TEACHING PORTFOLIO

Documentation supporting my application for the Basiskwalificatie Onderwijs (BKO)

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Contents

Introduction

My BKO portfolio is structured in two chapters. Chapter 1 contains some self-reflection in regards to teaching and, similarly, Chapter 2 contains some self-reflection in regards to supervision. A disclaimer is that sometimes I make rather categorical statements about these topics, but they should be interpreted as statements that apply mostly to my own style of supervision/teaching (which is itself subject to change over time). Whenever I want to emphasise certain points, I use a blue background. Ideas for further improvement are shown in a red background.

The document also contains five appendices. Appendix A contains a self-reflection document written back in 2019. Appendix B is the on-boarding questionnaire I wrote when I took the "Teaching in Higher Education" course in 2018. Both appendices are prefaced by short discussions in which I point out how the points that I raised back then (namely, various insecurities about my teaching) have been now been addressed. Appendix C contains a letter written by Prof. E. van den Ban after attending one of my lectures this year. Appendix D simply links to the supporting material for this portfolio. Appendix E contains my CV.

Self-reflection I

Teaching

1.1 Lecturing as storytelling

A question that I go back to often is: "What is the added value of my lecturing (compared to staying at home, reading the recommended book/notes, and doing the exercises on your own)?". The answer to this question depends rather heavily on the learning style and capabilities of each concrete student. What follows are some of my thoughts on it and how they relate to my teaching.

1.1.1 Clarity, pace, structure

A first (maybe obvious?) comment is that our lecturing should be *at least as good as the written material.* Namely, it should be paced adequately for the audience to follow and possibly take notes, and it should be structured/presented with an emphasis on clarity. Despite it being obvious, this point has always been a struggle for me; see Appendices A and B. My own natural tendency it to get excited about the ideas, skip details, and try to reduce most arguments to a handful of pictures (given in rapid succession with little idle time in-between).

Being aware of these issues (and preparing my classes accordingly) has improved my teaching noticeably in the last 2-3 years[1]. Every time I go into a class I have with me a detailed plan for the lecture. The plan includes a clear separation into sections/topics, which allows me to introduce stops in-between for the students to process what is going on. Every time I start a topic, I try to state a goal or motivating example that explains why this may be interesting. During the lecture, I am constantly forcing myself to write

[1] See the report (Appendix C) written by Prof. E. van den Ban after attending one of my lectures this year.

down carefully the arguments (as well as relevant pictures/insights) and to stop for a bit once a proof is complete. When an argument is involved, I always present it as a sequence of simple lemmas.

Part of this process has also involved learning to let go. Sometimes we are under rather strict timelines regarding the content we must cover, and it is tempting to sacrifice pace/intelligibility in order to meet them. This defeats the point of lecturing[2]. With this in mind, when preparing the lecture, I identify which proofs I will skip if there is not enough time to do it all. Furthermore, I have come to terms with the fact that postponing material to later lectures is sometimes the best solution.

A lecture that follows the original sources in a clear/structured manner is already accomplishing something: it forces the students to sit down and listen to the material for a couple of hours. The act of showing up to class, listening, asking questions (hopefully), and interacting with other students is an important learning mechanism. We can already see this as added value for the student that needs this extra push. However, it is arguably less impactful for the student that is autonomous and capable of learning by simply reading the book and doing the exercises. How can our lectures help those students?

1.1.2 Providing insights

This brings me to my second point. Lectures (or research talks) are meant to share the insights that are personal to us. It is often the case that the formal definition of a given mathematical object has very little to do with the mental model that we have for it[3]. Developing your own mental model is fundamentally rooted in *active learning* (since it boils down to coming up with examples, proving elementary properties, developing and solving questions about the object[4]...) but achieving it can be substantially sped up if someone guides you through some of the underlying insights/intuitions.

I see this personal understanding as our biggest asset as lecturers, and as one of the main reasons why mathematicians still embrace traditional lecturing[5]. Indeed: after taking the course "Teaching in Higher Education", I tried to incorporate active learning into my lectures. I prepared activities in which the students had to solve a problem in small groups[6] but I always found the results disappointing. Somehow, the time never

[2]I sometimes remind myself of the fact that throwing statements around at high speed is not lecturing.

[3]Furthermore, my mental model may be different from yours!

[4]As we now, this never really stops. As you research an object, your mental model evolves.

[5]With good ol' blackboard and chalk!

[6]I used various flavours of this idea: First work individually and then crosscheck with the other members of the group. Change the groups periodically so ideas transmit from one group to another and students are forced to explain out-loud what they have done previously. Work in groups and then present the conclusions in front of the class...

felt as well spent as just simply lecturing. I think there is a good reason for this: you cannot expect students that have just seen a concept to come up on the spot with new strategies to solve a related problem; the gap between the definition and a functional mental model is just too large[7].

That is to say: there are effective ways of activating the students (I discuss some of the ideas that I have tried in Section 1.2), but these should serve as support mechanisms (and not as replacements) for the lectures.

For me, my most important role (as a lecturer) is to be a bridge between the original sources (which may be dry/abstract/difficult to parse) and what each concept *really means*. This can be achieved in various ways: from heuristics and pictures to illuminating examples, concrete algorithmic ways of approaching a problem, or by relating to other areas of Mathematics.

When we do this, we have to keep in mind that, for a student seeing the material for the first time, it may be difficult to distinguish technicalities/busywork from the actual crux of the matter; making this distinction (through well-chosen emphasis) is part of our role.

1.1.3 The lecture as a murder-mystery

As researchers, we are familiar with the following *modus operandi*: We have a certain question in mind, related to our own research. After some thinking on our own, we look into the literature to find relevant content. Upon opening an article, we skim through the abstract and the main results and, unless something catches our attention (perhaps because it clashes with our expectations), we move on. Sometimes we go back to something that we already read to dive deeper into some of the details. Often, instead of reading a proof we just stare at the statement and try to figure it out on our own[8].

This manner of proceeding is very much non-linear and it stands in contrast with the manner in which we *write* Mathematics (which is very much linear, although we

[7]Imagine the following scenario: you try to implement "active learning" as part of your lectures. You have just defined the notion of smooth manifold as a topological space built out of euclidean charts glued by diffeomorphisms. Then you proceed to ask the students to work in groups to come up with examples... I am not sure this will be very fruitful unless they are very mathematically mature and have already seen closely related notions (say, topological manifolds, algebraic varieties...).

[8]The authors of [1] studied, using motion-tracking, how the eyes of a mathematician move around when reading a proof. Their conclusion is that, as someone becomes more mathematically mature, they tend to scan proofs in a more erratic manner, trying to figure out the overall structure first. By contrast, a young undergrad student will proceed through the proof line by line, focusing on the correctness of each individual statement.

This is closely related to the division of mathematical comprehension into three stages: pre-rigorous, rigorous, and post-rigorous. See this blog post by T. Tao.

compensate for it by adding examples or heuristics in-between formal statements). Our writing is almost deceiving, because it is not reflective of the way in which we develop or think about Math.

I like to approach my lectures as experiences that are somewhere in-between. Namely: even though I follow the usual definition/statement/proof format, I present the material in a story-driven manner in order to capture the attention of the audience. For this, you need a main character (some mathematical object) and a conflict/intrigue (a natural question to be addressed, arising from some curious observation about a familiar example), which after various twists, turns and revelations gets a satisfactory ending.

This goal-oriented approach can be quite effective at tying together the underlying theory, presenting it in an engaging manner[9], and *making the mathematical ideas feel inevitable*[10].

Lecturing as storytelling is closely related to the idea of lecturing as a vehicle for providing insights. I address both similarly, by asking myself how to structure each lecture in the most engaging manner possible. There are some questions that I find useful for this process:

- Which opening example can motivate the theory best?
- Can I apply the main theorem as a blackbox to various examples before I get to presenting its proof? (And will this make the proof itself more transparent?)
- Is there an easy-to-follow concrete case that I can present in parallel as I prove the general case?
- Can I break the main theorem not just in elementary lemmas, but in lemmas that are interesting on their own?
- Can we place the results within some greater context so that they feel more natural?

