Vision statement

Freek Pols

Contents

1. Introduction

Updated: 15 jan 2026 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 and innovator, 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 - also known as JupyterBook, 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. Moreover, this technology is used for the latest online interactive textbook publications, see for instance TUD's first year physics mechanics book.

Where in former years at Delft we have used this technology (were consumers of the system), we now have come to a stage where we actively contribute to the development of the MyST ecosystem (become producers of the system). For instance, this PDF version is made with a self-made bare-bone typst template which is open access available.

1.1 How to read this document

To support a clear and fair assessment, this guide explains how each chapter is intended to be read and what it demonstrates with respect to my development toward the role of associate professor with an emphasis on education.

Chapter 2 should be read as evidence of my role as an educational leader who designs, coordinates, and continuously improves education at scale. The focus is not on isolated teaching activities, but on systematic transformation of courses, curricula, and teaching practices, grounded in educational principles and sustained over multiple years.

Chapter 3 presents my work as a physics education researcher who develops theoretical frameworks and empirically grounded insights into scientific inquiry, argumentation, and engineering design. While my research is closely connected to teaching practice, this chapter should be read as a contribution to the international research community, not as a report on educational innovation.

Chapter 4 highlights my efforts to enable and amplify impact beyond my own teaching and research. This includes valorization of educational materials, leadership in professional communities, and organizational contributions that support others in innovating their educational practices. I make a clear distinction between local, national and international efforts.

Further evidence per chapter is provided in the appendices. These appendices include detailed descriptions of courses taught, research publications, and valorization activities. While these chapters contain important information, they should be read as supplementary material that substantiates the main narrative.

Sincerely yours,

Freek Pols

2. Education

Updated: 15 jan 2026 I think one of my first experiences with teaching is instructing sailing at an age of 14. At upper secondary school, I was a tutor for several years, helping fellow students with mathematics and physics. When I was 16, I became an instructor in a martial art (Pencak Silat) that I was practicing. In hindsight, it thus seemed 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.

2.1 Innovating lab courses

In 2019 I started my position at TU Delft as a lecturer/innovator of two lab courses.

The first-year physics lab course (TN1405, 6 ECTS) was largely unchanged from its format in 2004 when I took the course as a first-year student. The course had run more or less the same for 40 years and was not much appreciated in the last two decades. The course that was taught for third year minors (TN2985 - 2 ECTS) was a one-on-one translation of the first year course and was not much appreciated by the students.

The assignment given by Prof. Chris Kleijn (then program director) had three objectives:

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

After a year of getting acquainted with the two courses, identifying the bottlenecks and possibilities (also for the administration that was still done on paper and therefore labor intensive), I started the innovation process in 2020. The results of the innovation have been published in several educational journals and conference proceedings - especially in C. F. J. Pols & Dekkers (2024) .

To summarize, the main changes in the FYPLC that were implemented are:

- Redesign of the entire course to focus on research skills and scientific thinking instead of following instructions to perform experiments.
- Introduction of a new practicum on determining *g* with **0.1% accuracy**.
- Introduction of a final project where students design and conduct their own experiments (given some constraints).
- Introduction of a **final exam** covering Python, data analysis, measurement, and uncertainty.
- Implementation of blended learning, reducing contact hours by 50% and allowing students to prepare at home.
- Digitization and automation of administrative tasks, enabling TAs to manage attendance and grading independently.
- Complete revision of the labcourse manual (twice), with links to lectures, assignments, interactive quizes and activities etc.
- Revision of grading rubrics.

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) and 8.4 (2025)**.

Note that a **6-ECTS practicum** with around **240 students** cannot function without TAs. Major changes have been implemented here as well: 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.

With the renewed physics curriculum of 2025, the FYPLC has been further adapted. Rather than one course it is now split into two courses of 5 ECTS each, one in the first quarter and one in the second quarter. The first course was directly adopted from the previous FYPLC, no adjustments were needed. The second course however was redesigned to better align with the content of the second quarter (thermodynamics). Together with Roel Smit we designed nine laboratory activities and ten thermodynamic simulations aiming to develop better understanding of thermodynamic concepts at the macroscopic level through a focus on microscopic particle behavior.

> **example of simulation**
>
> Include a YT clip here of one of the simulations, e.g. brownian motion.

