

Small data and playful learning – Playful data as key to computational empowerment and well-being

CASE STUDY – DENMARK

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Summary

For over 10 years, the Danish school system has been characterized by increased digitization, heightened individual performance demands, and reduced well-being among schoolchildren and adolescents. In this case study, we investigate how playful approaches to learning and the production of small data related to students' shared learning environment can contribute to well-being and computational empowerment. Collaborating with teachers, we develop experiments focusing on digital data related to the shared learning environment, which they test in schools. Through the analysis of interview data, we demonstrate how these experiments foster engagement, participation, and an understanding of the significance of data in students' everyday lives. In open investigative learning environments, students have greater agency, which can contribute to inclusive learning environments. Through the case process we co-designed a framework for learning designs on small data and playful learning.

Introduction

This case-study from Denmark dives into the challenges of learning and well-being in the everyday classroom characterized by digitalization and datafication.

The Danish classroom is characterized by a comprehensive and complex use of data and digital technologies aimed at enhancing student learning. Since 2013 it has been mandatory for the Danish municipalities to use learning management systems (LMSs) and they are a key-component in the digital ecosystems in the K-9 educational system (age 6-16 years). They consist of a national joint municipal communications platform AULA and a LMS chosen by the municipality. The establishment and designs of the platforms was linked to the 2012 school-reform characterized by support for the students' learning by focusing on explicit learning goals for each student in every course. A tendency of visibility of learning (Hattie) and individualization of learning. As part of the 2012 reform digital measurement of student wellbeing also became mandatory and once every year a national survey is carried out. The results come on school and class level.

As part of this national strategy of digitalisation the government has supported the publisher business in developing digital learning materials. The platforms are integrated with the LMS-systems at the schools, and currently Alinea and Gyldendal are nearly the only providers to the LMS systems. The degree of dominance to these systems differs from school to school and municipality to municipality.

Further the primary school classrooms are characterized by a broad range of hardware and software to support learning, just as the personal computers (as cell phones, other own devices) are brought to the classroom by the students. Also, production and use of data from national and international tests contribute to the digital environment in the classroom and in this way take part in the local evaluation culture.

At the same time the well-being of Danish children and youth is decreasing. This is connected to acceleration, performativity and individualization of society and education, but also due to their social digital life including digital assessment (Rosa, 2019; Katnelzon et al., 2022). In an ethnographic study on self-evaluation in the everyday classroom the authors describe how the focus on evaluation and self-evaluation of learning and wellbeing – including digital forms of evaluation - detriment the self-esteem of some of the pupils, when they are not able to perform appropriate in the classroom talking about their sense of wellbeing. (Grumløse et al. 2020). Practices of evaluations of well-being in Danish Classrooms are prevalent. It can be physical practices where the pupils report their feeling of well-being in the open (sad, happy, in-between, angry...), and the teacher might ask for an elaboration (mood barometers) or it can be digital e.g. through web applications like Bloomsights and Woof. The Apps have different designs, some of them produce individual data and data-doubles, while others produce knowledge on class-level. (Kaas & Grumløse, 2021; Khamaneh, 2023; Ratner & Andersen, 2024).

Grumløse et al (2020) suggest a focus on common evaluation, where the class in communality evaluate teaching and learning in ways where teachers and students cooperate to develop teaching that support the children's learning, participation and well-being...

Evaluation and it's partaking in exclusive processes in education is also at the heart of Dennis & Harrison's (2020) concerns about digital well-being and the lack of ethics and virtue education to meet the new digital challenges. In a Danish educational context this challenge is, among other things, met with the idea of a Computational Empowerment competence as part of education, a competence to understand technology and its effects and to engage critically and curiously with digital technology (Dindler et al., 2022).

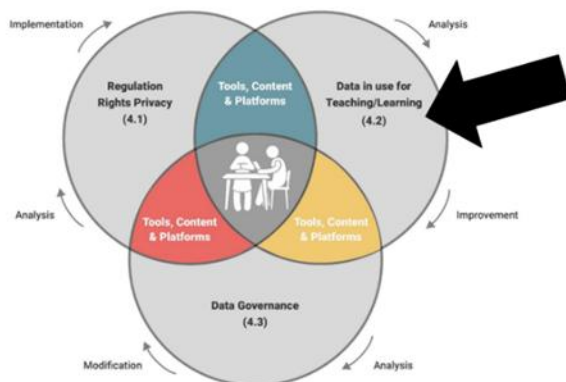
In the light of this, the case-study is about classroom interventions that will focus on computational empowerment through learning practices and data-production about the common learning environment, aiming at participation, well-being and inclusion for all.

In collaboration with teachers, we develop playful data-practices producing small data in the classroom with the pupils to test the quality of the classroom and school environment and thereby the common learning environment asking:

How can the integration of playful learning strategies with small data enrich the learning environment for students, to foster well-being, inclusion and promote computational empowerment?

The case will specifically provide insights related to the analytical framework on 1) data used in teaching and learning. Additionally, it will touch on areas related to 2) rights, regulations, privacy, and 3) data governance in relation to this concrete case.

ECOSYSTEM – DANISH APPROACH



6

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Figure 1 Ecosystem of education data for K-12

Background

The Danish case investigates how to enhance the quality of the every-day learning-environment of the school with a focus on computational empowerment and well-being. This is done through experiments with small data in playful learning environments in close cooperation with teachers.

Small data

Small data is defined in contrast to big data as “finely tailored to answer specific research questions and to answer specific research questions and to explore in detail and in-depth the varied, contextual, rational and irrational ways in which people make sense of the world” (Mitchin & Lauriault, 2015, p. 5) and can be characterized as ‘narrow mining’. Producing data in and about the classroom environment in cooperation with pupils is a scientifically inspired practice that may contribute into common knowledge and engagement. Working with small data produced by themselves about their immediate lifeworld and their learning environment with the perspective of improving this lifeworld may engage the pupils.