1.2 Combining different teaching approaches

Even though I find it difficult to imagine replacing traditional teaching with something else (in Mathematics at least), I believe that there is a lot that we can do to *complement* it.

[9] As lecturers, the worst-case scenario is that we lose our students because they check out mentally.
[10] Isn't it great when a given mathematical approach feels like the only natural thing you could possibly do to address a problem?

First of all, our students can benefit from a "multi-prong" approach to teaching. What I mean by this is that, when learning a new subject, it is helpful that they see the material tackled from different perspectives. In fact, matching these different treatments can itself be a learning experience[11].

Traditionally, students have had two sources: our lectures, and the dictaat/book. I already advocated for approaching the former differently from the latter. On top of that, students have now access to a myriad of other formats. For instance, one can find recordings in Youtube for most of the standard undergrad courses, sometimes supported by nice animations. Further, solutions to many exercises appearing in the standard textbooks appear in platforms like MathOverflow. With so many resources available, our teaching duties also involve "curating" the materials that are most relevant to the course under consideration.

In the next subsections I discuss some of the approaches I have attempted myself.

1.2.1 Kennisclips

Some of my teaching load during the academic years 2020/21 and 2021/22 has been dedicated to creating animated videos for the course Topologie en Meetkunde; they can be found through the link in Appendix D. At the moment, there are six videos available, each with an approximate duration of 15 minutes. Together, they cover all the material that I wanted "multimedia support" for (roughly, there is one video per topic to be covered in the course)[12].

The nature of the videos is determined by their purpose. Namely: I see them as a support for my lectures. Their goal is to provide students with an intuitive understanding and help their visualisation skills. Due to this, they are sometimes informal, providing only heuristic statements (with the understanding that students will later compare these to the formal work we do in class).

This can work in two ways (as was pointed out by the students themselves in their evaluations): The video can be watched before the lecture in order to introduce the ideas informally; in this manner, the material is less daunting when seen within the class for the first time. Alternatively, after working through the material from the lectures, the students can rewatch the video to ground their understanding thanks to the examples and visualisations.

[11] Here I am speaking from personal experience: Sometimes I attend talks about topics that I know well and have been thinking about for a long time and, nonetheless, I still leave the talk with an insight I did not have previously (because the speaker has a mental model different from mine!).

[12] As a side note for those that may be curious: Each video requires around 35 hours of work. This involves creating a script, working out the text that will accompany the animations, animating it all, recording the oral explanations going on top, and editing it all together as a video.

1.2.2 Werkcolleges

We learn Mathematics not by listening or reading, but by *doing*[13]. In this sense, the werkcolleges may be more fundamental to the learning process than the lectures.

It is then natural to ask: As lecturers, what should be our contribution to the werkcolleges? My take is that we have to go a bit beyond the free-form werkcollege. Let me argue this point by analyzing some of the standard student profiles.

Some students are able to assess the weaknesses in their understanding and to react accordingly: they will revisit relevant examples or theory, look for relevant exercises to work on and, ultimately, go to the TAs with a precise question. For these students, the werkcolleges do not need to be structured at all; all that is needed is for the TAs to be available and for a sufficiently exhaustive list of exercises to be provided.

Another profile is the student that is capable of doing the basic exercises (e.g. proving elementary properties from the definition) but gets stuck with exercises requiring higher reasoning (e.g. finding examples or providing proofs that require a non-trivial idea). A key tool for such students is an exercise sheet that is scaffolded in nature, so no large conceptual leaps take place in-between exercises.

For the next iteration of Topologie en Meetkunde, I want to consider creating "hint sheets" that go along with the exercise sheets, as well as a comprehensive list of all the important examples seen during the course. See Section 1.3 for a discussion of the current exercise sheets.

Lastly, there are the students that won't make use of the TAs. In some cases they are aware that they are stuck, but they are also afraid of asking "a stupid question"[14]. In other cases, the students go through the exercises, but are not aware that their reasoning is not formal (and perhaps completely incorrect). These students need the werkcolleges the most, but will struggle with a format-free werkcollege.

I am still figuring out what the best manner is to provide a valuable werkcollege for these students. Some of my thoughts for the next iteration of Topologie en Meetkunde are:

- Utilize the fact that there are two TAs to separate the students in two groups. Those that want to work on their own and those that would rather have "a more structured experience".

[13] Here one typically quotes P. Halmos' autobiography "*I Want to Be a Mathematician*", in which he wrote: "Don't just read it; fight it!".

[14] During my lectures I try to emphasise the mistakes I make (e.g. missing a hypothesis in a statement) and to take seriously the suggestions/questions of the students. The point is for them to learn that trial and error is a key part of the mathematical process.

- Have the TAs go through the recommended exercises on the board, asking for the students for ideas and helping them formalise them as a group. Various activities can be implemented to this end, for instance: brainstorming at the beginning of each exercise, annotating in the board all possible ideas; grouping them in a timed manner so that they can try to formalise their favourite approach, which they can then explain to the class; providing in the board various hints (some useful, some not), so the students can test them out....
- This year I created Wooclap quizzes. These were used by the TAs to begin the Tuesday sessions of the werkcollege and took around 30 minutes. They were meant to motivate discussion among students and to help identify common misunderstandings. For the next iteration, I want to match them better with the recommended exercises (e.g. so that an example appearing in the quiz is relevant to one of the exercises).

1.2.3 Group projects

During the academic year 2020/21, in the midst of the pandemic and with classes being online, I decided to replace the midterm in Topologie en Meetkunde by a project to be carried out in pairs. The projects involved a presentation mid-way, accompanied by feedback on whatever they had written at that point, and then a final submission of a written document at the end of the course.

In many ways, the project was very successful. In their evaluations the students pointed out that the project was very fun and that it had kept them highly engaged with the course. Chatting with me, some them said that interacting regularly with their project partner had helped them a lot with the corona isolation. Furthermore, I found the quality of the presentations to be very high.

On the other hand, rather early into the block, it became apparent to me that the projects had been a *mistake*. Their scope was much too large for two months, particularly when the students still had to work on the standard exercises for the course. However, at that point, it was too late to make major changes: the students had started working on the projects and I did not know how to reduce their scope while keeping them interesting/meaningful.

For the rest of the course I tried to do some damage control. The most instrumental step was to sit down with each group after the midterm presentations and, with a preliminary version of the document in front of us, agree on a more limited aim for the project.

Still, the projects ate too much of the students' time, which was reflected rather glaringly in the homeworks. Overall, I got the impression that the understanding of the basic material had suffered greatly.

The student evaluations confirm this: An overwhelming majority pointed out that the course was very difficult (rated as 1.5; compare this to a 2.1 in 2020 or a 1.9 in 2022) and my teaching was rated as a 4/5 (compare this to a 4.7/5 both in 2020 and 2022). However, an interesting feature shows up in the evaluations: the students blame the problem on the lack of a dictaat[15], and not on the projects. A take-away message is that student evaluations can help us notice that something is wrong, but they are not a substitute for an actual diagnosis of the problem.

Perhaps there is a manner of integrating a much more modest "project" into Topologie en Meetkunde. An idea that I find interesting is to give each student (or pair thereof) a space at the beginning of the course. Then, in each subsequent homework they have to study it with whatever new tool they are given. We shall see how I feel about it next year.

1.3 Feedback and assessment

I believe that the most decisive factor behind a student successfully completing a course is the number of exercises they have done (done rigorously to the point that they would be able to fill in all details if needed). As such, students should be given exercise sheets that are extensive enough so that doing *every* exercise (or a large portion thereof) guarantees a very strong understanding of the subject. Furthermore, the structure of the sheets should make the learning experience as painless as possible.

The current exercise sheets in Topologie en Meetkunde (to be found among the supporting materials for this portfolio; see Appendix D) are designed with this idea in mind. They are structured into topics and, within each topic, exercises appear according to difficulty. Ideally, once they have read the theory, students should be able to proceed in order through the exercises, without encountering major conceptual difficulties. This is sometimes a challenge, and every year I try to revisit the sheets and streamline them further.

At the same time, I have come to learn that most students will not do nearly as many exercises as I would hope. In order to partly address this, this year I also provided a list of *essential* exercises to complement the mandatory ones given as homework. This information was included in the *timeline* of the course: a document in which the contents of each lecture/werkcollege were broken down. See Appendix D.

