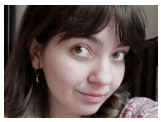
Nelly Litvak
Department of Mathematics and Computer Science
Eindhoven University of Technology
n.v.litvak@tue.nl



Mara Chelărescu
Department of Mathematics and Computer Science
Eindhoven University of Technology
vinyllaroll@gmail.com





Luuk Wubben
Department of Mathematics and Computer Science
Eindhoven University of Technology
luukwubben2@gmail.com



Pranab Mandal
Department of Mathematics and Computer Science
Eindhoven University of Technology
p.k.mandal@tue.nl

Column Better than blackboard

Student-teacher conversation

I remember when I started teaching 30 years ago, how thrilled I was to meet my first students. I still remember some of them, and their occasional messages on LinkedIn make my day. And now I feel the students are slipping away, disappearing behind a cold glass wall, and the only thing I get from the other side are long AI-generated e-mails demanding more points. Of course, I still have good contact with some students, but this slipping-away-behind-the-wall feeling grows in me every year. Can we dismantle the wall? I believe we can. And the first step is to have an honest conversation with the students, how does it feel on the other side?

Welcome to "Better than Blackboard"! Today's article, the last in the series, will be a conversation between teachers and students. Lo and behold, my co-author today is Mara Chelărescu, the talented illustrator of this series and mathematics student. As usual, she made the illustrations for this article as well. Check out more of Mara's art at https://cara.app/vinyllaroll. Mara and I invited two more conversation partners. Luuk Wubben is a former student and a former teacher, with degrees in Computer Science, Data Science, and Education Science. Pranab Mandal is an experienced University Lecturer; students often praise his passion for teaching, yet he can look at education with refreshing, emotion-free objectivity; I believe his balanced views will speak to many readers.

Attendance

We all went through this. The first lecture is full, but attendance drops very quickly week by week. In a post-COVID university, 50% is an excellent attendance and 10% is not uncommon at all.

In her first year, Mara tried to attend classes. Now she says, "Sitting down in a lecture room for two hours with a 15 minutes break doesn't really do anything for me."

It often happened that she looked at the formula and didn't understand it, and then the entire lecture fell apart. She tried to ask questions, but these weren't always answered; sometimes the teacher told her to ask these questions in the break. But then she couldn't follow anymore. Mara also noticed, and I recognize this, that if some students ask "hard" questions, then the lecturers tend to answer those. Then her own questions seemed too simple, and she did not even dare to ask. Ideally, it should not matter whether the question is "hard" or "easy". Pranab tries to answer any question if it is about this lecture. But if it is about previous material and requires a long explanation, he, too, asks a student to come and ask in a break. This is just a common problem with lectures, especially in large courses.

With his degree in education, Luuk brings up another massive issue with classical lectures. A typical attention span of a student is twenty minutes, while a typical lecture is two, sometimes four hours. It is impossible to concentrate for so long. Mara adds that students are also very tired because there is no break between the quarters. This makes it even harder to concentrate. Students start spacing out, lose confidence and motivation and stop attending. This happened to Mara and many other students. Besides, lectures often go really fast. Luuk tried to take notes during his whole masters, and it was really hard to keep up. I agree, and even wrote about the inefficiency of classical lectures in the very first column of this series [1].

But what about tutorials (also called 'instructions', or, in Dutch, 'werkcolleges')? Students can work there at their own pace and ask individual questions. Yet, the attendance is even worse than in the lectures. I personally gave an instruction where out of 400 students only one (!) was present.

Mara says instructions are too noisy for her to concentrate. With current poor attendance, I believe, this is hardly an issue, but by design, she has a point. Maybe we could offer one instruction room where talking is not allowed? In any case, when attendance is so dramatically low, we need new instruction formats. I wrote about some of them (group work [2] and thinking classroom [3]), and there are of course many more.