Student perspective on the learning environment

Recently a number of surveys have been conducted to learn more about how the students in the Danish schools experience their learning environments. Students often experience that their role in education is very passive; they have to sit quietly for a long time and listen to the teacher. Students find teaching particularly exciting when they are actively engaged, when the teacher allows input from them, or when teaching methods involve students being hands-on, for example during presentations and experiments. Many children appreciate that the teaching is different, that they

'have the topic in their hands,' or that they learn in a way that is both fun and helps the subject 'stick better.' Especially older students enjoy experimental teaching and find it exciting when the content is something 'they can use' (EVA, 2018; Mandag Morgen & Lego Foundation, 2021).

Several studies indicate that the dissatisfaction is also due to a greater performance pressure, where the measurements of the students' learning negatively affect the students' well-being. Performance-oriented goal structures are relatively dominant throughout the school system, strongly supported by learning platforms, national tests, and educational policies requiring support for children's learning based on academic assessments. It affects students that evaluations have generally become more individualized, and what it does to students' self-esteem when evaluations are formulated from a deficit perspective rather than a resource perspective. How the students who cannot meet the learning goals set for them experience themselves, as stupid, and lose self-esteem and motivation (Grumløse, 2020).

Playful learning

Play has proved to be an ambiguous, often subtle, elusive phenomenon and a highly creative and transcending practice (Henricks, 2009; Huizinga, 1938/2014). The powerful character of play has been adopted by education, hoping to bring motivation, learning for all, and new ways of learning into the educational system (OECD, 2018). Playful learning is characterized by bodily engagement, a luscious attitude, democratic values, risk-taking, and failure, and due to this, in need of safe spaces to flourish (Nørgård et al., 2017; Schrøder et al., 2022).

Working with a playful approach must be understood as an approach where you work exploratory, experimental and creative through more open creative tasks with more solution options in meaningful situations together with others. Mitch Resnick describes MAKE as a project-based approach, where you work with creators on projects that make sense to you. The focus is on working with learning communities, which are based on the four P's: Projects, Passion (working on projects that matter), Peers (collaborating and sharing with others) and Play (experimentation and testing) (Resnick, 2017).

Working with such learning spaces and environments requires a special teacher focus in order to give the students the best possible development and participation opportunities, where as a teacher you can take on a number of dynamic roles and positions that can support the students in their processes. Mitch Resnick describes in the work of establishing a makerspace culture with children that as an adult you can move fluidly between the roles of catalyst, consultant, liaison, and collaboration partner (Resnick, 2017).

In the Danish context, playfulness is linked to students' desire to learn through participation and influence on their learning environment (the two studies). This is rooted in the objectives of the Danish school system, which emphasize creating "frameworks for experience, immersion, and passion, so that students develop insight and imagination" (§2) within a school "characterized by freedom of spirit, equality, and democracy" (§3). (Ministry of Children and Education, 2006).

This approach to playfulness is the primary focus of this case, where we have aimed to develop experiments that allow students to express their understanding of their shared learning environment by creating small datasets about it and being invited to participate in decisions about the development of their immediate school life.

Computational empowerment

The notion of computational empowerment when related to children, learning and school often entails altering the power dynamics among children, digital technologies, and their social environments. Still the power dynamics entwined within empowerment efforts are far from simple or easily understood (Andersen, Tafdrup, Møller, Rehder & Schrøder, 2023). Power dynamics when related to computing or other subject areas is still complicated especially regarding children. Therefore, power must always be understood in relation to context, as Andersen et al. demonstrates (ibid.). Dindler et al. traces the empowerment back to traditions of participatory design in the 1970s, and discuss computational empowerment in relation to computational thinking, here they define computational empowerment as a method used by students to:

"... develop the capacity to understand digital technology and its effect on their lives and society at large and their ability to engage critically and curiously with the construction and deconstruction of technology" (Dindler et al, 2022 p. 121, Dindler, Smith, and Iversen 2020).

Here power is defined as the capacity to understand digital technology, and ability to engage with construction of technology. The definition of technology is therefore a broad definition and one which will easily encompass the production, playful engagement, understanding and analysis of data as understood here in the Danish case study of Agile Edu.

In this particular case the aim is to empower children through data literacy. Where data-literacy is understood as the ability to understand and interpret data.

The discussions of data literacy in education address for the most part management, teaching and teachers use of data to develop their teaching (Mandinach & Schildkamp, 2020). Though, data literacy may also be a case for the students. Computational empowerment as a knowledge area and a competence for school children may encompass data literacy but in a productive, constructive and critical way.

Inclusion

Our focus on inclusion in this case-study is therefore on understanding the playful and the experimental to offer multiple paths of participation, to take the children's perspectives to understand what engages them and to empower them in relation to behave in a school and a world characterized by digitalization.

The analytical framework

The case study is analysed based on the analytical framework developed by the Agile EDU literature review on datafication in and of education with the focus on data in use for teaching/learning (classroom and individual level). The analytical framework views data use and datafication as an ecosystem of various education stakeholders, each with their own priorities and perspective on tackling the challenges of education through the use of data.

This ecosystem is based on the interrelationship between three pillars:

- 1) data in use for teaching/learning (classroom and individual level),
- 2) regulations, rights and privacy (national, international level),
- 3) data governance (regional and local level).

At the core of these three pillars is the digital data generated by students and teachers.