[15]The course uses Hatcher's "Algebraic Topology", as well as some hand-written notes of mine. The 2020 evaluations do not bring up a need for a dictaat. The 2022 evaluations specifically mention that there is no need (I added as a question whether they thought the course would benefit from a dictaat).

The issue still remains: maximising the amount of practice that the students get is a struggle. For instance: Topologie en Meetkunde has four homeworks, each containing 4-5 questions. The pace (one hand-in every two weeks) is meant, from my perspective, to be relaxed enough so that the students have time to think carefully about their arguments (and hopefully also time to do some of the other exercises). In practice, this seems not to be the case: some of the submissions have a couple of completely blank exercises. Furthermore, some of the students pointed out that they had little time to do anything else.

These are issues that I want to address next year. A core problem, as I pointed out above, is that the students struggling the most are seemingly not making a good use of the werkcolleges. For this, a more structured format may be help. Namely, these students need to receive more feedback and receive it before their final homework submissions.

I am intentionally keeping the idea of feedback separate from the idea of grading. In Topologie en Meetkunde, the four hand-ins represent 15% of the final grade. In practice, this means that students have an incentive to solve those exercises as nicely as possible. In this case, I see the grading as a device that forces students to work throughout the block, and not just before the exam.

There are two questions I want to give some thought to for next year: Would it be better if the homeworks were not graded, but instead they simply had a pass/no pass assessment (perhaps with a pass being necessary to attend the final exam)? What if this was accompanied by a chance to resubmit each homework using the feedback received?

Self-reflection II

Supervision

A complete list of the students I have supervised or I am currently supervising can be found here. I will discuss the cases of bachelor/master/PhD students separately.

2.1 Supervision of bachelor students

I have supervised 9 bachelor students since 2020, three of which were TWIN students joint with Physics. On two occasions, my PhD student A. Gootjes-Dreesbach served as cosupervisor (more on that below). On another occasion, the daily supervisor was R. Versendaal and my role was limited to meeting with the student monthly to check on their progress[1].

In general, it is my preference to meet weekly to discuss. The nature of the meetings changes drastically from student to student and, often, it also changes as the project progresses over time. Early in the project I expect the meetings to be rather extensive, and I will often give short lectures about the material. Later meetings should be more of a back-and-forth process, in which we discuss whatever technical details are causing confusion. Towards the end, meetings should be brief and often focused on the writing (i.e. maybe the student wants some feedback on a chapter they have written).

Among the supporting material you can find a letter from H. Schroten, a former bachelor student of mine. She makes a very interesting point about my supervision: According to her, one of my strengths as supervisor is that I am very enthusiastic about the project and about working with my students. However, this comes with a caveat: Precisely because I am enthusiastic, I can be very demanding. Namely: in order to reach "the interesting part", I will provide these "mini-lectures" early in the project, expecting the students to absorb many new concepts at a high pace.

[1] So it is probably fair to say that I have only supervised 8 students.

However, this does not work for everyone.

First my personal experience: This style of supervision was very effective for me as a young master/PhD student. Tying again with the idea of teaching as providing personal insights: Back then I found it extremely formative/inspiring to discuss with my advisor, who would often explain his vision quite extensively. Our meetings (often extremely content packed) were then followed by work on my own, trying to unwrap it all. If a meeting was running for too long and I was losing focus, I would ask my advisor to call it a day.

Just because it worked for me it does not mean it will work for every other student. Being enthusiastic (and somewhat demanding) is something that I do not want to lose, but I also have to be *mindful*. Sometimes students will not tell us that they are overwhelmed, so this is something we have to keep an eye on. These days I try to check on them frequently about the rhythm of the project, trying to be flexible with their timing.

Being flexible should also extend to my expectations as a supervisor. In three years, I have seen some extreme variation in terms of the scope and the quality of the theses I have supervised. Roughly, they fall into three camps:

- The students that work on the thesis for an extended period (sometimes three blocks), and are able to get a glimpse of actual research (which I think is challenging for projects in Geometry/Topology, due to the amount of background to be learnt).
- The students that try to cram the whole project in a little more than a block.
- The TWIN students.

The students in the first group do extremely well, as one may expect. They easily go beyond the 7.5 credit requirement of the thesis. In some ways, this creates a problem for the students in the second group (or rather a grading dilemma for me), who are instead aiming to work a 7.5 credits' worth. As I explained above, I would never discourage someone that loves Mathematics and is willing to put the extra work. Fortunately, our current grading guidelines are helpful to reach a compromise: Grading the document focuses on the quality of the writing and not on the amount of material, but the later is nonetheless positively assessed when grading the thesis process.

I left the TWIN students as a separate group because, for me, they represent a greater (or different?) challenge compared to the others. I believe the issue boils down to the fact that their projects seem to arise in a rather ad hoc manner. For the students in Mathematics, I keep a file with potential projects, many of which involve some potential directions for original research (in the vein of working out some new example). The

TWIN projects instead come about because a student approaches me with some idea of what they want to do in Physics (often after discussing with someone from the other side) and then my role is to check that they are looking into the appropriate Math. Sometimes it is not clear to me whether the Math part of the resulting thesis really represents 7.5 credits of work.

It would be meaningful to produce a database of potential bachelor projects for the TWIN programme. These should be designed with interdisciplinarity in mind, hopefully involving meaningful content from both Mathematics and Physics. To this end, it would be helpful to match researchers across departments[a]. This may prove interesting not just for our education efforts, but also in terms of research.

Such a systematic approach may save us time in the long run. I think many of us have found people in Physics with whom we can talk meaningfully, but this has been left mostly to chance (i.e. to students arbitrarily making a good pairing of supervisors).

[a]Perhaps we could organise some social event with cookies, coffee, and tea in our library so people can chat?

2.2 Supervision of master students

I have supervised 4 master students since 2019 (3 of them since 2020) and I am currently supervising 2 other theses, one of them joint with Physics. For one of the theses last year, my PhD Aaron Gootjes-Dreesbach served as daily cosupervisor.

Most of the points I made above about bachelor theses apply as well to master theses. The key differences are the scope and my own expectations about the mathematical maturity of the student. Namely, I expect master students to be able to work out most technical arguments on their own (possibly after discussing a bit with me), and to be able to read (and find!) the relevant literature by themselves (at least after the first stages of the project, in which I will still provide the basic background).

This leads me my main struggle when advising master students. First, some context.

I always try to give each student a distinctive project, hopefully taylored to their interests. Sometimes this is easy: I have a concrete question in mind, an approach that I know will work, and it all seems doable in the timeframe of a master thesis. In these situations, even if the thesis departs from the original plan, the final outcome of the thesis tends to be very satisfactory.

Other times the project is much more exploratory: there are certain ideas I want to learn more about (because they tie to some problem I find interesting), but that I am not an expert on. Then, the goal of the thesis is to dive deep into the literature, with the goal of clarifying whether these ideas can indeed be useful to address the problem. Somehow, the quality of the resulting theses tends to suffer a bit.

Of course, this contrast is not surprising: In the former case I am able to keep my “high energy” input during the whole process, and I can immediately nudge the student in the correct direction if they get stuck. In the later case, the student benefits from my overall vision, but is left more often to their own devices, reading literature that I know only superficially. In particular, if they encounter a subtle technical point, I may not be able to immediately address it.

Now the first question is: How to grade theses that vary so wildly in their essence? The crucial point is to separate the work of the student from my own input, in order to evaluate the former. However, both are inextricably mixed in the final product.

Now the follow up question, which is even more relevant: Is it fair that two different students have such wildly different experiences of what thesis work is? In the former case I see that they are more motivated, because they see the project evolve rapidly. In the latter case, there is much more struggle and uncertainty, and it is fair to say that they are receiving less “meaningful insight” (at least at a technical level) from me.

For now, the only answers I have to these two questions are that:

- It is important to keep the nature of the project (and of my own contribution) in mind when grading.
- The students themselves should be aware of the nature of the project from the beginning.