2.2 Teacher education

For a long time I have been involved in the teacher-education program at TU Delft. It started with teaching specialized topics as ‘labwork in science education’ and the use of ICT. Over the years my involvement has increased, contributing (e.g.) to the development of a new course (implementation of education) - where students ought to consider the merits and trade-offs of different educational approaches (like doing an educational escaperoom) and test it in their own class.

With the upcoming retirement of the current main teacher educator for physics, my involvement in the program has increased, e.g. in supervising master thesis projects. Related to this is my senior university teaching qualification (SUTQ) project: The development of a learning pathway on scientific inquiry in the teacher-education program. What has been observed in the teacher education program is the lack of a coherent program on educational research in the teacher-education program. Still, students of the two year masters program are expected to do a research project. However, there is little scaffolding in the program to prepare students for this task. Moreover, the various teachers involved seem to have different opinions about the role and nature of educational research in the program. In the SUTQ project (2025-2026) I addressed *why, what, when, by whom, and how we are teaching educational research in TU Delft’s teacher-education program*, ultimately leading to a blueprint for a learning pathway.

2.3 Vision statement on education

Philosophy: My philosophy in education is that I want students to develop (in a structured way) a sense of what (scientific) quality entails. For teaching in the first year physics lab course, this means that I want students to learn how to make well-considered choices throughout the research process. There is no single method in science, and there are no set procedures that always lead to the best result. The question at the core is *What decision leads to the best result in the given circumstances?* Hence, rather than telling students what to do - or following a recipe - they should consider the quality of their choices and actions throughout the process and, ultimately, be able to argue why their decision is defensible in light of the constraints at that specific moment in time.[1]

In the teacher-education program a similar approach is used: there are so many ways to engage pupils in learning physics, I hardly can cover all of them. However, we might enable pre-service teachers to develop a sense of what quality teaching is, recognize it and therefore understand whether to adopt and adapt a certain teaching strategy or not.

This philosophy sets me as a teacher not in front of the class but in the middle of the classroom, coaching and guiding students in their learning process. I see my role as that of a facilitator who creates an environment (and materials) where students can explore, experiment, and learn from their experiences. This is not always successful as some students are more acquainted with the idea *"tell me what to do, and I will do that (for you)"*. However, in the end they all seem to benefit from my approach.

Technology: I like to explore new ways of teaching, especially with the use of technology. I explored and implemented the use of interactive textbooks (see impact section), and the use of ChatGPT. The latter might especially help students in writing - where I see a lot of potential but also want to be cautious that the AI is not taking over their thinking (and thus their learning process). Again, I want students to be able to develop a sense of what quality is, recognize it and therefore understand whether to adopt and adapt a text produced by genAI.

Future: I aspire to continue my role in both the educational program of Applied Physics and the teacher-education program. I enjoy teaching physics, in particular teaching scientific inquiry. At the same time, I am increasingly aware of the societal urgency of the teacher shortage. I believe that universities have an important responsibility in addressing this challenge. Universities should not only be educating future engineers and scientists, but also actively stimulating and supporting students who may consider a career in education. Besides, I really like inspiring future teachers and enjoy their creative ways of engaging pupils in physics.

In a dual role as physics educator in the Applied Physics program and physics teacher educator, I believe I can contribute optimally to both programs. Through my involvement in the bachelor program, I reach approximately 200 students per year at an early stage in their academic development. This allows me to make a larger number of students aware that the teacher-education program exists and to inspire them to at least consider a career in education.

Moreover, I see strong potential for cross-pollination between the two programs. My involvement in teacher education allows me to bring current insights from physics didactics into the Applied Physics curriculum. Conversely, developments in university-level physics education (such as innovations in laboratory work, inquiry-based learning, and the use of open and digital tools) can enrich the teacher-education program. In this way, the dual role strengthens both programs and contributes to a more coherent and future-oriented educational ecosystem within the university.

2.4 Reflection

I believe that the above demonstrates that I am not only able to teach physics at different educational levels but also that I possess the skills and experience to innovate educational programs in a sustained and systematic manner, both at the level of individual courses and at the level of the curriculum. Furthermore, my work extends beyond teaching and local educational practice. I actively contribute to the development of education by disseminating insights, materials, and results through professional and academic journals, as well as through national and international conferences (see Appendix A). In doing so, I connect educational practice with scholarly reflection and contribute to the broader community of physics and physics education

[1] I will come back to this in my research section.

educators. Taken together, these activities reflect my readiness to take on greater responsibility and leadership in education, in line with the role and expectations of an associate professor with an emphasis on education.