Luuk brings up another argument, which is new for me. He says: many stu-

dents feel insecure, especially if they were ranked low in a numerus fixus program. They don't dare to ask a question, because they are afraid to sound stupid. Many students have experience with bullying, either as a victim or as an offender. At university, they want to avoid it at all costs. If they cannot follow and don't dare to ask, they simply stop attending. Luuk recalls a PhD thesis [4] from TU Delft. This research suggests that first year bachelor students prefer private feedback moments, especially when it is about something that's wrong. TU Delft has created an electronic system, called Queue [5]: students ask their question online during an instruction and the best fitting TA comes to help them. This way, asking and receiving feedback may be more efficient and feel safer as well.

There are other issues with attendance, unrelated to what happens in the class. One colleague, who achieves 50% attendance, has asked the students and figured that the reasons for skipping a class were often logistical: a student lives far away and has classes at 8:45 and at 15:30. Then they would usually attend only one class or stay at home. And yet another perspective: one international student told me that in Dutch high schools students often work individually. At university, attendance is optional, so they stop attending.

Altogether, I believe, it has become a common culture to not attend the classes. We all comply with this by downsizing the room and staff capacity as a quarter progresses. Ineffective work forms clearly contribute to this, but sadly, interactive work forms alone won't solve it. We need a culture change that covers teaching methods, students' autonomy, social safety and logistics.

One crazy idea

For a while now I've been thinking: what if we offer students the choice between an online option and an on-campus option? First, students get detailed information about on-campus classes, and then they subscribe to attend on-campus or not. If a student chooses to attend on campus, then this is binding and they must attend. If they choose an on-line option, they just have weekly online Q&A and then come to the exam.

As teacher, I would love to have a dedicated group of students, no matter how small, attending every class. It breaks my heart when the number of students drops and drops each time. Pranab doesn't agree with me on this. He says, even if one student attends, I will happily teach this one student. But both Pranab and Luuk supported the idea for opting in or out for on-campus attendance because it gives students autonomy, which is crucial in education [6].

Luuk immediately sees a drawback: this will create more work for lecturers. And yes, any modification of a course, no matter how small, results in extra work. But I believe that any tangible solution for attendance problem is worth the work! I also believe that opting in or out is a better and a cheaper solution than counting on full attendance, building huge lecture halls, and then having all these rooms almost empty except for four weeks—the first week of each quarter—in a year.

Luuk adds that we will also need good arrangements when an on-campus student occasionally cannot attend. We don't want students to choose an on-line option out of the fear that they get in trouble if they get ill or have a family emergency.

Students may complain that they must fix their choice once for the entire course instead of for every lecture. Pranab doesn't see this as a problem: "That's just life. In the real world, you don't get infinite choices. You do get to choose this one thing, so choose what suits you best, and if it doesn't exactly work out for you, then that's just part of life." I couldn't agree more.

So, this is the crazy idea. Do you think it will work?

There is no such thing as stupid questions, really?

Most teachers I know, including Pranab and myself, would say, there is no such thing as a stupid question. But do students feel the same way when talking to us?

The short answer from Luuk and Mara is mostly yes. Mara says, "Every single time I asked a question at the end of the class, the teacher has stayed with me to explain it, and they have always been very patient and nice. I have had isolated weird instances that I cannot help but carry with me. But after that I have had TAs who were more than happy to stay with me extra hours, even a day before exams, they corrected my solutions before resits so I learn how to solve something properly."

The weird instances that Mara mentions are all about asking questions: "I went to the teacher and asked them to explain the solution to me. They explained first, and I still didn't get it, and then they said, 'I don't understand what you don't understand!'" There is nothing wrong with this phrase itself, but it is not only words, it is also the tone that sounded dismissive.

I immediately recalled how, many years ago, I was giving feedback to a student on their internship report. I tried to make it light and clear, so I used some metaphors in a joking way. Next time the student told me that they wouldn't continue graduation with me because I was laughing at their mistakes. This was not what I meant, but I can imagine why the student felt this way. I have learned my lessons and removed jokes from my feedback. Later, I also practically removed the word "you". Instead of saying "You use the same letter X to denote two different things", I say "Here X denotes one thing, and here it denotes something else."