2.3 Orientation in Mathematical Research

I have supervised OMR projects every year since my arrival to Utrecht (one per year, except on 2020, when I supervised three of them). A. Witte and A. Fokma have served as cosupervisors with me (one time each).

I find the OMR projects to be an incredible opportunity to get to know the new master students and to offer a glimpse of the topics I find interesting. Most of the students that later did their thesis with me, got to know me through these projects.

2.4 Supervision of PhD students

I have served as informal coadvisor for Lauran Toussaint (a former student of M. Crainic who defended in 2020, now a postdoc at ULB). Currently I supervise two students of my own: Aaron Gootjes-Dreesbach (started in March 2021) and Anna Fokma (started in September 2021). Lastly, I cosupervise the thesis of F.J. Martínez-Aguinaga (based in Madrid with F. Presas as his other supervisor; will defend at the end of this year).

I will now explain, in broad strokes, how I see my role as supervisor, but ultimately the experience has to be adapted to each individual student.

I am a proponent of working closely with one's PhD students, particularly at the beginning of their doctorate. In particular, I find it important to be actively involved so that they are able to gain expertise as fast as possible. I see sharing my insights, in order to help my students navigate the literature smoothly, as part of my role.

This ties with the idea that their first project should have a clear goal (and preferably an accompanying strategy that I know I would be able to work out myself). The point, I believe, is that one should be given some tools before before being thrown into the unknown. Namely: a high-level understanding of a field, to the point of being able to come up with (and address!) original questions, has to be preceded by a good understanding of the techniques available. Working on this first project is supposed to bridge precisely this gap.

Even in these early stages, I limit my contributions to proposing ideas and engaging in mathematical discussion. The writing process itself (which includes working out the technical details of the arguments) should be carried out by the student. My role in regards to writing should amount to providing feedback, perhaps multiple times, until the student has extracted some of the "principles of good mathematical writing"[2].

This early "hand-holding" will eventually be replaced by academic independence. This is a natural process: as students mature mathematically they will come across new ideas, which will become projects of their own. This can be further incentivised by creating opportunities for the students to interact with other researchers (either internally to the department thanks to seminars or by going to conferences).

For instance, Aaron and Anna are meeting each other weekly to share the work they have been doing, and both are active participants in our geometry seminar (the Friday Fish). Anna also meets with Lauran regularly in order to discuss her project (which is joint with Lauran and myself). They also attend other relevant seminars, conferences, and workshops (both within and outside the Netherlands). Furthermore, I try to create opportunities for them to cosupervise students jointly with me.

It is probably worth remarking that there are some noticeable differences in how I approached my supervision with Lauran and Xabi compared to how I currently do it with Anna and Aaron. In the case of Lauran, his PhD was well underway (halfway-through) by the time I started cosupervising. I was myself a recent graduate, so our academic

[2]Of course, none of us really know what those principles are, but we can still have rather strong opinions on it (as I do).

relation felt much closer to that of collaborators rather than supervisor/supervisee. In the case of Xabi, I have been his supervisor from the very beginning, but this has been mostly long-distance[3]. In particular, even though we interact frequently to work on our joint projects, I have had limited input in terms of his daily math life. Nonetheless, many of my previous points apply to my experience with him. For instance, I have seen his writing and mathematical maturity evolve thanks to my input, leading him to being more independent (to the point that, now that he is close to graduating, we have a joint project that has developed out of an idea of his).

Now that Anna and Aaron are working on their first papers, one aspect that I want to be very aware of is that of visibility. Namely, once the papers are out, I should take some steps so that the community notices these results. In some cases this may be as easy as forwarding the papers to some researchers I know, but it may also involve creating opportunities for Aaron and Anna to give talks about their work. The aim is that, down the line, a couple of years from now, there are researchers interested in their work and thus willing to host them for an academic visit.

[3] He has spent 4 months in Utrecht during his studies. This was meant to be longer, but it became very difficult due to corona

Appendix

A personal teaching essay from 2019

What follows is a personal reflection on my teaching, written in mid 2019. At the time of writing my teaching experience was limited (my only experience as a lecturer had been in the Mastermath Symplectic Geometry course).

In the essay, I bring up three main points: activating students in the classroom through various activities, creating assessments that are effective as learning tools, and not just as grading-devices, and putting more emphasis on writing. My current take on each of these three items can be found in Section 1.2, Section 1.3, and Chapter 2, respectively. See also Appendix B.

A.1 Introduction

My experience as a post-doc has been a experience of many "firsts". For the first time, I have tutored master students as they tipped their toes on the waters of research. I have shared my ideas with my first PhD students and, as I have done this, I have seen them mature into extremely competent mathematicians from whom I have also learnt a great deal. I have assumed, for the first time (or rather, co–assumed together with another lecturer), the task of giving a full course for master students, along with the rather daunting task of developing a set of notes for it.

As I have done these things, I have tried to look critically at my performance: Are my lectures structured correctly and do they complement the existing notes? Are the students receiving from me feedback that is useful and that they can use to improve? Is my interaction with them conductive to learning? Do my notes and exercises provide the correct steps to build up proficiency? Am I addressing the differences in background of my students suitably so that they all benefit from the course/project? In the case of my PhD students, am I providing adequate support for the next steps in their career, not only mathematically but professionally?

I started formulating these questions about my teaching while I was attending the "Teaching in Higher Education" (THE) course at Universiteit Utrecht. The weekly meetings helped me to structure these concerns better, and to bring to light issues I had not considered before. I believe this has allowed me to produce a strong portfolio that justifies my application for a Basiskwalificatie Onderwijs (BKO).

In this personal essay I will look at the teaching concerns I have just voiced, and at the issues I have observed when self-reflecting about them. My goal is to focus on three key aspects that I want to improve on as I progress as a docent.

A.2 Different students require different approaches

Most of the students I have interacted with at this stage have been part of the Geometry track. Despite of this, they form an extremely ample spectrum, having differing degrees of motivation, disparate strengths and weaknesses, and very different mathematical backgrounds, interests, and manners of thinking.

Early in my Symplectic Geometry lectures I noticed that many of the students had extremely strong backgrounds, and were able to easily follow the classes in their entirety (despite them being 3 hours long). They were also interested in the material and willing to step up when a more challenging exercise appeared. At the same time, I observed a couple of students slowly slipping, handing-in progressively weaker assignments as the course progressed and the gaps in their knowledge became greater.

These two groups require different approaches, different methods of teaching. Let me go over the latter group first.

Early in the course I decided that I would create an atmosphere of active learning during the class to help those struggling. Instead of doing all of the examples myself, I set-up in-class activities to force them to think about the material covered up to that point and how it may be applied. Implementing this idea has been a learning experience for me: I have observed that it works well in simple situations where the students are given plenty of time to think. For instance: coming up with examples of a new definition, or solving somewhat mechanical computations. That is, it is effective to activate their low level knowledge and to make them more familiar with the material. At the same time, I have had a couple of failures when the task required higher level thinking grounded on higher proficiency (that they did not have yet): most of the students were simply unable of making any progress. I would like to keep experimenting with this idea in future courses. Particularly, I would like to improve my ability to guide their thinking by posing effective questions.

Another important aspect to remember, in order to help those struggling, is that following a lecture in Mathematics can be, by itself, active learning: Understanding each of the steps involved in an argument requires that the listener takes an active role. As such, as a lecturer, I must try to make this task as easy as possible for the student. For instance, I should pace myself, giving the students time to process new information by having moments of silence when an idea is complete. Key ideas should jump at them, by being clearly marked as such in the blackboard. I believe having a helpful set of notes, that they can print and bring to the lecture, is a first step in this direction.

At the opposite end of the spectrum, one must keep the course interesting for the over-achieving students as well, by providing them with a challenge. A mistake I made (as pointed out previously) was to propose demanding in-class activities based on material we had just seen. This is very far away from how understanding in Mathematics works: proficiency requires time. In fact, at the end of the course, one of the students told me he felt more comfortable thinking at home, without the pressure. On the next iteration of the course, I would like to try an inverted approach: to have them work on something more elaborate as a preparation for the lecture and then spend time revisiting it during the class. This can be done with different scopes: either solving an exercise from one session to the next, or perhaps a small (optional?) project requiring several weeks to complete with a scheduled evaluation in the middle to provide them with feedback.

