NRO: Promotiebeurs voor leraren	V	V
2023	Perspective Agility for Navigating Diversity, Collaboration and Conflict in order to advance Equity and Inclusion	NRO: Comenius Senior fellow	X	V
2023	A modular programming book for engineering students	TUD Open Education Stimulation Fund	X	X
2023	Opening Up Classroom Demonstration Experiments	TUD Open Education Stimulation Fund	X	V
2023	The road to scientific inquiry	TUD Education Fellowship	V	V

Year	Title	Call	Main applicant	Accepted
2023	To ChatGPT, or not to ChatGPT: Effectief gebruik van Artificial Intelligence in het onderwijs	NRO: Comenius teaching fellowship	V	X
2024	Integration of Argumentation and Engineering Design	NRO: edVenturous Questions	V	X
2024	Towards a coherent curriculum: Guiding curriculum transformation through educational design theory	NRO: Hoger onderwijs van de toekomst	X	X
2024	From Closed to Open: Bottom-up Open Educational Resources with and for pre-service teachers	NRO: Comenius teaching fellowship	V	X
2024	Curriculum	TUD Education Fellowship	X	V
2025	The Scientific Graphic Organizer as aid for practical work in science subjects	NRO: Pareltjes uit de praktijk	X	X
2025	gAI in secondary education – designing exemplary activities to develop student and teacher competences	NRO: Kennis voor de toekomst, Klein	X	
2025	Integration of Argumentation and Engineering Design	NRO: Kennis voor de toekomst, Middel	V	X
2025	Building Thinking Classrooms in Wiskunde-, Natuurkunde- en Scheikundeonderwijs	NRO: Kennis voor de toekomst, Middel	X	
2025	Student-Centred Learning with AI Tutors in Project Work	TUD: AI-Augmented Engineering Education	V	X
2025	Jupyter Books for education & open publishing: Next Level	TUD Open Science Fund	X	V
2025	Doe de Fysica	Betadecanen	V	X

Year	Title	Call	Main applicant	Accepted
2025		Open Hardware	V	V
2025		Open Science	V	X

Comenius 2x

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