3. Research

Updated: 15 jan 2026

Warning

2. Clarify prioritization across research strands

You currently present:

- inquiry + argumentation,
- engineering design,
- writing & AI,
- teacher knowledge.

All are interesting, but together they may appear overambitious.

Recommendation:

- Make clearer (implicitly or explicitly):
- what is core (your main line),
- what is supporting or derivative,
- what is exploratory.

5. Sharpen the final Reflection toward promotion readiness

Your reflection is honest and reflective—but slightly cautious.

Committees are reassured when a candidate:

- acknowledges limits,
- but still claims readiness.

Recommendation: Without changing tone, ensure the reflection clearly answers:

- Why is this the right moment for the next step?
- You already have the evidence; it is mostly a matter of emphasis.

3.1 Research line 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 the structure arguments. It emphasizes 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 — Argumentation 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.

However, many of these studies focus primarily on the structure of the argument (e.g. identifying claims, warrants and backings) rather than looking at the content itself: what arguments are used as backing, what is the quality of the evidence, and how do students decide what data to collect and how to interpret it. But if we want to teach students (at whatever level) how to setup a rigorous scientific inquiry, or design a durable and long-lasting solution to a technical problem, we need to go beyond the structure of the argument. We need to understand how students make decisions throughout the research and design process, what knowledge they use to justify their choices, and how they can be supported in developing a more sophisticated understanding of scientific practices.

My former PhD research focused on integrating argumentation into scientific inquiry education at the secondary school level (Pols, 2023). Building on this work, my current and future research aims to further explore the integration of argumentation in both scientific inquiry and engineering design education. The goal is to develop theoretical frameworks and practical teaching approaches that help students not only understand the structure of scientific arguments but also engage deeply with the content and reasoning processes that underpin scientific research and engineering design. To further elaborate on what this entails, I provide two sections below that outline the research directions in scientific inquiry and engineering design education, respectively.

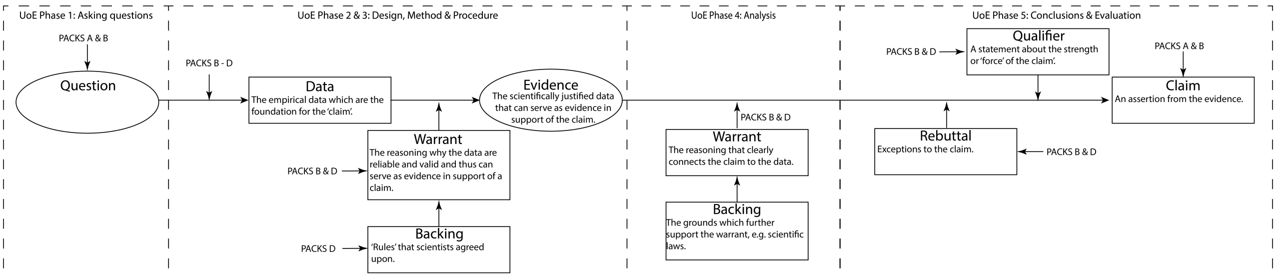

Figure 3.1: The Toulmin argumentation model integrated with the PACKS model, linking argumentation elements to types of knowledge required for scientific research.

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. (2022a). 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 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.

Given the structural realities of education research, I build research capacity through mentoring, collaboration, and embedded research. For instance, in addition to my own research endeavors, I (try to) play a role in supporting assistant/associate professors and colleagues who wish to investigate their own teaching practices. Moreover, several papers have been written with students 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.

> **Warning**
>
> show that working with other is not incidental, but a deliberate, field-aware strategy. It builds capacity.

> What "capacity building" looks like in your case
>
> Without adding new activities, your work already shows that you:
>
> enable colleagues to turn teaching into research,
>
> create publication opportunities for students,
>
> translate innovation grants into scholarly output,
>
> support others through reviewing and proposal feedback.

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.