A.3 What is the purpose of an assignment?

One of the most frustrating aspects for the students of the Symplectic Geometry course were the assignments. Having a weekly deadline can feel like an insurmountable pressure, particularly when one struggles with one of the exercises. Even if we, as lecturers, are willing to be flexible with the hand-in dates, the students are often reticent to ask for this flexibility. Having to hand-in problems from one session to the next implies that there is no in-class time in which they may ask about the assignments. These are issues I have observed myself and that students have rightfully pointed out in their evaluations.

What is important here is to realise that the purpose of the assignments is not to grade the students. This is readily apparent from the fact that they amount for an extremely little portion of the final grade. Instead, they are meant to activate the learning process of the student, reinforcing and complementing what is seen in class. It may be true that having weekly hand-ins forces them to look at the material before they attend the next lecture, but that is precisely the issue: it is an imposition. It does not take into account the personal situation of each of them. It does not give them the freedom of choosing how or when they learn.

Next year, I would like to implement a block by block scheme. That is, the students will be told at the beginning of a thematic block what the exercises are that they must solve. As the lectures progress, I will point out how the material is relevant for each exercise, and I will encourage them to look at those activities that they may already solve with what we have seen. This will allow them to ask for clarification during the classes and to look at the material at their own pace. Additionally, having this extra time might allow for more involved activities as opposed to disconnected exercises. Being this the case, the hand-ins could make up a larger portion of the final grade, with room for bonus points based on extra performance.

A.4 Coaching: writing and presenting

In my role as an advisor/tutor, I often get carried away by the mathematical content. I am infinitely marveled by the discussion of ideas and clever arguments. However, a large part of what we do in our professional lives relies on soft skills. It is important to be able to convey all these beautiful ideas through the talks we give and the papers we write. And yet, I believe this is an aspect I have neglected when I coach others.

I have tutored master students during the so-called "Orientation in Mathematical Research" (OMR) course that they must take. The students must carry out a small project in which they get a small taste of how research works. Having done it twice, on the second iteration I tried to emphasise the research aspect: I proposed a topic that required a somewhat limited background, but that would allow them to explore new ideas. In that sense, it was a big success, because they were able to actually come up with new results that some of them would like to pursue further.

Despite of this, I was not satisfied with the document they produced and the talk they gave. Both of them seemed like an afterthought, completely secondary to the mathematical content. I had been unable to convey to them that these were also important facets that they had to worry about.

I believe there were two problems from my part. Firstly, I did not give them clear parameters at the beginning. I did not inform them about how their work would be graded. Since I excitedly jumped straight into the Mathematics, so did they. Secondly, upon seeing a preliminary version of their project, I did not provide surgical feedback: I gave them too many pointers and it was unclear to them what the most important aspects to work on were.

I hope to be part of the OMR course later this year as well. I will keep what has worked so far, by proposing a project that allows the students to be creative. However, I will provide a more structured environment for them to work. At the beginning, I would like to give them a rubric of how I will grade, stressing the importance of the writing and presenting. This rubric will also guide me when I provide feedback during the project: it will be easier to compare where they are currently, with where they should be when the project comes to an end.

A.5 Final remarks

Next year I will be teaching, for the very first time, a bachelor course as the sole lecturer. This is, partly, why I decided to focus on the first two aspects I discussed. Working with a bigger and more heterogeneous group of students will certainly present a new challenge for me, but I think I am asking myself the right questions to approach it. What is certain is that I will be going into the experience with plenty of enthusiasm.

Appendix

“Teaching in higher education” starting document

What follows is the onboarding questionnaire for the course “Teaching in higher education” offered by the UU. I filled it in when I began the course, back in late 2018. Of particular interest is item 3, where I describe some of the struggles/insecurities with teaching that I had back then. Some of the major issues were board organisation, lack of clarity, and lack of attention to the little details. My improvement in these directions is discussed in Section 1.1.1 (see also Erik’s letter in Appendix C). Separately, I also voiced a concern regarding lack of innovation in my lectures. Over time, I have come to embrace this, while trying to make use of innovation *outside* of the lectures; see Section 1.2.

Starting Document

Before the start of the course in Teaching in Higher Education, we would like you to answer the questions to get a better idea of your starting situation. At the end of this course, we will look back to your starting situation, in order to be able to assess your progress. Please fill in this document and send it to the course instructor by e-mail (E.M.B.Zijderveld@uu.nl)

Name: Alvaro del Pino

Courses you teach: Symplectic Geometry (master course starting in February 2019), Orientation in Mathematical Research (supervision of a 2-month research project for 7 master students), PhD supervision (currently I co-advise two students, one in Utrecht and one in Madrid that visits me yearly).

Position:

1. What are your most important teaching tasks/responsibilities?

At the moment my teaching duties are essentially three:

1. I am the co-advisor of a PhD student in Utrecht. This evolved naturally out of the process of discussing research ideas with him and eventually working them out together. Apart from the research aspect of it (guiding him through the literature, explaining key ideas, suggesting potential lines of investigation), now I am faced with practical issues (having the student interact with other members of the research community, facilitate him giving talks to disseminate his results…)
2. At the moment I am supervising a project within the so-called “Orientation in Mathematical Research” course. This is a 2 month project for 7 master students whose aim is to have them get a glimpse of current mathematical research. The project I proposed includes carrying out some genuinely original computations, and not just reading already existing literature.
3. Starting in February 2019 I will be teaching the Symplectic Geometry course within the Mastermath programme (the national master programme of math). Before it starts, I will have to rework the current set of notes for the course (so that they address certain aspects of the topic that I believe were insufficiently discussed in previous iterations of the course).

Other (more minor) teaching tasks include the organization of our local research seminar (in which I often also give talks).

2. What aspect(s) of your teaching are you most satisfied with? Why?

I think I am very passionate about math, and this enthusiasm shows when I teach. Additionally, I have the impression students find me approachable, so they are not afraid of asking questions.

Mathematics can be quite dry if things are done without explaining what the motivation is. I often try to be quite geometrical and offer insight on what is happening behind the scenes (through drawings, heuristics, and big picture arguments). I have found that students often find this quite helpful.

3. What aspect of your teaching are you not quite satisfied with? What do you want (to do) more/differently?

I think that a big weakness of mine is that I struggle to explain the small details. I usually feel happy with the general structure of the classes I teach, but sometimes when I carry out technical steps (that are somehow "uninteresting" or "routine" for someone that knows the key ideas already but not for a student seeing them for the first time), I feel my explanations are a bit lacking. I think I need to motivate myself more to tackle these steps in a more interesting way.

Another issue I have noticed is that I do not know how to deal with an audience that does not provide feedback. When students ask questions, I am able to gauge whether they are following, but if they do not, I feel a certain insecurity and sometimes I repeat myself (possibly unnecessarily), not really adding anything new.

Although this is a general phenomenon in mathematics teaching, I do not really innovate a lot in my classes. I just use blackboard and chalk. I do not know if this is a problem (using the board is a good way of pacing oneself and allows me to easily stop and clarify things when people ask), but it might be interesting to incorporate other approaches into my teaching.

A related problem is that I need to be more organised with my blackboard arrangements. When I teach, what I write in the board complements what I am saying and together they work fine. However, what is written on the board by itself is sometimes incomplete and may be confusing for someone that is trying to take notes and is not fully listening.

4. What would you like to learn and do in this course? Please describe your expectations, wishes and concerns as specific as possible.

I would like to address the aspects I mentioned in point 3. Furthermore, I have never really self-assessed my teaching (for instance by looking back at a recording of myself), and thus I do not know whether there may possibly be other issues I am not aware of. This is something I am looking forward to.

Something I would like to learn is how to engage my students more and get more feedback from them. I do not think this is a general problem I have, but when it happens I do feel at a loss.

5. What are the most inspiring aspects of student teaching to you?

In mathematics it is often easy to see whether a student has understood or not (unless all the pieces have fallen into their place it is usually quite hard to solve certain exercises or explain the big picture). I really enjoy seeing students start a course with no knowledge at all and eventually see them have that moment in which everything "clicks". This is particularly true if at first they were struggling.