In this case-study the question to shed light on these analytical pillars are the practice related research question already presented in the introduction:

How can the integration of playful learning strategies with small data enrich the learning environment for students, to foster well-being, inclusion and promote computational empowerment?

Method and data

The Danish case study is done through the work on the three national Dialogue Labs held as an integral part of the Agile EDU design. The participants at the labs were teachers, municipal consultants, edtech owners, teacher trainers, student teachers and school leaders. The activities on the labs were development of experiments to try out in the school, group discussions and differing reflective practices. The labs worked as an ongoing laboratory producing common knowledge on constructive learning environments in a school characterized by immense use of digital data in the student's everyday life as well as entangled in the wider structure of the school in teaching and learning.

The experiments developed was inspired by Design Based Research and the data in the case study is based on interviews. The interviews were conducted both as a part of the Country dialogue labs (CDL), held as an integral part of the Agile EDU design and as a part of the interactions with teachers and students in the connection to development, implementation and evaluation of the design experiments (Barab & Squire, 2014; Mckenney & Reeves, 2019).

Activity	CDL 1, September 21 st 2023	School experiments	CDL 2, September 9 th 2024	School experiments	CDL 3 Oktober 30 th 2024
Content	Presenting Agile EDUEdu project and the Danish case	The What is a joyful school-day-experiment	Data from the school experiments are presented and discussed in roundtable sessions.	The mobile-phone and wellbeing-experiment	Codesign the learning design
	Roundtable sessions on data in the school	The Checking the pulse on the Learning Environment-Experiment	Codesign experiment		
Data	Co-design experiments	The Nice break-experiment			
	Audio recordings of roundtable sessions	3 teacher interviews – one for each practice experiment 4 group-interviews with students focused on the learning experiences from the practice experiments	Audio recordings of roundtable sessions	1 teacher interview 1 group interview with students	Audio recordings of roundtable sessions

Three primary and lower secondary schools from Copenhagen have participated in the labs and the experiments. The experiment was implemented in three classes and in one cross-class thematic week. The age of the students was between 10-14 years.

All respondents have filled out the necessary consent forms for us to record and use their data in the project according to Agile EDU's guidelines. The interviews and data collection took place February 2024 – May 2025. The interviews were transcribed and used for thematic content

analysis. Data is stored according to demands of GDPR. Parent consents are secured when students are interviewed.

Analysis

In this section we discuss the outcomes of the case study. The section is organised under the three subsections, each focusing on one of the pillars of the Agile EDU analytical framework as described in the analytical framework section.

- 1) data in use for teaching/learning (classroom and individual level);
- 2) regulations, rights and privacy (national, international level);
- 3) data governance (regional and local level).

In the first subsection, on data in use for teaching and learning, the analysis focuses on the experiments in the school and is based on data produced within the school. In the second and third subsections, on regulations and data government, we also incorporate empirical data generated during our initial dialogue lab in the analysis work.

Data in use for teaching and learning

In this section we present and discuss the four learning experiments at the school based on interviews with the involved teachers and students.

Checking the pulse on the Learning Environment - experiment

This experiment is conducted in conjunction with a thematic week at the school, where all students across different classes and grade levels collaborate on a mutual theme throughout the week. The theme for this week is “the sustainable city,” and it recurs periodically.

Students’ activities are organized into workshops. The specific workshop we are following is aimed at students in grades 5 – age 11. Participants are invited to explore digital technologies, program self-propelling transport systems, use micro-bits, engage in Lego Scratch programming, and unleash their creativity to construct a model of a sustainable city. The workshop process is described more elaborate in the learning story “Engaging students through small data and playful learning”.

The two teachers responsible for this workshop have developed an evaluation approach at the dialogue lab: Together with the students they assess the learning environment’s quality by analysing small data generated by the students.

The final model to check the learning environment consists of smiley -buttons, presenting a 1-5 scale, to evaluate the students experience of the instruction through a number of questions. The teachers initiate the week with a conversation with the students about the machine and the

purpose of the data-production. They want to use the data to create common knowledge about the activities of the week. In practice each of the students evaluated the instruction at the end of each day after which the teachers processed the data. The following morning the processed data was presented for the students and gave rise to common discussions about the quality of the learning environment.

The interview with one of the teachers takes place several weeks after the implementation of the intervention. Through this retrospective approach, the teacher's experiences provide retrospective insights.

The lessons learned from the perspective of the teacher concentrate on qualification of the learning environment through common interpretations of small data and on the inclusiveness of creative digital learning environments. Also, the teacher describes some challenges in working with small data to evaluate the quality of the common learning environment.

The students were genuinely pleased with the learning environment created around "The Sustainable City." As the teacher put it, "they truly felt it was a pleasant way to learn." Overall, the students rated the teaching positively. When the teachers shared the results of yesterday's evaluations, the students willingly recounted micro-stories that provided detailed insights for the quantitative assessment. Interestingly, the teachers themselves observed that students felt more recognized due to the analysis and discussion of their own processed small data.

During the interview, the teacher emphasized that, from their perspective, one of the key factors contributing to the high ranking of the workshop was the students' sense of empowerment. They actively participated in decision-making, influencing what tasks to undertake and when to tackle them. The teacher aptly described this phenomenon as the students feeling like "great actors".

Furthermore, through the production and analysis of small data within the classroom, the learning environment transformed into a collective responsibility. This responsibility encompasses student-teacher interactions as well as student-student relations.

In the workshop, the learning environment was characterized by the teacher through dynamism, creativity, investigation, and experiential learning. The two teachers dedicated efforts to foster cooperation among the students, ultimately contributing to an inclusive and engaging educational setting:

Teacher: "[So], that dynamic continued, which had been established during the first couple of days, where we work together. Cooperate with each other. It was really exciting to experience. And some of these students, who could easily have gotten into conflicts and such, didn't."