Another of Mara's examples is how she followed a course at another faculty, and the lecturer was visibly upset with her for asking basic questions. Apparently, the lecturer didn't know she was from another faculty. Luuk's example, too, is related to assumptions. Once a TA ridiculed the solution of his project group, while they actually followed an earlier suggestion from another TA. Probably, the TA assumed that the students didn't work hard enough or didn't seek advice before. Plausible, but wrong. Pranab doesn't assume. I know I do, and I try not to. Whether right or wrong, any negative assumption simply doesn't help to communicate that "there are no stupid questions".

Whether we want it or not, the school has engraved in our students' brain that errors in math are bad and stupid. If we want to change this deep belief at university, we need to do more than just claiming that "there are no stupid questions". We should make students feel safe making mistakes. And apparently, not only our grades, but also our exact wording, facial expression, and our assumptions play a role in this.

For years already, I believe that the University Teaching Qualifications have been missing a very important module, that is a standard part of Education Science degree: how to talk to the students, and especially

how to respond to “simple” mistakes and “basic” questions. I am convinced this is a very important skill for an educator, and I will subscribe to such module the moment it opens.

Points negotiations

I chose this profession to be able to interact with students. And I am very sad that in recent years, most of my conversations with the students are about their points at the exam.

AI has made it worse. Nowadays students don’t even need to check solutions. They upload their graded exam to a chatbot and ask where they could get more points. At the review sessions, students show up with detailed notes around their two-line solution. I didn’t realize that those detailed notes were often produced by AI, but when one student told me about it, it became obvious.

I like Pranab’s reaction to students who try to explain, with AI or not, what they really meant in the solution. Remaining sympathetic, he points out that in a written exam we must assess exclusively what is written on paper. “Suppose, later, this exam will be checked during the audit of the educational program? I must assess what is written, otherwise I will lose my job!”

But why the only thing students want to talk about, is those points? I could teach them so much, don’t they want to learn?

Luuk’s answer to this is very realistic. Most students don’t yet know what motivates them. After high school, university is the only valid option. They have been whipped into this system where everything is about grades. Whether they care about the material or not, at the end of the day the question isn’t why you have not learned enough, it’s always why your grade point is low. Students need a degree to get a job and to earn money. Even if they like the study, still in the back of their mind it is about the degree for most students.

Yes, I know. I even wrote about it in one of the previous articles [7]. But when a specific student asks for more points, while in their answer the standard deviation is negative, it hurts me every time. Pranab looks at this pragmatically: it is students’ duty (or nature, or ‘dharma’ as he calls it) to try getting a higher grade, and our dharma as teacher is to maintain the standards.

No matter how we look at this, we must admit that in the current system, poor learning has no direct consequences for the students, but poor grades do. Especially for first year international students, succeeding in studies relates to their residence permit. The discussion about points is pointless for me (pun intended) because it is not about knowledge. But for the students it might be all that matters.

As long as the system is in place, there will be grade negotiations. If I want to keep my sanity, I need to learn from Pranab how to be pragmatic and sympathetic at the same time. Or change the system. Or both. I think I am going for both.



Illustration: Mara Chelărescu

Figure 1 Points negotiation.

The hardest part of teaching

Teachers’ reactions can be inconsiderate, yes. But I can confidently say: the same applies to the students.

I long stopped to use open questions in anonymous online quizzes. I used to start my Statistics course for mechanical engineering with this very general question: “A chisel is a tool for turning, which needs to be positioned at the origin. You need to test whether the machine has sufficient accuracy of the positioning of a chisel. What will you do?” At best, I’ve got abrupt answers like “measure” or “average”. But also “cry”, “drink beer” and “T.B. knows the answer” (T.B. being another, apparently very cool, teacher). Once I shared this in a presentation, and a young female colleague quoted the answer that she got, which was not just silly, it was a downright harassment! Now I use an open question only when students login and can be held accountable for their answers.