The other side of this is to encounter a very motivated student that engages in your course fully and asks for additional resources to learn from. It is amazing to have a student study a beautiful theorem or proof and see that they find it beautiful too.

In this direction, I love posing interesting problems for my students and seeing that they tackle them with passion. As someone that loves research, I like steering students towards academia and towards topics that I find interesting.

I checked the WP-FLOW III document and found the following (teaching) criteria for Universitair Docent positions. I think some of them are not really needed at my stage, but rather a few years down the line (particularly those referring to assessing whether the current curriculum components are suitable). Nonetheless, here it is:

Criteria	**Yes**	**No**	**Partially**	**Notes**
To specify the learning objectives of a curriculum component			●	I am currently working on the notes for the Symplectic Geometry course. During this process I will elaborate exercise sheets. Beyond this, I am not sure how to effectively elaborate a curriculum.
To implement allocated curriculum components (ensuring that the objectives of the curriculum are achieved by the students)			●	As a tutor in the "Orientation in Mathematical Research" (this will be the second time I take part in this), I am familiar with the supervision of small groups of master students. However, I have never handled bigger groups.
To test academic achievement using assessment methods approved by the Teaching institute		●		I have never held examinations. I did evaluate the project of the master students I was supervising (and the professor organising it found it very thorough), but never for a big course.
To contribute to the evaluation of the framework and implementation of curriculum components		●		Never done this.
To supervise students, including assessment of their work and progress	●			
To supervise Promovendi in the content of their thesis work and its progress	●			

Appendix

Visit of Prof. E. van den Ban

On 3rd March 2022, Prof. E. van den Ban visited one of my 2-hour Topologie en Meetkunde lectures. His impressions are recorded in the pages that follow. Erik had attended already one of my Symplectic Geometry lectures back in Spring 2019; his text also makes references to this prior occasion.

Intervision of a lecture in the course “Geometry and Topology” by Alvaro Pino Gomez
Date: March 3, 13:15 – 15:00.

Observations
This was a lecture in the level 3 bachelor course mentioned above. I attended the entire lecture, sitting on row 4. The lecture was given on a blackboard, with chalk.

Alvaro used the blackboards (in a configuration of 2) efficiently and in an orderly fashion, creating blocks to separate the text units. The lecture was about the universal covering of a “sufficiently nice” topological space constructed in terms of the fundamental groupoid, which has the advantage of incorporating all possible choices of basepoints. I was not too familiar with this subject, and decided to take notes. The pace of the lecture was just right for this. The writing was clear, and legible for all 30 students in the lecture room.

Alvaro carefully avoided to block the area of writing, allowing the students to follow the writing without delay. His attitude was open and enthusiastic. This was clearly appreciated by the students, who were engaged, and asked questions when they had difficulties comprehending what was being said or written. The amount of writing was precisely right, adequately supporting the oral part of the presentation.

Alvaro invited questions, and frequently checked if there were any. He answered the questions adequately.

The material was well organized, with a few references to clips (made by Alvaro) with examples. The presentation was clear, stating the results clearly, providing a well-chosen selection of proofs, with sufficient amount of motivation. The timing was right, resulting in a pleasant pace.

Opinion and suggestions for improvement.
Altogether, this was a very nice lecture, which was clearly helpful for the students and well received by them. The quality of Alvaro's lecturing has substantially improved in comparison with a lecture I attended two years ago. Personally, I enjoyed the lecture very much, and I learned something from it. As always, there is some room for (slight) improvement.

It is better not to interrupt the student before the question is finished – even if you think to understand the question already -- and to repeat the question to make sure you and the other students understand it. Then answer it, and make sure everyone understands, and not just the student who asked.

After an interruption it may sometimes be difficult to keep track of the ‘story’. If this happens, make sure to share this explicitly with the students so that they are not lost. Towards the end the writing on the blackboard stayed neat, but became less legible because of decreased pressure on the piece of chalk, which diminished the contrast of the white chalk relative to the blackboard. Be aware to keep the pressure.

Using colored chalk can be useful, but make sure the colored pictures or text are visible from a distance. E.g., the use of blue chalk is problematic on a green blackboard, due to lack of contrast.

Erik van den Ban
Utrecht, March 11, 2022

Appendix

Teaching resources and student evaluations

During my trajectory as a lecturer, I have developed various teaching materials. These include lecture notes (for the Mastermath Symplectic Geometry, and for a Summer School course on Morse Theory), kennisclips (for Topologie en Meetkunde), and exercise sheets (for Topologie en Meetkunde).

All of these can be found here. Student evaluations for the courses I have taught and statements from students I have supervised can be found in the same link.

Appendix

Curriculum Vitae

My curriculum vitae follows. It includes itemised lists of both the courses I have taught and the students I have supervised.

Name: Álvaro del Pino Gómez
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Email: alvaro.pino.gomez@gmail.com

Positions

- **Assistant professor** — Utrecht, Netherlands
  Universiteit Utrecht — *April 2020 – present*
- **NWO Veni Fellow** — Utrecht, Netherlands
  Universiteit Utrecht — *October 2018 – present*
- **Postdoctoral researcher** — Utrecht, Netherlands
  Universiteit Utrecht — *June 2017 – September 2018*
  - Funded by the NWO Vici grant of Prof. Marius Crainic

Education

- **PhD. in Mathematics** — Madrid, Spain
  ICMAT, Universidad Autónoma de Madrid — *September 2013 – June 2017*
  - Thesis title: “Engel structures and symplectic foliations”
  - Advisor: Francisco Presas
- **Master degree in Mathematics** — Madrid, Spain
  Universidad Autónoma de Madrid — *September 2012 – June 2013*
  - Thesis title : “Symplectic Lefschetz Pencils”
  - Advisor: Francisco Presas
- **Bachelor degree in Mathematics and Computer Science** — Madrid, Spain
  Universidad Autónoma de Madrid — *September 2007 – June 2012*

Research publications

- L. Dahinden, A. del Pino. *Introducing sub-Riemannian and sub-Finsler Billiards.* Discr. Cont. Dyn. Sys. (2022).
- A. del Pino, T. Vogel. *The Engel-Lutz twist and overtwisted Engel structures.* Geometry & Topology 24(5) (2020), 2471–2546.
- R. Casals, A. del Pino, F. Presas. *Loose Engel structures.* Compos. Math. 156(2) (2020), 412-434.
- R. Casals, A. del Pino. *Classification of Engel knots.* Math. Ann. 371(1-2) (2018), 391-404.
- A. del Pino. *Tight contact foliations that can be approximated by overtwisted ones.* Archiv der Mathematik, 110.4 (2018), 413-419.
- A. del Pino. *On the classification of prolongations up to Engel homotopy.* Proc. Amer. Math. Soc. 146 (2018) 891-907.
- A. del Pino, F. Presas. *Flexibility for tangent and transverse immersions in Engel manifolds.* Rev. Mat. Comp 32(1) (2019), 215-238.
- A. del Pino, F. Presas. *The foliated Weinstein conjecture.* Int. Math. Res. Not. 16 (2018), 5148-5177.

- R. Casals, J.L. Pérez, A. del Pino, F. Presas. *Existence h-Principle for Engel structures.* Invent. Math. 210 (2017), 417-451.
- D. Peralta-Salas, A. del Pino, F. Presas. *Foliated vector fields without periodic orbits.* Isr. J. Math. 214 (2016), 443-462.
- D. Martínez Torres, A. del Pino, F. Presas. *Transverse geometry of foliations calibrated by non-degenerate closed 2-forms.* Nag. Math. J. 231 (2018), 115-127.
- R. Casals, A. del Pino, F. Presas. *h-Principle for Contact Foliations.* Int. Math. Res. Not. 20 (2015), 10176-10207.

Expository writing

- A. del Pino. *Topological aspects in the study of tangent distributions.* Textos de Matemática. Série B [Texts in Mathematics. Series B], 48. Universidade de Coimbra, Departamento de Matemática, Coimbra, 2019.

