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Column Better than blackboard

My innovation blunders. And why they didn't stop me.

`This was the most stressful experience in my entire student life …' I stare at the student's e-mail, and I know they have a point. I tried something new, and guess what, it went totally wrong. Welcome to `Better than blackboard'! In my previous seven columns I was mostly talking about successful innovations, that may be even called best practices. But of course, an experiment may fail. I want to be honest about it. And I want to share ideas that didn't work as intended because maybe one day you have a similar idea, and then my experience could help you to do better than I did.

As usually, this column is brightened up with drawings by Mara Chelărescu, an applied mathematics student at the TU/e. Check out more of her art at https://cara.app/vinyl-laroll.

The video exam

When universities closed in March 2020 for the COVID-19 pandemic, the main question was: how are we going to hold exams of Quarter 3 in April? In that quarter, I was teaching the course `Statistics for Mechanical Engineering' for about 150 students.

My course was in a good shape for the online mode because in September-January 2019/2020 I had recorded the entire course on video. You can check these videos out on YouTube [1]; I still receive thank-you messages for this playlist from all over the world.

But the exam was a big problem because in 2019 I started experimenting with a new exam form, which I already discussed in columns [2,3]: most of the questions were automatically graded, and only a few questions required written solutions with a good write-up. But if students do exam from home, it is too easy to cheat on multiple-choice questions!

I could revert to a written exam and just hold it online as many teachers did. Except I wouldn't do it for my own historical reasons. I had a very unfortunate experience in the 2018 edition of this course. There were, on average, 30 students in the lecture (I gave lectures back then), and 130 at the exam. When dragging home two heavy envelopes of substandard work, I swore to myself to never ever give a written exam for this course again. I am not a grading machine.

Paradoxically, the beginning of COVID-19 pandemic was a potent time for me as a teaching innovator. No one knew what to do, no rules applied, I could get away with almost anything.

I started thinking: 'what is the best way to check students' knowledge online? Of course, the best way is to hear students' own explanations. Oh, wait a minute! Why not ask them to record their explanation on a video?'

So, my 2020 edition was given as a Canvas quiz. There were two (highly randomized) open questions, where the students had to type or scan a written solution. And there were only four multiple choice questions, but it wasn't enough to choose the answer. After answering each question, the students had to record on video an explanation of why they chose this answer.

Theoretically, it wasn't a bad idea. One needs to really think the solution through in order to explain it on a video.

Except on the day of the exam, when 150 students started uploading the videos, the entire Canvas crashed! Screens froze, students were stressed, the exam time was ticking. I did what I could. I communicated any fix that students and I could find; I extended the exam time; I was checking uploads and answering every e-mail. But I know it was very stressful for the students. This is when I had received the e-mail that opened this column.

I must say that at the end, all videos did upload successfully. I graded quickly, and the students appreciated that I handled the crisis professionally. Yet, it was a crisis. So, what did I learn from this experience?

Conclusion 1. Check that technology works!

Obviously, the first conclusion is that no technology-intensive exam should be given untested, especially for large groups.

There was another point that I didn't foresee in advance at that time.

Conclusion 2. When asking for a video, mind students' privacy.

When I watched the videos, I saw the stu-

Illustration: Mara Chelăresu

A stressed student in their room

dents in very different conditions. Some were in a large sun lit living room at their parents' house. Some were in their student room, with their bed and personal things on the background. Some were in a cramped space that looked almost like a Harry Potter closet. After watching 5-10 videos, I started feeling that I was invading students' private spaces. This resonated in me as a bigger mistake than the Canvas overload. Even if my video exam was well-intended, it wasn't right to ask the students for recordings right then and there. I used video assignments several times after that. But then I always made sure that the students had enough time to choose when and where to do the recording. This way, I never encountered the privacy issue again, at least not in my perception.

Conclusion 3. Plus points of the video: replacement of an oral exam

While this particular experiment clearly failed on many levels, my original motivation wasn't wrong: the videos were very informative on students' knowledge. In later years, a video exam worked reasonably well for a small MSc course. I find video a good alternative for an oral exam. In the oral exam, the presence of the teacher is intimidating, but in the video, the students can just say what they want to say. In that sense, the video might be even more informative. Also, grading videos takes much less time than giving an oral exam, and it is more objective.

An attempt of a non-intimidating and objectively graded oral exam is my next topic.