The strong wording and harsh comments in student evaluations are infamous and well-studied in the literature. Fill out your own favorite quote here. I’ve got plenty including “all students agree that the teacher is very bad.”

I also still don’t know what to do if students come to the class late or stand up and leave while I am talking. It feels disrespectful. My class is not a train station! Pranab usually stops and looks at the student till they sit down (if they are late) or leave the room (if they leave early). Guess what, this year a student complained that they were intimidated because the lecturer followed them with his glance when they were late. Yet, based on education theory, Luuk supports Pranab’s approach. Sadly, there is no solution without any (negative) consequences. The teacher must be authoritative, even if some students don’t like it. The art is to be authoritative and kind. This ties to the “mentor mindset” (high standard—high support) of Yeager [8] and tracks back to many similar concepts such as “warm

demander" [9] or being in a top-right quadrant of the Interpersonal circumplex [10] that goes back to the 1957 book by Leary [11].

Once I was discussing with four students in a break. A fifth student approached us, said hi and gave hands to all four students, interrupting our discussion, and didn't even say hello to me as if I was invisible. In the spirit of "warm demander", I interfered. I looked the student in the eyes and said hello. They said hello back, but I don't think they realized something was wrong. A young talented colleague of mine insists that students say hello to him at the beginning of the class. "I say hello to you. Say hello to me!" And he doesn't start before he hears a convincing "Hello Mike!"

But no matter what we do, we can never reach all students. Luuk says that this is the hardest part of teaching. "Some students are just not nice. It's been repeated in every educational science class that it is a really difficult thing to deal with students that just don't value you or your time and will use you if you let them."

I believe the answer to this is again the shift of the culture towards mutual default respect and accountability. And I agree that we might force this on the students if needed. It doesn't mean enforcing the high school discipline, as many colleagues and students fear. But it does mean enforcing autonomy, accountability and respect for other people's time, expected from adults.

To begin with, I believe, we must treat students as individuals. Brandan Kelly, the Director of Introductory math at Harvard, shared one idea with us during his visit to 4TU.AMI in 2025. They ask each student to prepare one slide about themselves: motivation for their study, hobbies — anything. Then they share a deck of slides with a teacher. And even if I cannot remember the content of 400 slides, I know for fact that flipping through them will help. I experienced myself and shared in my previous column [3], how knowing about what my students are good at, changed my perception of the class.

Knowing students' names is a game changer. I am now even reading a book about it [12]. For myself, I have devised a very simple algorithm. If a student asks a question, ask their name first, then give the answer. I am surprised how hard it is to do it! I just keep jumping to the answer. I didn't expect that treating students anonymously is such a persistent habit! And this is not okay. I believe in the main idea of Yeager's book [8] that young people respond to individual respect and individual accountability. Even with our scarce resources and large classes, we should try to build it into the system as much as possible.

I hope you are doing well

One thing that AI has changed drastically is the e-mails from students. There are more of them, they are much longer, and so overly artificially polite. The opening line alone annoys me beyond bounds: "I hope you are doing well." Why are the students suddenly so interested in my wellbeing? And why wouldn't I do well? I was giving a class yesterday and you were supposed to be there. It's not that I was taken away by an ambulance in the middle of the lecture.

Alas, AI is trained on many emails, most coming from business. And apparently expressing the hope that your co-worker is doing well a very common way to waste the time and the word limit in the corporate world.

The content of the e-mails varies, but mostly falls into one of the two categories.

First, the students ask for more points, higher grades and exceptions. The worst for me have label "Urgent" or a subject line like "Unfair mark", complain that I didn't act "after multiple reminders" or threaten to appeal to the Examination Committee. Pranab is cool about it. "Let them write, I will answer. I will spend time and write an even longer email." And when I lament that these emails are AI-generated, he shrugs, "Unless I have a proof, I don't know about that." I wish I could react this way. But so far, I cannot and get upset every time.