Interviewer: "Why do you think they didn't?"

Teacher: "Because they felt they could step back when they needed to. Check in and out as it suited them, without anyone hovering over them, telling them they had to

participate... So it usually ended up being just a short break, and some would ask if they could step out occasionally, and they were allowed to do so."

The teacher also addresses challenges in working with small data to evaluate the shared learning environment. Initially, the teacher attempted to involve the students in creating the categories for the evaluation, but this proved to be a little too difficult for them:

"On the first day, we explained to them that we would collect data and why we were doing it. They were encouraged to think about what they found interesting for us to learn from them. If they had any suggestions about what they wanted us to know about what had happened, they were welcome to share. However, it was a bit abstract, and they found it somewhat challenging. Um, but on the first day we asked, ...just like..."

The students grasped the overarching concept of generating their own data based on their instructional experiences, but they did not connect this to their own empowerment.

The experiment demonstrate that it takes some detailed teacher work to establish a genuine student perspective and connections to computational empowerment.

This empowerment might be supported through teacher's competence development on producing, treating and interpreting small data in the classroom.

The Nice Break Experiment

The nice break is a teacher experiment with playful data-practices producing small data in the classroom with pupils to test the quality of the breaks and thereby the learning environment in the class. The experiment is further described in the learning story "Engaging students through small data and playful learning".

The experiment invites pupils to participate in building a robot that can measure whether the breaks have been nice for the pupils in the class. It takes place during the so-called UU (Lessons dedicated to student's homework and well-being) lessons, which are lessons aimed at supporting well-being in the school's education. The task is for them to collaborate on building a robot or a machine that can measure with small digital data during the week whether the students perceive the breaks as nice. The robot can also be designed to help make the breaks better - for example, by giving students ideas for activities during the breaks.

The purpose of the experiment is for the teacher, together with the pupils, to investigate how collective digital evaluation can support a good childhood and contribute to engagement and motivation for both students and teachers. As well as to work on empowerment of both teachers and students, as they together take control over the data and have conversation upon identifying which data are important in their everyday school life.

Just before the interview the students participated in a teaching experiment where the teacher experimented on taking measurements using small digital data of the students' experience of a good break.

The students who have participated in the experiment until now, are generally positive about working with design and creative processes involving technology. It is seen as meaningful, and it is emphasized that it is more varied teaching where you're not just sitting down.

A: I think it's a lot of fun. I enjoy building Lego robots.

I(interviewer): And what about you?

M: Just, yeah...

A: Doing something creative.

M: Yeah. Just doing something other than just sitting on a chair all day.

E: Well, I think programming robots is quite exciting because earlier this year in 7th grade, we also had something about robots and stuff like that.

The purpose of the experiment is to investigate whether collecting digital data together with children can contribute to creating better breaks and well-being. It also aims through design processes, to support the students' understanding of digital measurements and their intent and gain computational empowerment and comprehension.

An important element in working with the subject area technology comprehension including computational empowerment in Denmark, is that students learn to collaborate and co-create, including the ability to develop good solutions together.

E: I would say, the team we have, we're actually quite good at collaborating on what we were doing, because Christian (the teacher) gave us that prototype, and then we all just picked out the Lego pieces we thought could work, and then for example, if A... was building something, and then I also had an idea for it, and then we came up with an idea together, which fit well, so all our ideas together were a good idea.

Through the students' collaborative creative design processes, the teacher's task is to support knowledge sharing and communities. It is important to build upon each other's ideas, borrow ideas from each other, and remember to credit each other's ideas. This way, the teacher can foster an open-source culture and a positive learning environment.

The students also express that working with the creative processes in designing digital data artifacts is experienced as more meaningful, not least because they feel more influence over what happens in the teaching.

E: But I'm just thinking that this, it's not actively done in that way?

A: But it's a bit more creative. You use your brain in a different way.

E: Exactly.

A: Than if you're just sitting there reading something on the computer.

Interviewer: So, this thing where you have to build these machines yourselves, which will collect data?

E: And sort of have more like/ That thing where we ourselves have/

A: Influence.

E: Influence on the teaching.

In the interview, we asked the students about their experiences in connection with their education. Initially, they find it difficult to articulate themselves, but gradually, through the collective conversation, they can recall that they are often digitally tested both in terms of their academic level and their well-being. Generally, they experience the tests as boring and sedentary, but at the same time, they can see the point of being tested, because they think the teacher use the data to improve their teaching. They express confidence that the teachers handle their digital learning and well-being data with the aim of creating better education for them.

A: What about helping in teaching a bit more? Looking at the data one has about

Interviewer: Looking at the data that exists. And then making the teaching better?

E: Yes, I would also say that. For example, in mathematics. If now, the majority of the class has answered fractions, and the rest haven't. So maybe focus more on fractions and less on the others, somehow like that.

Several of the students express that data can be influenced by the situation in which the data is collected. It could be that one is having a bad day or is tired, and they are aware that this data may not always be 100 percent valid.

1: Of course, you can figure out what people are good at, what they like, and stuff like that. But also, that it can be because when you can figure something out, it's also based on whether you're tired. If you're really tired and taking a test, you might not be able to focus as much, so therefore it can be like that/ You can actually figure it out, but you just did poorly because of/

In the two previous experiments, we can see that it is largely the teacher's perspectives that are implemented in the process. An important element in working with playful approaches is that the work takes place from the students' perspective and creates enthusiasm and passion. Therefore, there is a need to develop pdc's for the teacher to plan for and create playful learning environments as well as competences to include and scaffold the perspectives of the students.