Grading with dominos

When I studied in the 1990-s in Russia, all our exams were oral exams. We entered a class, and there were small cartons (called `tickets') on the teacher's desk, turned upside down. A student picked a ticked, and there were two theoretical questions and a problem. The student solved the problem, wrote down the theory, and then talked to the teacher. For about 25 students, it took all day.

Now, 20+ years later, I was giving a master course of about fifteen students on random graphs and complex networks. My exam consisted of three parts: problem sets for solving problems, project for the applications, and an oral exam for the theory. I didn't mind to spend a day on the oral exam, and I decided to do this Russian style, let students choose one `ticket', with one theoretical question. I formulated about 20 questions, and made them known already at the beginning of the course.

I used this system before, in an advanced MasterMath course, and it worked quite well. But already then somehow the idea of taking random `tickets' sounded scary to the students, and with years students seemed to find it only more scary.

I did not want to intimidate the students, so I decided to make an oral exam in a form of a game or discussion.

I have split the students in 3 groups of 5 students. Each student picked a `ticket' at random, with one theoretical question. I have arranged three flip-overs, and divided the board in two parts, so all students could write their answers.

Students in each group were assigned numbers 1 to 5. Once students were done preparing their answers on the board or a flip-over, the exam started. Student 1 explained the answer to the group in 5 minutes and could get up to 4 points. Then other students could add something in the order: Student 2 first, then Student 3, etc. For adding something, students could receive up to 2 points. Of course, it is easier to add something when you go first, so the order was rotating. Student 2 presents, Student 3 is the first to add something, etc. To count points, I brough with me domino pieces of 4 different colors (see Figure 1). Red color meant 4 points, yellow 2 points, green 1 point, and blue 0.5 points. Every time after a student gives and answer or adds something, I would give them a domino piece of a corresponding color. At the end they count their points and this was the grade.

In general, this went reasonably well. In fact, I believe that this form of the discussion was really good. Students gave meaningful answers and additions. Many said

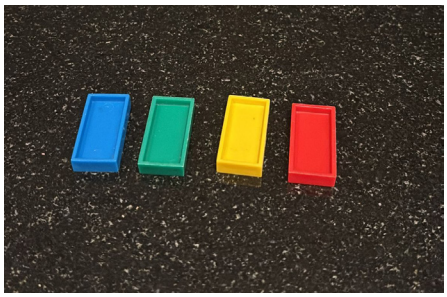

Figure 1 Domino pieces that I used to grade students

they actually learned the material better in the exam. Yet, I wouldn't use this format for an exam again.

Conclusion 1. Students could feel exposed.

The exam is not the same as a discussion. In the exam, students feel judged, and rightfully so. I believe that giving points for their answers right away may put students in a vulnerable position. Numbers have ultimate judgmental power. In fact, it is known that once a number is attached to a feedback, students become blind to the feedback [4]. So I believe that attaching numbers to the answers, in front of the group, made students exposed, even if these numbers were domino pieces.

Conclusion 2. Grades were too high.

I did feel that I had put the students in in a vulnerable position. Therefore, I was quite generous with the points. In the evaluations, students complained that the grades were too high!

Conclusion 3. Plus points of the structured discussion: learning from each other.

If it wasn't a test, the activity itself was fun! Later, in the book `Building thinking classroom in mathematics' by Peter Liljedahl [5] I have read about `gallery walk', as a method of consolidating knowledge. The students work on vertical surfaces (in my case, the board and the flip-overs), and then the class walks from one solution to another, and other students comment on the work. Liljedahl writes that this method of consolidating knowledge encourages students' thinking, and this is what my students noticed as well.

Don't change horses in midstream

In 2023, I was teaching `Statistics for Mechanical Engineering' again, using flipped classroom. All lectures were on videos. In the class, I did two different things. For most classes I used an online quiz with somewhat tricky questions. And two times I did what I called case studies. I gave students homework problems using the data from the project of this quarter; they made the homework and then discussed it in groups and made corrections in class. The groups usually were self-formed, and sometimes I used the same groups as they had in the project.