Second, students ask something about the course; most of the time it is something they should already know from the LMS (in my case, Canvas), the schedule, etc: "Is goodness of fit a part of the exam this year?", "Where will the exam be?" or "How will the grade be calculated?". My absolute favorite was received by a colleague: "Can you please explain in a short e-mail what should we know for the test?"

It triggers me when students ask things that they should know. Yet, every time I go to Canvas and check what exactly is written there. And guess what? Sometimes I realize that the text was not as clear as I thought it was, and the student had a point asking about it. It doesn't help that Canvas sites are often very different for different courses. It is not always easy for a student to find information. Clear communication is crucial, and we often assume that something is obvious, while it is not obvious at all. Especially first-year students don't yet know the system. Some of them don't even know that a study advisor can arrange exceptions for them due to personal circumstances.

Here is my dream scenario. For large courses, I wish that someone (maybe even some students or communication specialists) checks my Canvas for completeness and clarity. I also like it when there is a template, so that students don't need to rediscover Canvas in every course.

And in my next large course, I seriously plan to disallow e-mails. Instead, I will have on-campus and online Q&A every week. I've heard a podcast with the author of the book "World Without Email" [13], and they suggest exactly that: instead of sporadic e-mails, regular short check-ins. Maybe it won't work. But I will try. I hope it will reduce e-mails and increase live conversations that I miss so much.

Expectation management

Very often, the bottleneck in student-teacher conversations is an alignment of expectations of the teacher and that of the students. The expectations can be about the content, the activities, the assessment method, etc.

I have been amazed for many years how Pranab navigates these situations. He openly discusses most common issues, where the expectations clash, thoroughly and classically at least once. On some issues, he reiterates the interpretations of the rules whenever an opportunity arises. He likes to do this in low-stake conversations at the breaks.

In such discussions, he tries as much as possible to avoid to say that students are wrong. To the contrary: he often points out arguments based on which the students are right. However, he does explain his perspectives: "Ultimately, of course, I as the teacher define the rules. In my experience, the messages come across better with a friendly, informal atmosphere. I keep the tone light-hearted, often using metaphors and examples from life. After all, I have more life experience than them!"

For example, students often ask which

formulas are (the most) important for the exam. Also, they keep asking for more and more sample/past exams in the pretext of "preparing for the exam". Pranab's usual response is that his primary goal is not to make them pass the exam, but to prepare them for their (work) life in the future. If they properly understand the material, then they will not only pass the exam, but also stay ready for plenty more challenges that may come to them in the future. By learning to solve only the stylized questions (from past exams) and/or only memorizing the important formulas, they may pass the exam, but they may not be ready for the reality when they would face a problem that they have not seen before. He gives an example of COVID lockdowns. Within a week, each teacher had to move to an online teaching that they had never seen/experienced before. We needed all our understanding about how "learning" happens to design the new system, not just the important "formula" that I go to a room explaining stuff to the students, possibly using a blackboard! Luuk ties this to the motivation. It helps to explain to the students how the teacher's approach and their learning is relevant to their future life and career.

Believe it or not, Pranab's conversations with students work. In recent evaluations students wrote, "We like that he teaches what we will need in real life." Luuk ties this into the idea of togetherness, combined with authority as a teacher. The students feel connected through shared experiences and light-hearted conversations, which increases respect for the teacher and their authority.

Often, students complain that something is not fair. Once again, Pranab starts with agreeing to their perspective. And then he points out that life is no different. In life also, we must navigate through some unfairness, some unjust obstacles. Any system is unfair. For instance, in a written exam, we must assess what is written on paper; no correction is allowed. Unlike in an oral exam, where a student has a chance to correct themselves. However, having chosen the system, we must follow it through.

Sometimes students complain that the answer varies depending on how you interpret the problem. Pranab: "My standard response, with a smile on my face, is that they are completely right in approaching me. This only shows that they are on the right track of their learning. In reality, too, we communicate through normal language, which can be ambiguous. The only way out is to discuss with others about the meaning and how to proceed with the solution." To reduce their worry for the exam, Pranab promises to do his utmost best to describe a problem in an unambiguous manner.