Preprints

- L.E. Toussaint, A. del Pino. *Wrinkling h-principles for integral submanifolds of jet spaces.* arXiv:2112.14720
- F.J. Martínez Aguinaga, A. del Pino. *Convex integration with avoidance and hyperbolic (4,6) distributions.* arXiv:2112.14632
- A. del Pino, T. Shin. *Microflexiblity and local integrability of horizontal curves.* arXiv:2009.14518

Supervision of PhD students

- **Anna Fokma** — Universiteit Utrecht
  "TBA" — *September 2021 - present*
- **Aaron Gootjes-Dreesbach** — Universiteit Utrecht
  "Non-local differential relations" — *March 2021 - present*
- **Francisco Javier Martínez Aguinaga** — Universidad Complutense de Madrid
  "Knots tangent to bracket-generating distributions". Coadvisor: Francisco Presas — *September 2017 - September 2022*
- **Lauran E. Toussaint** — Universiteit Utrecht
  "Contact Structures, codimension-1 Symplectic Foliations". Coadvisor: Marius Crainic — *September 2016 - March 2020*

Supervision of master students

- **Frank Imbens** — Universiteit Utrecht
  "TBA". Coadvisor: T. Hinderer — *January 2022 - present*
- **Giacomo Cristinelli** — Universiteit Utrecht
  "Anisotropic deformation on contact three-manifolds" — *March 2021 - March 2022*
- **Bas de Pooter** — Universiteit Utrecht
  "Differential relations with delay" — *October 2020 - July 2021*

- **Jan Denkers** — Universiteit Utrecht
  "Multijets and non-local h-principles" — *February 2020 - June 2021*
- **Lotte Bruijnen** — Universiteit Utrecht
  "Filtered structures" — *July 2019 - August 2020*

Supervision of bachelor students

- **Sam Lindauer** — Universiteit Utrecht
  "Horizontal knots in Martinet distributions". Coadvisor: A. Gootjes-Dreesbach — *November 2021 - present*
- **Esther Steenkamer** — Universiteit Utrecht
  "Fundamentals of Geometric Analysis" — *October 2021 - present*
- **Jelle Draijer** — Universiteit Utrecht
  "An Exploration of Gauge Theory and Spinors on a Spacetime Manifold". Coadvisor: D. Schuricht — *February - July 2021*
- **Mick Schilder** — Universiteit Utrecht
  "Regular Homotopies and the Sphere Eversion". Coadvisor: A. Gootjes-Dreesbach — *February - July 2021*
- **Hanneke Schroten** — Universiteit Utrecht
  "Geodesics in semi-Riemannian Geometry and links to General Relativity". Coadvisor: T. Grimm — *February - July 2021*
- **Ket Bottelier** — Universiteit Utrecht
  "Semi-Riemannian Geometry and Wavefronts in GR". Coadvisors: T. Hinderer and R. Versendaal — *February - July 2021*
- **Floor ter Haar** — Universiteit Utrecht
  "Constructing distributions in low dimensions" — *August 2020 - February 2021*
- **Juri Sampieri Bjornsson** — Universiteit Utrecht
  "Prolongation of Semiriemannian structures" — *May 2020 - February 2021*
- **Robin van de Griend** — Universiteit Utrecht
  "Simplicial Complexes and Persistent Homology" — *March 2020 - June 2020*

Conferences organised

- **Lie theory and Poisson Geometry** — CIRM
  Coorganisers: Ana Balibanu, Chiara Esposito, María Salazar — *10–14 January 2022*
- **A Topological Theory of Tangent Distributions** — Lorentz Center, Leiden
  Coorganisers: V. Franceschi, F. Pasquotto, M. Seri — *30 August – 3 September 2021*
- **Young Researchers Workshop on Geometry, Mechanics, Control** — Universiteit Utrecht, online
  Sole local organiser — *30 November – 4 December 2020*
- **Topological aspects of Symplectic Foliations** — Université de Lyon 1
  Coorganisers: K. Niederkrueger, F. Presas — *4–8 September 2017*
- **Symplectic Techniques in Hamiltonian Dynamics** — ICMAT
  Coorganisers: V. Ginzburg, B. Gurel, F. Presas — *13–17 June 2016*

- **Junior GESTA** — Universidad Politécnica de Cataluña
  Coorganisers: A. Kiesenhofer, E. Miranda, A. Planas, F. Presas — *27–28 April 2016*

Seminars organised

- **Dutch Differential Topology and Geometry** — Amsterdam, Leiden, Utrecht
  Coorganisers: F. Pasquotto, T. Rot, R. Vandervorst — *October 2020 - present*
- **Friday Fish** — Universiteit Utrecht
  Coorganisers: M. Crainic, M. Mol — *July 2020 - present*
- **UGC** — Universiteit Utrecht
  Coorganisers: G. Heuts, M. Pieropan — *November 2019 - present*

Graduate minicourses

- **Topology of bracket-generating distributions** — Universidade de Coimbra
  13th International Young Researchers Workshop — *6-8 December 2018*
- **Engel Topology** — Université de Neuchâtel
  Séminaire de géométrie — *12-17 March 2018*
- **Wrinkling** — Universidad de Barcelona
  Distributions and h-principles Summer School — *10-15 July 2017*

Talks in conferences

- **Ampleness up to avoidance** — IAS
  Workshop on the h-principle and beyond — *4 November 2021*
- **Flexibility of distributions through convex integration** — U. Paris
  Advances in Symplectic Topology conference — *19 May 2021*
- **Non-local differential relations, a teaser** — Online
  GQT cluster meeting — *22 January 2021*
- **Integral submanifolds of jet spaces** — ICMAT
  Workshop on Geometric Methods in Symplectic Topology — *16-20 December 2019*
- **Convex integration without ampleness?** — Timisoara
  Workshop on Contact and Poisson Geometry — *1 November 2019*
- **Multi-sections of jet spaces** — Santiago de Compostela
  XXVI Encuentro de Topología — *18 October 2019*
- **Bracket-generating integration** — ICMAT
  XXVIII International Fall Workshop on Geometry and Physics — *3 September 2019*
- **Wrinkled embeddings and horizontal submanifolds** — Radboud Universiteit
  Poisson aan de Waal — *12-14 December 2018*
- **Haefliger structures and the h-principle** — Universiteit Utrecht
  Higher geometric structures along the Lower Rhine X — *20 October 2017*

- **Some tight contact foliations can be approximated by overtwisted ones** KU Leuven
  Pure and Applied Differential Geometry *21-25 August 2017*
- **The Engel-Lutz twist and the Engel extension problem** American Institute of Mathematics
  Workshop on Engel structures *21 April 2017*
- **A global characterisation of flexibility for Engel structures** American Institute of Mathematics
  Workshop on Engel structures *18 April 2017*
- **The h-principle** Universidad Carlos III
  Día ICMAT *6 May 2016*
- **Fun facts about convex curves in the 2-sphere** Universidad Politécnica de Cataluña
  Junior GESTA workshop *27 April 2016*
- **An existence h-principle for Engel structures** Augsburg University
  X CAST workshop *27 February 2016*
- **Flexibility in Engel geometry. Part II** Université Libre de Bruxelles
  Flexibility and contact geometry *16 December 2015*
- **A look at distributions** Universidad de Murcia
  Royal Mathematical Society Young Researchers Meeting *8 September 2015*
- **Distributions: contact, even contact, and Engel** Universidad Complutense de Madrid
  4th Spanish Young Topologist Meeting *29 June 2015*
- h–**Principles in Contact Topology** Universidad de Santiago
  3rd Spanish Young Topologist Meeting *20–23 October 2014*
- **Donaldson techniques in Symplectic Foliations** Universidad Complutense de Madrid
  8th Workshop of Young Researchers in Mathematics 2014 *22–24 September 2014*
- **Contact and symplectic foliations** Lorentz Center, Leiden
  Rigidity and Flexibility in Symplectic Topology and Dynamics *21–25 July 2014*
- **An h–principle for contact foliations** ICMAT
  GESTA workshop 2014 *2–6 June 2014*