It so happened that at the beginning of that quarter, I was reading Liljedahl's book [5], about how to facilitate thinking process in a mathematics class. It was fascinating! In particular, in Practice 2, how to form groups, Lijedahl had strong arguments for randomly formed groups of three students. With three students, everyone has a good share in discussion. And random groups made a lot of sense because students come there without expectations from others, like who takes the lead and who struggles. This makes discussions better in the sense that students speak up easier and listen better in a random group. I loved this idea, so I decided to implement it right away. For 150 students! It was quite some logistics. I divided students in groups on Canvas in advance. Case study was mandatory but other classes weren't, so I asked students to comment in Canvas discussion if they won't attend, and reshuffled the groups accordingly. I have made small cards with numbers 1-50 and came to the class earlier to place the cards of the desk for each group. But 50 groups is a lot, how will the students find their desk? I drew a chart on a board which number is where. Of course, in reality, more students didn't show up than expected, I had to merge the groups on the fly. The first time I tried this, it took 10 minutes before we could start. Students complained a lot. They said that 50 random groups and the chart on a board were a terrible idea!

Conclusion 1. Don't change the rules during the course

I did work with random groups in other courses and usually there were no complains. I think, for methods like this, it is important that the students know in advance what is going to happen. No matter how great innovation is, changing rules after the start of the course is not a good idea. I should have been more patient and think it through better, maybe leave it for the next year.

Conclusion 2. Plus points of random groups of three: students do work better

Even though I made quite some mess and students complained, I could see that the discussions were better in random groups of three. This particular batch of students had a very low social coherence because they started in 2020; they barely knew each other. Without random groups they clustered together in small groups where they knew who is `smart'. Random groups broke this dynamic as intended. Yet, it was a mistake to do it there and then.

It works till it doesn't

I am always excited about my innovations. Sometimes it works well and becomes a best practice. But sometimes it works well in the first one-two years and then somehow it doesn't work anymore. It is not always true that this innovation wasn't potentially a best practice. I don't know exactly why it happens, but I do have three potential explanations.

The first is obvious. Students change, high school curriculum changes, and we must adopt. We cannot teach in exactly the same way 10 years in a row. But sometimes innovations stop working much faster than over 10 years. Why?

Here is my second, hypothetical, explanation: maybe innovations stop working when they evolve to become overcomplicated. For example, in my course `Statistics for Mechanical Engineering', after the 2020 video disaster, I have replaced an exam with an assignment. Students had to find their own case study, formulate their own problems, write down detailed solutions, and explain explicitly which techniques they used. My colleague Fulya Kula and I described this in detail in [6].

Most students liked the assignment.

Illustration: Mara Chelărescu

A confused student near flipchart with domino pieces.

In the second iteration, one student even wrote a personal note to me: '*My father and brothers studied statistics, and I expected it would be many boring confusing formulas. But it was nothing like that! I actually liked to figure out which technique was used in different problems*'.

However, the assignments were very large and took forever to grade. Fulya and I wanted to reduce grading, so we replaced some of individual work by group work. The groups were small and students knew what was expected from others and themselves. We tried it in 2023, and the students liked it less. I believe one of the problems was that the entire course set-up became too complicated. There are only so many new rules that the students wish to learn and follow.

Perhaps this is one of the reasons why the traditional lecture-tutorial-exam system is widely used despite of all the evidence of its ineffectiveness in terms of students' learning. This system is very simple, and this is a strong advantage. But innovative teaching engages students and helps them learn better, so we should keep looking for the right balance between effective learning and complicated rules.

Finally, my third, also hypothetical, explanation is that every course has a `reputation' among the students. When there is a drastic change, students follow all the rules because they do not know what to expect. But if the innovation is effective, it will result in better learning and therefore higher grades. Based on the high grades, the course gets a reputation of being `easy'. Then in the next years students start looking for an easy pass. The intended good learning doesn't happen, and the students massively fail the course.

Conclusion 1. KIS – keep it simple

New teaching methods will always require some polishing over years. However, we shouldn't forget that innovative systems are not so simple to begin with. So, when revising our innovation we should never make it more complicated than it already is. Golden rule, KIS – keep it simple. It is also very important to explain the system very clearly. Students must know exactly what is expected from them. This was also one of our main conclusions after implementing a very complicated innovation – alternative grading (we wrote about it in detail in [3]).

Conclusion 2. No flare of an easy pass

In an innovative course, the standards must be not lower than in the standard lecture-tutorial-exam set-up, and all activities that contribute to the grade must be set up as rigorously as the standard exam, with presence registered and minimal to no possibility for cheating. The students should see very clearly that they must work for this course.