What is a Joyful School Day Experiment

In this experiment the teacher's focus is upon how to facilitate the students to make their own qualified questions based on their own perspectives upon joyful and meaningful learning environments. The What is a joyful school day-experiment is therefore a teacher experiment with a 6th grade class (12 years old children), where the students design a study with small digital data to investigate a joyful and meaningful school day. The experiment is more thorough described in the learning story "What is at Joyful School Day".

The experiment was built on the following content and actions, where phase 1 and 2 was completed in the experiment.

1. Students investigate what they experience as a good and engaging school day
2. Students design studies with small digital data about learning environment
3. Students experiment with different digital technologies to gain knowledge and technological capability to further development and implementation of the small data study.
4. Execution and evaluation of the digital data study.

It can be challenging for a primary school student to investigate something if they do not have the opportunity to delve deeper, understand, and develop the language and imagery needed to define what they actually want to investigate. The main purpose of the experiment is therefore on having focus on the two first phases to learn more about what a joyful school is through a playful, investigative, and experimental approach. The experiment intends to take place in an interaction between immersion, shared reflection, development, and peer feedback, where the forms of collaboration and the conversations themselves also develop language and ability to act about data measurements and the good school life in the class community.

To gain the quality, language and ownership of the students' investigations the important phase is at the start to get the students to reflect on what constitutes a joyful school day. This is facilitated through an investigating process, where the students create a joyful memory by building LEGO. This step also intends to strengthen their ability to identify what to look for in their own measurements of the joyful school day in class. This process exemplifies in a playful way what characterizes the joyfulness of the situation, and it becomes clearer what you can look for and measure when you have to investigate similar situations at school.

This awareness and findings from their construction and presentation processes, will the students continue to work with in the next phase.

In the following, the primary findings from the interview with the teacher are elaborated upon, particularly regarding the teacher's work with framing student-involved creative teaching. She is part of a larger project about playful learning and digital technologies in teaching, and she works daily to challenge herself in terms of framing more open-ended courses:

It might be emphasized. That is, the aspect of equipping the children as well as possible to actually be able to work creatively. It still challenges me in so many ways. That is, the thing with/ The... There are many of them who benefit from us talking about it. And just remembering that this is the hook you should hang this on. And this is what you should do. Um, but there are still many who find it difficult still. Despite having talked about it. Despite saying, well, this is what you're doing right now. So, I think it's interesting, and it kind of gives me a hunger to keep looking, like, does it have to do with age? The level of maturity? What can you do with 6th graders? How much can you challenge them?

There appears to be a challenge in just telling students what to do, and a need for students for the tasks to be framed in ways that allows them to navigate through the creative processes on their own, and she is very aware that she could have spent more time in making the design-process more exemplary and immersed.

L: Regarding design processes in schools. Even though we have six lessons, I believe/ Well, they could have easily spent several days working on this. And moving back and forth in the process. And getting feedback. And going back again. We haven't done that at all in a day like today.

Interviewer: No, it made me think. Because/ But there wouldn't be an opportunity for that, or?

L: I don't think there was room for that as such.

Interviewer: No. Because that's right. I mean, there were some who... That thing with... I also think there was someone who specifically said, "Well, we haven't managed to gather data." No, but in principle, you could have if we now... Well, maybe. Finish it. Or something, right? To look at it like that, right? I mean...

L: And there were some of them who sought each other out. I mean, for the feedback. "Well, I can see that some others made a button. Well, I'll go over to them and try to ask them, how do you make a button?"

In the process she discovers that her pupils use peer-feedback without instructions, and she sees the potential in increasingly working with peer feedback as a method to support students' creative processes.

In the interview, the teacher also reflects on the meaning of the physical space when working with creative processes. This specific school has furnished a special room; and calls it Playspace. And room she hadn't considered to book for this project. Although she clearly sees the potentials.

L: Mmh... That could easily have been the case. Because, I definitely think, as we've also talked about before, that there are certain atmospheres associated with the spaces. And it's clear, there's a specific atmosphere in the classroom, that there is... With the division that exists in a space, there might subconsciously be some competition. When we're sitting around in groups, with our own things.

So, the act of going over to another group and just looking over the shoulder might not feel quite as natural as when you're maybe in a play space or a mega space. Whatever you want to call it. Because/

I: There aren't fixed seats or anything like that.

L: No, exactly. And there are some things that are dissolved there in a different way. And we mess around, and we take, and we try things out. But then there are also some other things, I think, that could have become legitimate. In that space. Which might be hard to break in a classroom. Even though it's the same children, and even though I'm the same teacher. It's the same materials we're working with.

The teacher reflects on the challenges in creative processes when structure and mindset is challenged by shifts in the process. Overall, the interview evidence that the project has inspired the teacher to work with data comprehension in various subjects and in connection with the national test of student well-being.

L: It was about making the transitions from one exercise to another. I mean, you can sense when they're done thinking or done doing something. Like, building the school mindset, they asked for more time for that. They weren't quite finished with/ And it can both/ I mean, I think the act of building and thinking at the same time does a lot. You need to finish thinking before what you've made really makes sense. Or before you have something to say. Um... And... So, I couldn't have made a switch for it to be meaningful for them next year. But of course, that also means you're pressed for time throughout the day. So, I find it difficult to make the transitions in a creative process and say, okay, now you stop with that. You have to try to separate it, or you need to take your hands off. And then you move on to the next thing when/ I mean, we struggle with that, but, it's part of it.

The thing about having ownership of what you've created, but they don't want to part with it. It's something they've made, and you understand it well because they

really feel like they've reinvented the wheel, and then they don't want to let go of that wheel right away, so I find that difficult.