Talks in seminars

- **Microflexibility and local integrability of horizontal curves** U. Paris
  Singularity seminar *29 November 2021*
- **SubRiemannian geodesics and billiard trajectories** U. Illinois in Urbana-Champaign
  Symplectic & Poisson Geometry seminar *1 April 2021*
- **An introduction to SubRiemannian billiards** Online
  DAI Seminar on Dynamical systems *25 March 2021*
- **Submanifolds tangent to bracket-generating distributions** Paris
  Séminaire de Géométrie et Analyse Sous-riemannienne *19 May 2020*
- **What is holonomic approximation?** TU Delft
  Analysis colloquium *26 November 2019*
- **The role of multi-sections in the holonomic approximation problem** SISSA
  Geometry and Mathematical Physics seminar *22 October 2019*

- **A control-theoretic version of convex integration** Vrije Universiteit Amsterdam
  Colloquium *25 September 2019*
- **Submanifolds of jet spaces and wrinkling** Universität Heidelberg
  Symplectic Seminar *17 July 2019*
- **Convex integration and the bracket-generating condition** Universität Heidelberg
  Geometry Seminar *16 July 2019*
- **Distributions, submanifolds, and nilpotentisation** KU Leuven
  Geometry Seminar *1 March 2019*
- **Wrinkled embeddings and horizontal submanifolds of jet spaces** Universiteit Antwerpen
  Analysis & Geometry Seminar *17 October 2018*
- **Horizontal curves in bracket-generating distributions** Universiteit Utrecht
  Colloquium *9 October 2018*
- **Flexibility in Engel Topology** ICMAT
  Geometry seminar *1 October 2018*
- **Topology of bracket-generating distributions** Université de Neuchâtel
  Colloque *13 March 2018*
- **Overtwisted Engel structures** Université Libre de Bruxelles
  Geometry Seminar *20 February 2018*
- **Engel structures and symplectic foliations** Universidad Autónoma de Madrid
  Thesis defense *23 June 2017*
- **Lutz twists and extension problems** Utrecht University
  Friday Fish Seminar *6 June 2017*
- **Spaces of distributions** Universidad Autónoma de Madrid
  Thesis predefense *11th May 2017*
- **Spaces of curves and the h-principle** Universidad Complutense de Madrid
  PhD Seminar *11 May 2017*
- **Contact foliations** Stanford
  Northern California Symplectic Geometry Seminar *1 May 2017*
- **Spaces of curves and the h-principle** University of California, Santa Cruz
  Geometry and Analysis Seminar *27 April 2017*
- **Spaces of immersions tangent to distributions** Ludwig Maximilian University, Munich
  Oberseminar *29 November 2016*
- **Recent developments in Engel topology** Universiteit Utrecht
  Friday Fish Seminar *18 November 2016*
- **An introduction to Engel structures** IHP, Paris
  Simplectix Seminar *7 October 2016*
- **Open problems in Engel geometry** Universidad de Barcelona
  Geometry Seminar *29 April 2016*
- **h-Principle for Engel structures** Ludwig Maximilian University, Munich
  Oberseminar *16 January 2015*
- **Spaces of distributions and the h-Principle** KU Leuven
  Geometry Seminar *17 December 2015*

- **The foliated Weinstein conjecture** — Renyi Institute, Budapest
  Differential Topology Seminar — *27 November 2015*
- **h-Principle for Engel structures II** — Universidad Complutense de Madrid
  Geometry and Topology Seminar — *13 October 2015*
- **h-Principle for Engel structures I** — Universidad Complutense de Madrid
  Geometry and Topology Seminar — *6 October 2015*
- **A foliated analogue of the Weinstein conjecture** — ICMAT
  Geometry Seminar — *5 October 2015*
- **What is an Engel structure?** — Renyi Institute, Budapest
  Singularity Theory and Low Dimensional Topology Seminar — *7 May 2015*
- **Introduction to pseudoholomorphic curves** — Universidad Autónoma de Madrid
  Mathematics Junior Seminar — *11 February 2015*
- **Introduction to Floer Homology** — Universidad Complutense de Madrid
  Mathematics PhD Seminar — *4 December 2014*
- **Contact Foliations and the Weinstein Conjecture** — Universidad Complutense de Madrid
  Geometry and Topology Seminar — *14 October 2014*

Teaching

- **Topologie en Meetkunde** — Universiteit Utrecht
  Lecturer. 3rd year course — *Spring 2022*
- **Bewijzen in de Wiskunde** — Universiteit Utrecht
  Lecturer. 3rd year course — *Fall 2021*
- **Foliations and Haefliger structures** — Universiteit Utrecht
  "Orientation in Mathematical Research" project. Cosupervised with A. Fokma — *Fall 2021*
- **Topologie en Meetkunde** — Universiteit Utrecht
  Lecturer. 3rd year course — *Spring 2021*
- **Plugs and the Seifert conjecture** — Universiteit Utrecht
  "Orientation in Mathematical Research" project — *Fall 2020*
- **What is a Lie groupoid?** — Universiteit Utrecht
  "Orientation in Mathematical Research" project. Cosupervised with A. Witte — *Fall 2020*
- **Controllability of diffeomorphisms** — Universiteit Utrecht
  "Orientation in Mathematical Research" project — *Fall 2020*
- **Topologie en Meetkunde** — Universiteit Utrecht
  Lecturer. 3rd year course — *Spring 2020*
- **Introduction to foliations** — Universiteit Utrecht
  "Orientation in Mathematical Research" project — *Fall 2019*
- **Symplectic Geometry** — Universiteit Utrecht
  Lecturer. Mastermath course — *Spring 2019*
- **Teaching in Higher Education** — Universiteit Utrecht
  Attending the course to build up my BKO portfolio — *November 2018 - June 2019*

- **Tangent distributions** — Universiteit Utrecht
  "Orientation in Mathematical Research" project — *Fall 2018*
- **Morse Theory** — Universiteit Utrecht
  Geometry Summer School — *27th August 2018*
- ***h*-Principle** — Universiteit Utrecht
  "Orientation in Mathematical Research" project — *Fall 2017*
- **Contact Topology** — ICMAT
  JAE Intro Summer School — *11th-16th July 2016*
- **Linear Algebra II** — Universidad Autónoma de Madrid
  Teaching assistant. 1st year Physics — *Spring 2016*
- **Algebra** — Universidad Autónoma de Madrid
  Teaching assistant. 1st year Computer Science — *Spring 2015*
- **Mathematical Appendices (d'après V.I. Arnol'd)** — ICMAT
  JAE Intro Summer School — *14th-18th July 2014*

Thesis committees

- **Luca Accornero: Topics on Lie pseudogroups** — Universiteit Utrecht
  Committee member — *29 September 2021*
- **Aldo Witte: Between generalized complex and Poisson geometry** — Universiteit Utrecht
  Committee member — *27 September 2021*
- **Davide Alboresi: Poisson manifolds and holomorphic curves** — Universiteit Utrecht
  Committee member — *29 October 2018*

Service

- **Member of the Utrecht Geometry Centre board** — Universiteit Utrecht
  Role: Webmaster of the UGC site — *January 2021 - present*
- **Referee**
  Indagationes Mathematicae, Mediterranean Journal of Mathematics, Journal of Symplectic Geometry, International Mathematics Research Notices, Journal of Topology and Analysis, Revista Matemática Iberoamericana, Algebraic Geometry and Topology, International Journal of Mathematics

Grants and honors

- **NWO Veni Fellowship 2018** — NWO
  Three year grant awarded by the Netherlands Organisation for Scientific Research (NWO) — *2018*
- **Vicent Caselles prize 2018** — RSME-BBVA
  National thesis prize awarded by the Spanish Royal Mathematical Society — *2018*
- **Premio Extraordinario de Doctorado 2017** — Universidad Autónoma de Madrid
  University prize to the best thesis in mathematics — *2018*

- **La Caixa-Severo Ochoa scholarship** La Caixa - ICMAT
  Grant for PhD studies *2013-2017*
- **Beca de máster del Departamento de Matemáticas** Universidad Autónoma de Madrid
  Grant for master studies *2012-2013*
- **Beca de Excelencia de la Comunidad de Madrid** Comunidad de Madrid
  Grant for undergraduate studies *2007-2011*

Bibliography

[1] M. Inglis and L. Alcock. Expert and novice approaches to reading mathematical proofs. *Journal for Research in Mathematics Education*, 43(4):358–390, 2012.