Closed door

When I was a student, we had a very strict Linear Algebra professor. He closed the door exactly at the scheduled starting time of the lecture, and late comers couldn't enter.

Usually I am not a fan of such rigid measures. But here I am, giving, ironically, a Linear Algebra class that starts at 8:45. In the first week, a couple of students are necessarily late. This is understandable. First-year students don't know the campus yet, and accidents can happen: a train delay or a broken bike.

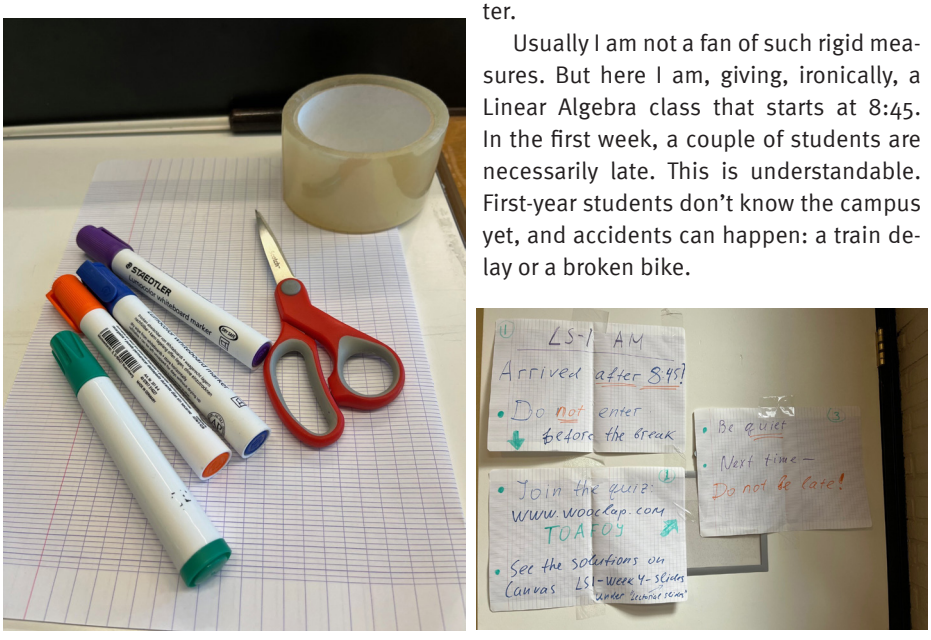

Figure 2 My poster for latecomers

Photo: Andreas Weith. Wikimedia Commons

Figure 3 Online teaching iceberg (after [8]).

Usually I explained to the students that we would start on time as scheduled, that their late entrance distracts me and the others, etc. I asked them to be respectful of this. But of course, in the second week even more students come late, and then more, and more. Around week 4 only a half of the students showed up on time, and they kept entering for the first 20 minutes, alone and in batches.

Some colleagues take it easy. They just allow the late comers to enter. But I don't like this at all. It interrupts the flow of my carefully designed class, it distracts others, and sends a message that the beginning of the class is not important.

I tried everything. I explained, I joked, I asked them in front of everyone why they were late. All in vain. So guess what. A couple of times in my career, I closed the door and didn't let the late comers in, like my former strict professor.

The last time I did it was in September 2022. But I knew it was a drastic measure, and I wanted to be nice. I wanted to make the students feel responsible, but still give them a chance to follow the class. It was possible because I used `flipped classroom', and my class was an online quiz. Anyone with a code could do the quiz. So I took paper and markers, and posted instruction for the late comers the door (see Figure 2): `Arrived after 8:45? Do not enter before the break. Join the quiz [website, code]. See the solutions on Canvas. Be quiet. Next time do not be late!' I also wrote a Canvas announcement that I won't let late comers in before the break.

On the day itself, it went ok. Only two students were late. Some smiled at my handicraft, and they seemed to understand where I was coming from.

But then some negative stir did emerge around this event. One student complained that they were warned only one day in advance that they couldn't enter late. I found it a strange complaint. Was this student intentionally planning to be late? This in-

cident was prominent in evaluations, even though I did it only once. And then, I was careless and blunt enough to tell about this experience during my interview for the final of the national teaching award. I felt this was the moment from which the interview didn't go very well, and I didn't make it to the final.