Working creatively, creating, and investigating takes time, even for students who are used to working playfully. This way of teaching requires a flexible schedule, where students can immerse themselves in the various subtasks over a continuous period.

Further, the teachers need to be able to act and facilitate in a complex learning environment and support the student's creative processes through teacher roles like being a catalyst, a consultant and a collaborator (Resnick, 2019). These competences may also be a focus in professional competence development.

The Mobile Phone and Well-being Experiment

The last experiment was implemented in a grade seven class (age 12). In Denmark the local school decide when and how the students have access to their mobile phones. In the actual school it is the teacher and the parents that together decide the mobile policy for the individual classes. The students in the class had the permission to keep their phones through the school-day, but both their parents and their teacher was worried about the well-being in the class. They were nervous that the children did not play, move around and do sports in the break and that the use of the phone produced isolation in the class.

The teacher and the students decided in cooperation to implement a mobile-free week to see what happened in the breaks, and at the same time make a survey in the class about their own well-being and access to their mobile-phones.

The design for the students developed their questions on well-being and access to the mobile phone through class discussions and through working with prompts in School GPT. School GPT is a language model developed for University College Copenhagen, designed to understand and respond to questions and perform tasks. It is based on the Mixtral-8-7b model and is trained to provide assistance in a helpful and friendly manner for students in primary school.

The teacher set up 24 questions formulated by the students in a survey and all the students answered the questionnaire. Then the students interpreted and discussed the results of the survey in groups and wrote it up in a Padlet as recommendations. The plan is that the students present the findings to the parents as a feature in the meeting where parents and teacher are to decide the mobile -phone policy for the class.

Example of survey questions:

Is the break more exciting without telephones? Have You been more or less tired after the break without phones. 1. Is very tired and 5 is not tired? Have You at any time wanted to go outside and do something else that being on the screen, when you had your phone? Did You talk more to your friends than before? Etc.

Examples on the recommendations on the Padlet:

We think it seems best if we have them all day. Most of the responses show this. People have answered that they feel safer with their phones, and that breaks are more fun with phones. Most have also said that they are more social during breaks with their phones because they play together and can talk about the game. Many have also said that they become more stressed without their phones because they can't see the time during breaks, for example, when they are out buying food. Of course, there are times when you are not allowed to use them. In lessons. The reason we should have them all day and not just during breaks is that it takes a bit of time for the teachers to fetch our phones. If you are then seen using your phone during class, it can just be taken away from you, for the rest of the lesson, maybe.

We think that students should have their phones during breaks because 92% of students feel safer with them, and only 8% are a little indifferent. Most per cent also say they have been more active with their phones. Also, 71% think we thrive better with phones

In the third Country Dialogue Lab (CDL) the case was presented through an open interview with the teacher. The participants had a listening task through the interview and their reflections were feeding into a group discussion. Based on their notes and group discussions, participants were asked to contribute ideas for redesign and suggestions to strengthen the learning design developed by us through our own learning process during the experiments and the CDLs. This was done by writing them on post-its and placing them within the corresponding phases on the floor. The final design is presented and discussed in the conclusion.

In this experiment we succeed to implement a genuine student-perspective, as an engaging and playful practice in the class. In the interview the teacher describes the environment in this way:

Interviewer: Yes. So, it was about the playful aspect, which has been something we've thought about—how to incorporate playfulness and engagement, so that one forgets everything else because they get involved in something. Do you think, looking at the process, that it has been playful for them to work with this?

Teacher: Well, for a 7th-grade class, yes. In the sense that there hasn't been any resistance, which, you could say, is something you often experience with 7th graders in much of what you do in a school setting. So, they were actually on board with everything from start to finish. In terms of exploring things, they thought it was really fun. And of course, there were also some who, when they got to use SchoolGPT, also wanted to explore other things. That's fun too. So, there was some freedom in it, but I think the fact that they had the right to define things themselves

meant that it wasn't me deciding, other than that I apparently think that many people together is good well-being.

Interviewer: Yes. So, it has actually engaged everyone in a completely different way?

Teacher: Yes, you can see that.

Interviewer: So, it's a greater engagement than you usually see, or what? everyone has responded. Everyone has made recommendations. Everyone has asked questions. In that way, everyone has been involved. It's a completely ordinary Danish public-school class with a very wide range academically and in other ways.

Teacher: Yes. I wish there was much more teaching that was met with that kind of engagement.

All students participate in the production and interpretation of small data and data literacy and computational empowerment is offered to all students. The experiment exemplifies that playful learning might be a way to create an inclusive learning environment. Though, it is important to cater for the student perspective through the whole learning process. In the teachers CPD it is important to learn to have an overall perspective on the process of engagement and to frame this engagement throughout the didactic design.

| Conclusion

As demonstrated in these experiments the students demonstrate a general understanding that there are ongoing digital measurements of their academic abilities and well-being. They expect teachers to utilize data to enhance teaching practices. They perceive traditional teaching methods as static and dull, while they find working with design and technology to be more diverse, meaningful, and stimulating, largely due to the collaborative nature of these activities and their increased influence on the teaching and learning process. These more open learning environments are also experienced as inclusive, because the students can leave and take a break and then return. The students are giving agency to take care of their well-being themselves, and this agency is not experienced as disturbance by the teachers and their fellow students. In the experiments, we have focused on challenging the tradition of measuring student results and academic progression, aiming to explore how we can utilize digital measurements in ways that actively engage students and contribute to the development of a more conducive learning environment. Our investigation has centred on the feasibility of incorporating student involvement in data measurement processes, thereby fostering an environment that considers their collaborative interactions, shared

objectives, and consequently, the very essence of teaching methodology, all geared towards enhancing computational empowerment and student well-being.

