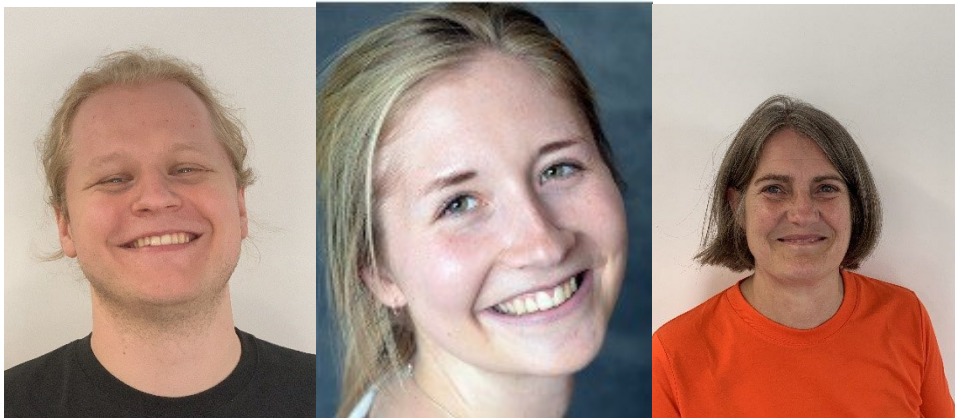


“Can sustainability in mathematics become a bestseller?” Toft, Sterup & Hjelmberg.



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## Can sustainability in mathematics become a bestseller?

Sustainability in the teaching of mathematics? "It's probably not a bestseller" reads the title of a blog by Henning Westphael (2023) on folkeskolen.dk. The title does not reflect Henning's opinion, but Henning often encounters similar statements when he discusses sustainability in mathematics with preservice teachers and teachers. We had similar experiences in the beginning of a course on sustainability with our preservice teachers (2nd and 3rd semester). In a survey, two of the preservice teachers express: *"It [sustainability] seems a bit like something "new and smart" that UCL has produced. To be fashionable."* and *"I expect that mathematics will take a backseat and that the time could therefore be better spent"*.

Regardless of attitudes sustainability will be a central part of teaching in primary schools as well as teacher education.

## Is there a connection between sustainability and mathematics?

In the formal aims of the Danish Folkeskole, §1, sustainability is mentioned indirectly: "In cooperation with the parents, to provide pupils with the knowledge and skills that: (...) contribute to their [the pupils'] understanding of the interrelationship between human beings and the environment (...)" (Ministry of Children and Education, 2023).

In the curriculum for mathematics, sustainability is also mentioned indirectly regarding the mathematical competencies for lower secondary education: "Teaching within the mathematical competencies generally takes place in a progression from the well-known and manageable towards the less well-known and more complex. In the last part of the progression, this means that the situations in which the pupils are expected to be able to act,

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expands from local society and nature to also include Danish social conditions and global developments (e.g., regarding climate and population)" (curriculum p. 51).

In the description of the interdisciplinary subjects, it is mentioned that the pupils must be able to "solve problems that go beyond mathematics itself" (curriculum p. 58). The climate is also mentioned as an obvious interdisciplinary issue. The mathematics teacher's task then becomes having an eye for what mathematics can contribute to the topic, e.g., the potentials and limitations of mathematical models in relation to interdisciplinary issues.

It is also worth noting that sustainability is also written into the teacher education's new formal aim, §1.3: "Teacher education must prepare the preservice teachers to work actively, independently and responsibly in the development of the Folkeskole in accordance with the formal aim of the Folkeskole and in a democratic and sustainable perspective."  
(Retsinformation, 2023)

We will not deny the fact that we think it can be challenging to connect sustainability and mathematics in a meaningful way. However, we have tried to include a sustainability perspective in mathematics in Teacher Education.

## Can we make a difference?

At a meeting for all the teacher educators at UCL, the head of Facility Service, Lars, gave a presentation about the sustainable initiatives at UCL. We were impressed by the number of interventions and their effects. We then decided to launch a project called 'Your sustainable education' for our preservice teachers. Here, Lars had to play a significant role, and fortunately he agreed to participate.

Almost seventy preservice teachers sit in a warm and crowded room, listening curiously to Lars. He presents the concrete and almost invisible initiatives that Facility Service has initiated. E.g., Facility Service has switched off the Wi-Fi-routers at night – the savings surprisingly correspond to the annual electricity consumption of three households. Facility Service has also replaced all water nozzles, which reduces water consumption for hand washing by approximately 90%.

After the presentation, the preservice teachers were eager to ask questions, and it was a good and informative day. Lars asked the preservice teachers to formulate concrete proposals for new sustainable initiatives at UCL and estimate savings for these. He also asked them for ideas for means of communication of existing sustainable initiatives at UCL. The preservice teachers approached the task with great commitment and presented posters, flush-ads, and

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stickers three weeks later with their ideas of initiatives and estimated savings at a poster session. Lars was at the poster session and was extremely interested in the preservice teachers' contributions. Employees in Facility Service, who had helped with printing the posters and flush ads, also commented on the exciting project and how they could make use of the ideas. Lars also expressed that he plans to implement several of the preservice teachers' suggestions.