Conclusion. From this story I have only one, maybe unexpected, but profound, conclusion. We lack community between teachers and students. I first encountered the idea of community, when I saw the drawing of the `online teaching iceberg' (Figure 3). The figure surprised me. I could totally relate to the iceberg, but I understood it only as deep as `*Ongoing conversations and following up with the students*'. The `*community building*' was a radically new idea. Very quickly I realized that yes, community and culture are very foundational in the learning process. Community means students' trust that I am on their side, it stands for an open and collaborative culture. Opposite of community are transactional relationships, indifference and stand-off. The lack of community manifests itself when students come late and hide in the last rows. And when I close the door.

I don't know how to solve this problem, I am out of my depths here. I did find some hints in the recent book *10 to 25: The Science of Motivating Young People* by David Yeager [8]. Yeager says that young people are mostly motivated by `earned prestige', the respect that they earn by making meaningful contribution to their social circles. In that line, students should develop a strong feeling that by coming to the class on time they honor the efforts of the teacher, the time of their classmates, and the trust of the society that gave them the opportunity to study. But how to achieve this? I really don't know.

Why my blunders won't stop me

Now that I have honestly spilled out my teaching blunders, I want to tell you why I keep trying and will not revert to the traditional ways.

I want to put it very bluntly. I strongly believe that the traditional system is broken. Here are the signs that convince me about it. And even if you don't find these signs convincing enough, I am sure you will recognize them.

- When we explain a challenging material, the most common question is, `Will it be on the test?'
- When discussing exams, students mostly focus on the points and whether the points were fair. It is hard to get them from the point-counting mode to the open-to-feedback mode.
- It is not uncommon that 20-40% of the students show up to the class, but all of them come to the test. Then, what is the role of the teacher? Only grading?
- Cheating is massive. The (highly recommended) book `Teaching with AI' [9] cites the numbers: even before AI, cheating in online exams was over 50%, and with AI academic misconduct only increased.
- From what I've seen, tutorial classes are often like railway stations: students come and go as they please without even acknowledging the teacher.
- Evaluations are often offensive, especially to female lecturers.
- When a teacher asks a serious open question in an online quiz, they may expect many silly or even offensive answers.
- In a class, students tend to sit further from the teacher.

I could continue, but I think I made myself clear. So I won't revert to the traditional methods because they push me into frustrating situation of stand-off, where I lose touch with students' learning.

You may shrug it off. You may say, `I believe the system is not broken'. It is up to you what you believe. I only ask you to be honest with yourself: do you truly believe in the traditional system, or you don't want to invest time in fixing it?

I wrote many times: not everyone should be an innovator. Academic staff has many other important duties, like research, leadership and fund acquisition. But the more people admit the big problems with the current system, the more chance we have to build a better system. I will keep building, making mistakes on the way. And there are many others doing the same. We meet a lot of resistance. If you simply admit that our work is meaningful, this already will be a great support.

References

1 Nelly Litvak. Applied Statistics and Probability for Engineers. Full course with real-life engineering examples - YouTube

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

3 Litvak, N., & Müller, N. (2024) Competency-based grading. *Nieuw Archief voor Wiskunde*, December 2024, pp. 227-233.

4 Clark, D., & Talbert, R. (2023). *Grading for Growth: A Guide to Alternative Grading Practices that Promote Authentic Learning and Student Engagement in Higher Education*. Taylor & Francis.

5 Liljedahl, P. (2020). *Building thinking classrooms in mathematics, grades K-12: 14 teaching practices for enhancing learning*. Corwin.

6 Litvak, N., & Kula, F. (2024). No exam: assessment of third-year engineering students on the basis of self-generated Statistics cases. In *Takeaways from Teaching through a Pandemic* (pp. 89-97). Routledge.

7 Fawns, T., Aitken, G., & Jones, D. (2022). A little more conversation, a little less factionalisation: Thoughts for the postdigital future of online postgraduate education. In *Online postgraduate education in a postdigital world: Beyond technology* (pp. 217-232). Cham: Springer International Publishing.

8 Yeager, D. (2024). *10 to 25: The Science of Motivating Young People*. Avid Reader Press/Simon & Schuster.

9 Bowen, J. A., & Watson, C. E. (2024). *Teaching with AI: A practical guide to a new era of human learning*. JHU Press.