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Introduction	How can students investigate	The investigation is carried out	Processing Data	Using student findings in data
<p>What is the student's investigation questions?</p> <p>How are students engaged in this process – The children's perspective</p>	<p>Investigation design</p> <p>(including building it – choice of technology</p>	<p>How is it scaffolded by the teacher?</p> <p>What data is expected to be available for phase 4?</p>	<p>– How do students find answers to their questions and identify patterns?</p> <p>What does the data translate into so they can work with it in the next phase?</p>	<p>Students' investigations must be taken seriously.</p> <p>How can frameworks be created to ensure that their results are shared with the world and makes a difference?</p>

Rights, regulations and privacy in teaching and learning

In this section we present findings on teachers work with and reflections on learning about rights, regulations, and privacy in school. The material stems from both the first Danish dialogue lab and the interviews conducted in relation to the interventions created in collation between project participants and the teachers from the dialogue lab.

Teacher's data use

In summary, the interviews from the first national dialogue lab, demonstrates how teachers discussed methods for fostering student awareness of privacy and data usage. Many teachers emphasized the use of data in their teaching, incorporating statistics and encouraging students to actively engage with data production. However, one teacher shared an experience where students encountered legal obstacles while attempting to collect data at a shopping centre, leading to an unexpected lesson on rights and privacy.

A common stance among the participating teachers, was the use of data in class. A teacher stated:

"It could be that we have used Statistics Denmark, for example. Just get some data into the teaching that we can use for something. I am also a social studies teacher, and we find statistics quite interesting, don't we?"

Another teacher added the importance of student's own production of data, which involves them actively in the discussion and dilemmas of producing and storing and the ethical dilemmas of rights and privacy, which often connects to regulations and laws.

"But it could also be 'okay, so let's work to obtain some data. Now we need to go out and produce some data ourselves.' We have been at Frederiksberg Centre, and then we had to figure out who shops at Frederiksberg Centre. It could be another way, right? Sometimes it can also be 'well, what is data anyway?' Such a critical awareness about data. I often think about 'are we doing it to get some data, are we doing it to know something about data, are we doing it to use some data.' There are many ways to work around that, right?"

Here the teacher identifies three approaches to introducing data in the classroom. 1. Producing data, 2. Learn about data, 2. Using and analysing data. But what the teachers then continues to talk about the project where the students are going to the mall to produce data, as a part of the first category of introducing data into the classroom shows how the intentional learning outcome can sometimes shift.

"They went around like... We had made a template in advance, and then they went around and filled it out by asking people 'Hello, where do you work, where are you from?'. But you are not allowed to do that. It's illegal." (Laughter) (...) A security guard came up to me and said 'you look like a primary school teacher'. 'Yes, I am'. 'You're not allowed to collect data.'" But we managed to do it for 45 minutes, so we collected a tiny bit of data before I was kindly informed that I couldn't do that."

Here the intention was to produce data, but in addition to the data production, the students and teachers learned on firsthand something about rights, regulations, and privacy. Here the teachers

own categories 1 and 2 was overlapping, producing data created the opportunity to learn about data.

In relation to the production of data another teacher was distinguishing between data produced by humans and data produced by machines.

"But what I find interesting is 'is it us humans who collect it, or are we using a machine? In other words, is it something technical that produces it?' And here it is very human-driven."

The distinction between data produced by humans and data produced by machines seem to be a topic that interested the teachers, as demonstrated earlier in this section the connection between producing data and learning about data created an unexpected learning experience, as the students was creating data themselves. This generated a new topic on privacy, rights, and regulations for the teacher to dive into with the students.

A problem raised by another teacher in connection to this discussion was, that the students are more passive in the work with and analyse of data, if they let a machine process the data.

"I also believe we've used Google Forms and some other tools before, where they simply process the data. There's a significant aspect called 'how do they handle their data.' It's very convenient if something has processed the data immediately for them. I mean, something as simple as having it already presented in a chart for them. At least, I find that it can be a significant challenge."

The distinction between production of data and analyse of data get blurred, nevertheless there is a point to be made that students might have more opportunities to learn about the complexity about data if they produce, analyse and present it themselves.

A teacher adds to the conversation producing data versus analysing and understanding data:

"Right now, we're very much in the phase of collecting data. It's not so much the student who is reflecting on it."

Teachers acknowledged the current emphasis on data collection over data analysis and reflection among students, prompting a shift in focus towards encouraging students to critically engage with data they produce. This reflects a concern among the teachers about students' roles as data consumers versus producers and highlights the need for more comprehensive approaches to data literacy education.

In the next section teachers are discussing more in depth, what the student's learn and experience when they are creating and reflecting on their own data.

Teacher perspective on students' entanglement in data

In this interview the teachers from the experiment What is a joyful school day reflect on how students experiment with and reflect about their own data and how this is connected to competencies linked to computational thinking and computational empowerment as competencies in the new school subject technology comprehension.

The teacher reflects on the students understanding of themselves as data producers and consumers during an interview after the school intervention. She explains how she tried to engage the students in reflections on their own data production and that they are relying on this data that they produce, in their own daily lives, as this enables their columnized newsfeeds.

"And I think it's important for them to know that everything you do leaves traces. And there are just some people who use them. Just because something is free doesn't necessarily mean it's 100% free. You still pay in some way. And it has affected... And it's not... I mean, I don't take any credit for it myself. I think there's also something parents have done. Something that we as an institution also do. But it has affected the way they are themselves. And how they use, well, yes, the internet and how they use their devices. There are some things they have become aware of."