The assessment, especially the grading of the written exam, is probably where the differing expectations become contentious. In particular, what it means to be a well-explained answer that is required to get full marks. Instead of trying to find the best and clearest explanation, Pranab admits upfront that it is difficult to describe what a "good" explanation is. Then, during the course, he tries to give as many examples as possible.

Study trip

Besides the classroom, I believe informal contact with students goes long way. And sometimes we get a chance. I just started teaching the course "Statistics for Industrial Engineering" with 400+ students, when I received a message inviting me for their two-days study trip to Belgium! The program included a study visit to a company and social activities. One teacher must join the trip and participate at least in the company visit. And I was invited to be that teacher.

We took a bus early in the morning. The company visit to a shipyard was very exciting. Then I joined the bowling and the dinner.

The dinner was pizza, and we ate in two shifts; I joined the first shift. The room was full of guys (apparently, all girls were scheduled to the second shift). I looked around and joined a half-full table. Admittedly, no one came to sit next to me. But couple more students joined the table on the other side, and it became reasonably full. I started asking students' names, where they are from, and then asked the ever burning question: "Why don't you come to the classes?".

Pizza was served and eaten, everyone left, but we still stayed at our table talking till the second shift came and we had to leave. We were talking all the way to the hotel. About their study, how they think things could run better, and how brain learns. But also about hobbies, holidays, and I even told how I was going on canoe trips with parents when I was young.

I came home as happy as I could be. I still know how to talk to the students! And most importantly, they still need it. All my colleagues are very interesting people. Students miss out so much by coming to us only to discuss the grades! Students need conversations with different and interesting adults. And they like it. We just have to figure out how to reach them.

Student-teacher concert

In my previous article [3] I wrote how I asked students in my elective course what they were good at. Many were good at mu-



Illustration: Mara Chelărescu

Figure 2 Barbershop quartet, one student and three teachers, at the student-teacher concert.

sic. I know that many of my colleagues are good at music too. So I thought: maybe we can organize a student-teacher concert! I was very lucky to find enthusiastic teacher- and student- organizers, especially Annika Bach, who had lots of experience in organizing a concert.

The idea was that in every performance there must be at least one teacher and at least one student, all from our faculty of Mathematics and Computer Science. To connect performers, we held a matching event.

We stepped into this with lots of unknowns. First, we worried that no one would come to the matching event. Then, we worried that there would not be enough performances. Finally, we worried that there would be very little public.

Eventually it all worked out, and we had a great one-hour-plus program with six performances, plus funny sketches by the hosts (one teacher, one student), in front of a room of 150–200 people: staff, students, family and friends.

And it was fantastic! The performances were very varied, from a string quartet to a rock band to a choir. The hosts were hilarious. And we ended with a closing self-written song about our faculty. Everyone was enthusiastic and very impressed by the quality and the variety of the concert.

A month later, the organizers gathered again to look back and discuss the next year. "What was most difficult?" I asked everybody. A student organizer answered right away, "To convince the students!" --- to convince them to participate, to convince them to attend. Partially it was so hard because no one knew whether this would be a flop or something really cool!

At the end, it was really cool. And most importantly, all performers said how much they enjoyed practicing together. We've heard from a student, "I didn't know my teachers personally. And now they say hi to me in the corridor!" We've heard from a teacher, "Rehearsing with the student was the best part." And we all felt the same way!

This echoes my experience from the study trip. Students and teachers need each other, and we should not give up looking for ways to connect.

This article closes my "Better than Blackboard" series. It was a joy to write these articles, be the first to see Mara's beautiful drawings, receive heartwarming reactions from colleagues in the Netherlands and all over the world. Recently, I have built a website with the entire series; I am quite happy with the result, check it out at https://nellylitvak.com/better-than-blackboard/.

I am looking forward to meeting you again and talking a lot more about education. And for now, I wish you inspiring conversations with your talented amazing students in the coming academic year!

Thank you, best wishes, and see you soon!