3.3 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 3.2: Certificate of IoP's trusted reviewer

3.4 Reflection

I believe that the above illustrates that I found a niche in research that is worthy and interesting to pursue. I want to dedicate the next years to further develop this research line, and to contribute to the field of physics education research - at both secondary and tertiary level. Although have not had the opportunity to formally supervise PhD students yet, I am actively involved in mentoring and guiding researchers in this domain. Moreover, I am recognized and frequently consulted by colleagues and editors to review educational research proposals and manuscripts. Taken together, I am confident that I can make meaningful contribution to the research as well as serve our university by disseminating this knowledge to our students and colleagues.

4. Valorization, impact, leadership, organization

Updated: 15 jan 2026 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 Open pedagogy

Open Education can be described as the (re)designing and sharing of learning materials, teaching methods, and practices that are freely accessible to everyone. Open pedagogy goes beyond merely making materials available; it also encompasses the open sharing of the associated didactic approaches and pedagogical strategies used to provide effective education.

My commitment to open pedagogy is reflected in my efforts to not only create open educational resources but also to openly share the pedagogical principles and methods that underpin these materials. This includes documenting best practices, sharing experiences, and fostering a culture of collaboration. I actively engage in these activities at local, national, and international levels.

4.1.1 Local:

At our university I initiated and participated in various initiatives to promote open pedagogy. For example, I contributed to the **TU Delft Education Day**, **TNW education day** and **Teaching Lab** by conducting workshops and presentations (e.g. Python4All). I also organized a **TU Delft-wide day** focused on Python for educators, emphasizing the use of open tools and methods in teaching.

In the committee for the establishment of the **Revising Academic Position Criteria** report (resulting in The Academic Development Guide), I advocated for the recognition of the importance of open education in academic career paths[2]. Additionally, I participate in the **Open Interactive Learning Materials (OILM) working group** within TU Delft, focused on developing and promoting open learning materials and pedagogical approaches. In this **committee** we define guidelines and strategies regarding open education (especially the publication of books and learning materials).

I also contribute to **COMBINE**, a Comenius initiative aimed at co-creating open learning materials with students. In this project I focus on the tools that allow both teachers and students to create interactive materials using Jupyter Book technology. Related to this, I am involved in the development of **Teachbooks**. A TU Delft initiative easing the way how open textbooks are created. Involvement in these initiatives allow other to create shareable resources more easily, thereby promoting open pedagogy.

4.1.2 National:

At national level, I have been actively involved in various ways to promote a culture of open pedagogy and teacher professionalization. On a regular basis I report on educational practices in the Nederlands Tijdschrift voor Natuurkunde and the NVOX, the professional journal of the

[2] I have been asked to contribute to the development of the Academic Development Guide for all UD’s, UHD’s and Professors at TU Delft, replacing the Performance (WP) criteria. I was asked by the TU Delft Recognition & Rewards Committee to act as an expert in focus groups and individual consultations – particularly for the result area Education and the Career Path with Emphasis on Education Handbook.

Dutch Association for Education in the Natural Sciences. I have also organized and contributed to national conferences (landelijke practicumdag) and workshops focused on open education (NPulse / Surf), sharing insights and best practices with educators across the country. Next to that I am involved in teacher professionalization in various ways: I have organized trainings and workshops on Arduino in secondary physics education, python for teacher, teaching physics inquiry. Moreover, I am in the board of the **Werkgroep Natuurkunde Didactiek (WND)**, the Dutch Physics Education organization that organizes a yearly professional development conference for ~600 physics teachers.

4.1.3 Internationaal:

Internationaal heb ik bijdragen geleverd aan conferenties GIREP, AAPT, en CDIO en middels artikelen in AAPT's The Physics Teacher en IoP's Physics Education. Jupyter Book …

Figure 4.1: 2025 Open Education Award for Excellence Nominee

Together with TU Delft colleague Peter Dekkers we published the interactive book Show the Physics as an open educational resource. This book is now used internationally to professionalize pre-service and inservice physics teachers.

5. Appendices

Updated: 14 jan 2026 Below are the appendices with additional information on my academic activities categorized by the three different sections in this document.

5.1 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 Youri Barends

2025 Master Thesis Marcel Claus

2025 Master Thesis Mila Dobrovinski

5.2 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.

5.3 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.

5.4 Books & Chapters

- Broekzakdemos (2026) NVON van den Berg, E & Pols, F
- Show the physics (2024)

NVON & TUD
Pols, F. & Dekkers, P.J.J.M.
- 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.
- ShowdeFysica 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.
- 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.