## Can you really run out of sand?

In an internal interdisciplinary collaboration with the science educators at UCL, we have also worked with sustainability, albeit from a STEM perspective. One of the science educators, Anja Rousing Lauridsen, has previously explored scarce resources, and her work became the starting point for our project.

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The mathematics preservice teachers are standing in the biology laboratory. Some are wearing lab coats, protective glasses, and gloves, presumably for fun. They are in the process of categorizing sand. There are optical microscopes, soil sifters, heat lamps, petri dishes and scales. Discussions take place between group members, and the sand is categorized according to shape, color, size, smell, etc. - limited only by imagination.



Afterwards we watched a video with the title ‘Vi er ved at løbe tør for sand’ [We are running out of sand] (<https://www.youtube.com/watch?v=ZGaRwvNcT9A>), then the preservice teachers worked on the problem: How should we deal with the problem that there will soon be no more usable sand? Who is or should be responsible for reducing sand consumption, how should it be done and why do you think this is the best solution?

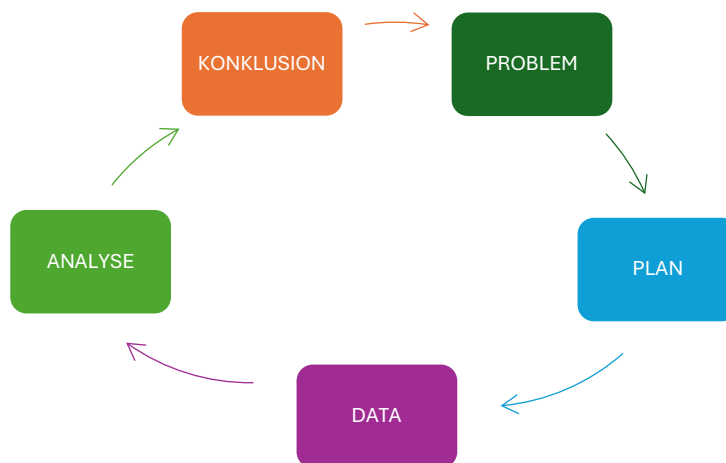
Surprisingly, for both educators and preservice teachers, it turned out that sand used for construction is a scarce resource and that the entire world's population uses an average of 18 kg of sand per day per person (UNEP, 2019, p. 3). Sand used for construction is angular and has varying grain sizes, which were also some of the categories the preservice teachers had found. A preservice teacher happily nodded and smiled when these criteria for categorisation were mentioned in the video.

The preservice teachers worked with great enthusiasm and produced creative ideas to reduce sand consumption. The ideas ranged from fetching sand from Mars (however, it quickly became extremely expensive), to using processed wood instead of concrete for buildings, to supplement or replace the sand in concrete with plastic, bamboo fibers or something else.

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As part of the work on the sand problem, the preservice teachers also worked as data detectives (Schou et. al, 2013), assessing the robustness of alternative concrete mixes when exposed to kettlebells of varying weight from different drop heights. In the picture you can see concrete mixtures supplemented with plastic, Leca balls and paper, both blended and torn into small pieces. It was found that the recommended concrete recipe (1 part cement, two parts sand and three parts gravel) produced the strongest concrete. However, the alternative concrete mixes survived surprisingly well.



## It was a bestseller!

When we consider the two developed courses, some significant differences emerge. For the preservice teachers, a key element was that they predominantly worked with realistic initiatives that could be acted upon directly. A preservice teacher addresses: "That it must be realistic solutions we work with, big ambitions are fine, but I can't put up 3 wind turbines on UCL's roof, so rather something that can create real change". Despite a more idealized situation in the sand course, the preservice teachers were engaged in their work, as they really found the sand problem giving something to consider. The same was true for the inquiry-based work in the project with Facility Service: "What we did for the poster session

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was very exciting, fun and thought-provoking in a really good way," says one preservice teacher. Two other preservice teachers reflect on the possibility of doing something similar in primary school or lower secondary school: "It can start small and be done very hands-on. It is important that the pupils can see that the ideas they come up with are taken seriously and are not just theoretical" and "We have already in this short project opened our eyes to how to work with it [sustainability] in a school context and got ideas for tasks that you can use in practice.”

The sand course also excelled in the way that the preservice teachers could work hands-on with their inquiries of the robustness of concrete and categorization of sand.

We see opportunities for working with similar projects at primary and lower-secondary level, because for one thing the mathematics that the preservice teachers resorted to primarily consisted of the four types of calculations as well as ratio and percentage calculations. However, we see immense potential in working with similar projects in a modeling context.

We leave the final remark to a preservice teacher, who wants to remind us not to focus on doomsday scenarios with the risk of catalyzing climate anxiety among the pupils: "It [sustainability] must be part of the teaching in primary and lower secondary school, it must be implemented in the ordinary education and be relevant, not just implemented because it "has to". And it must be done in a way so that it does not become a "scare campaign" for the children."

We wish you the best of luck making sustainability a bestseller in mathematics education.

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