References

1 Litvak, N. (2023) We shouldn't give classroom lectures anymore. *Nieuw Archief voor Wiskunde* 24(3), 145–149.

2 Litvak, N., & Weedage, L. (2023) Do we teach what we preach? *Nieuw Archief voor Wiskunde*, 24(4), 233–238.

3 Litvak, N. (2026) The dream course. *Nieuw Archief voor Wiskunde* 27(1), 41–45.

4 Van Beek, L. (2024) *Cracking the code: Investigating feedback perceptions in large Computer Science Education classes*. PhD thesis, Delft University of Technology.

5 *Queue*. TUDelft. https://queue.tudelft.nl/

6 Ryan, R. M., & Deci, E. L. (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

7 Litvak, N. (2025) What are we selling? *Nieuw Archief voor Wiskunde* 26(3), 153–157.

8 Yeager, D. (2024) 10 to 25: *The science of motivating young people: A groundbreaking approach to leading the next generation—and making your own life easier*. Simon and Schuster.

9 Bondy, E., & Ross, D. D. (2008) The teacher as warm demander. *Educational Leadership*, 66(1), 54–58.

10 https://en.wikipedia.org/wiki/Interpersonal_circumplex .

11 Leary, T. (1957). *Interpersonal diagnosis of personality: A functional theory and methodology for personality evaluation*. New York: Ronald Press.

12 Miller, M.D. (2024) *A Teacher's Guide to Learning Student's Names*. Book 2 of 7: Teaching, Engaging, and Thriving in Higher Ed. The University of Oklahoma Press.

13 Newport, C. (2021) *A World Without Email: Reimagining Work in an Age of Communication Overload*. Portfolio.

Vervolg van pagina 173

Daarna moet deze vergelijking nog opgelost worden. Jammer dat de manier van oplossen niet vrijer kon worden gelaten. Nu worden creatieve geesten beperkt in hun denken. Misschien was wat meer vrijheid aanvankelijk wel de bedoeling van de makers van het examen, wie zal het zeggen. Uiteindelijk hoort probleemoplossen nu nog wel nadrukkelijker tot de examenstof van het centraal examen.

Het examen wordt afgesloten met de opgave "*Begrensde inhoud*", waar de grafiek van

$$f(x) = e^{-x} - e^{-2x}$$

om de x-as wordt gedraaid en stiekem komt er een onbepaalde integraal om de hoek kijken. Geschikt voor N&T en N&G.

Als straks het nieuwe examenprogramma van kracht is, dan zouden er naast deze opgaven ook nog opgaven van de nieuwe onderwerpen Statistiek en Differentiaalvergelijkingen opgenomen kunnen — en misschien wel moeten — worden. Bij Wiskunde Natuur N&G is daar wel ruimte voor, want de meetkundeopgaven en de bewegingsvergelijkingen verdwijnen. Bij de N&T-variant wordt het misschien een beetje dringen of slim keuzes maken.

Tot slot nog even terugkijken op het gebruik van ICT in dit examen. Er wordt nauwelijks een beroep gedaan op ICT. Een eenvoudige rekenmachine volstaat bij het leeuwendeel van de opgaven. In het nieuwe programma valt het gebruik van ICT binnen domein B, samen met Redeneren en Bewijzen, Probleemoplossen en Modelleren. Die zogeheten Wiskundige Activiteiten zullen vooral in het schoolexamen getoetst worden, zo is de bedoeling. Wat ICT betreft behoeft dit afgelopen examen dus niet zoveel aanpassing (we stappen gemakshalve even over Statistiek heen), maar de definitieve besluiten over welke hulpmiddelen er bij het centraal examen toegestaan gaan worden zijn nu nog niet genomen en bij publicatie van deze tekst ook nog niet, naar het zich laat aanzien. Er moet nog wel een en ander geregeld worden, voordat de nieuwe examens het licht gaan zien...

Noten

1 https://www.actualisatie-examenprogrammas.nl/wiskunde-havo-vwo

2 https://www.examenblad.nl/2027/onderwerpen/conceptsyllabi