5.5 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.

Comenius 2x

5.6 Software & Educational tools

- Teachbooks
- plain_typst_template: A minimal Typst book template for Jupyter Book users, allowing users to create a high-quality PDF version of their Jupyter Book content using Typst.
- Myst plugins: A ....
- [tutorial] workshops
- Jupyter Book:

documentation

5.7 Education

Updated: 15 jan 2026 Below is a selection of relevant elements supporting the …

5.7.1 Courses

Course code	Course name	Year	Role	Description
TN13010	Inleidend practicum 1	25 - now	Coordinator	A redesign of the FYPLC complying with the renewed physics curriculum. It includes now a 2 ECTS project on mechanics.
TN13015	Inleidend practium 2	25 - now	Coordinator	A redesign of the FYPLC complying with the renewed physics curriculum. It includes now a 2 ECTS project on thermodynamics.
TN1405	Inleidend practicum	19-25	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	19 - 25	Coordinator	This course (2ECTS ∼40 students) introduces students how opted for the minor in physics to the basics of experimental physics.
WM0318TN	Wetenschap en argumentatieleer	22-23	Tutor	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.
SL4301	Implementatie van onderwijs	23 - now	Guest lecturer	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.

SL4220	Vakdidactiek basis	22 - now	Guest lecturer	In this lecture I teach the basics of the pedagogy of practical work.
SL4320	Vakdidactiek verdiepend	22 - now	Guest lecturer	In this lecture I introduce the students to the use of four different ICT tools which can be used in the classroom.

Table 5.1: Courses taught

5.7.2 Dissemination of course innovations

This is a selection of the outputs related to the innovation of the lab courses.

- Pols (2020): *A Physics Lab Course in Times of COVID-19*. A paper on the transition to online education during the COVID-19 pandemic.
- C. Pols & Dekkers (2024): *Redesigning a first year physics lab course on the basis of the procedural and conceptual knowledge in science model*. A scientific article on the redesign of the FYPLC.
- F. Pols et al. (2021): *Students' report on an open inquiry*. A paper on students' experiences with open inquiry in the redesigned lab course.
- Pols (2023): *One setup for many experiments: enabling versatile student-led investigations*. A paper on the newly included experiment to determine g with 0.1% accuracy and how it enables various students-led investigations.
- Pols (2024): *Elements of proper conclusion*. A paper on writing of proper conclusions at first-year level.
- Pols et al. (2021a) *(Comparison of practicum courses across four universities)* A GIREP Symposium where we compare different approach to physics lab courses across four universities.

5.7.3 Books and manual

5.8 Research

Updated: 15 jan 2026 A selection of relevant research outputs supporting …

5.8.1 Scientific publications

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

- Pols & Dekkers (n.d.)
- Bickel et al. (n.d.)
- Putter-Smits et al. (2025)
- C. Pols & Dekkers (2024)
- C. Pols et al. (2023)
- Pols et al. (2022b)
- Pols et al. (2022a)
- Pols et al. (2021b)

5.8.2 Publications with colleagues

- Ockhorst et al. (2024)
- Pols & Hut (2023)
- Hut et al. (2020)
- Pols & Idema (2024)
- (n.d.-a)
- (n.d.-b)
- (n.d.-c)

5.8.3 Publications with students

- F. Pols et al. (2021)
- F. Pols et al. (2023)
- Pols et al. (2020)
- Pols (2023)
- Pols et al. (n.d.)
- Smit et al. (n.d.)

5.9 Valorization

Updated: 15 jan 2026

5.9.1 Articles published with students

Pols et al. (2020); Pols (2023); F. Pols et al. (2021); F. Pols et al. (2023)

5.9.2 Articles published with colleagues

Hut et al. (2020); OCKHORST et al. (n.d.); Ockhorst et al. (2024); Ockhorst & Pols (2025); Pols et al. (2020); Pols & Hut (2023)

5.9.3 Books

SdF 2,3 en online chapters in handboek

5.9.4 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
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

Year	Title	Call	Main applicant	Accepted
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	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	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
2025	An affordable and adaptive educational escaperoom	Open Hardware	V	V
2025	Connecting and boosting open science and open education through JupyterBook	Open Science	V	V

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