The teacher also reflects on how to encourage the students to think about the data being produced about them, and how this data could be put in to use in a way that would benefit them.

"They mentioned it themselves. You know, like, what does my email actually know about me? It actually knows my name, how old I am, and what my gender is. I mean, it knows a lot of things about me. So when I use it to log into a game, they mention that themselves. And we'll also talk about that afterwards. But what does the game actually need all this information for? Why does it need to know how old you are and what gender you are? The same with YouTube videos. They talked about how, I'll watch one cooking video at some point. And then it just gives me thousands of cooking videos. I think Oscar mentioned that. And it keeps giving me cooking videos. So I ask, did you click on a cooking video? Well, he clicked on one of the videos. And then they disappeared again. All those thousands of cooking videos. So it's quite good for, you know... For those reflections you can have afterwards. And there's not, I mean, for me, there's not really a specific goal as such. It's more like/I think the goal lies in/ In the action itself. In the process itself. To get them to consider things. And reconsider."

The experiences from the student's own data production and the data being harvested from their digital interactions is then connected to how there is also created data about them in school. Connecting to the learning goal of the students begin computational empowered, she argues that

the awareness of school's creation of data is a part of the student path to learning about computational thinking.

"Well, it's computational thinking, you know? It's about understanding what the computer can do? What kind of data? I mean, what lies behind some of those mechanisms? That's it. So, I draw on the school as an institution and what information it gathers. What they themselves notice, to try to explain to them what you're dealing with. I mean, devices and such also draw on some other information and use them (...)"

As such the student's own work with data, both producing and collecting data is something that the teacher argues enforces their consciousness both about data, but furthermore a stepping stone to an awareness of the data production taking place in multiple contexts. She highlights how these learning processes also becomes a way for the student to see new facets of what a good and playful school could look like.

"One could, conversely, say that their gathering of data also provides them with... So, about good schooling... also gave them a heightened awareness of what constitutes good schooling. Which, of course, because what is fun and what does fun look like. So, yeah. So, one can certainly use the subject of data, which also opens up to delve deeper into some of those considerations one has with data, but has with more fluffy concepts, such as fun and excitement."

The teachers reflect on the role of schools and educators in guiding students to become computationally empowered individuals. They share examples of students questioning the data collection practices of various platforms and the implications for their privacy. Moreover, the experiences of students producing and interacting with data in digital environments are connected to the data collected about them within the school context. This is argued as an element in enhancing students' awareness not only of data itself but also of the broader implications of data production across different contexts. Furthermore, engaging with data in this manner becomes a vehicle for students to envision what constitutes a fulfilling and playful learning environment.

Surprisingly, the interviews revealed that the new project, developed collaboratively, not only introduced novel strategies to engage students and foster motivation in school but also facilitated complex discussions on computational thinking concepts and raised awareness of privacy, rights, and regulations linked to data issues.

| Conclusion

In conclusion, the synthesis of findings from the initial national dialogue lab and the case study on "Playful Data as Key to Computational empowerment" highlights an evolving landscape of data literacy education in schools. Teachers can be encouraged to explore methods to foster student

awareness of privacy and data usage, emphasizing the importance of hands-on engagement with data production and critical reflection on ethical considerations.

As the interventions began to take place and collaboration between teachers and project participants led to new interventions, the teachers demonstrated an enhanced understanding not only of the role of students' own data production in developing computational thinking and empowerment but also of the broader implications for creating a better school environment and postering a more enjoyable way to work with students. This process also involved a critical investigation into the school's production of data about the students.

The experiences shared by teachers underscore the need for a balanced approach that encourages students to move beyond passive consumption of pre-processed data towards active involvement in data creation, analysis, and reflection. This shift reflects a broader concern among teachers about empowering students to become not just consumers, but also producers and critical evaluators of data.

Furthermore, the case study illuminates the potential of playful engagement with data to cultivate competencies linked to computational thinking and technological comprehension among students. By integrating data literacy into the curriculum, teachers are not only preparing students to navigate digital environments effectively but also fostering a deeper understanding of the broader implications of data production and usage.

Overall, these findings underscore the importance of continued collaboration and innovation in data literacy, as teachers is encouraged to navigate the complexities of data-driven society and strive to empower students to become informed and responsible digital citizens.

Data governance

In this section, we discuss teachers' focus on learning about and reflecting on data governance and small and playful data. The section is based on data from our mapping of the data ecosystem in Danish schools and data from our Dialogue Lab 2 September 2024, where the theme was Future competences for teachers and students to be able to jointly explore and develop the pedagogical and academic potential of smaller digital datasets to create more engaging, playful, and meaningful learning experiences.

First, we take a view upon the Danish digital ecosystem in schools. In 2012, a new national primary school reform was decided. One of the important aims was to support students' learning to a higher extent by focusing on explicit learning goals for each student in every course. According to John Hattie's research, the reform was driven by the belief in making learning visible for students as a way to enhance their learning.

Concurrently, the User Portal initiative (Brugerportalsinitiativet) was introduced from 2013 and aimed to take the digital primary school one step further by establishing up-to-date digital solutions to support communication, learning, and well-being. The User Portal initiative includes,

among other things, municipal procurement of an LMS system that the municipalities themselves have chosen, as well as the national joint municipal communication platform AULA. The main purpose was also to protect students' data and be prepared for the GDPR regulation in the EU while making data portable from one municipality to another and from kindergarten to primary school.

Unilogin is the Danish national login solution that enables users to log in and access a range of public and private online services using a single set of login credentials. Unilogin is primarily aimed at students (and parents), teachers, and educators at all levels of education in Denmark, providing them with access to a range of online learning resources and other educational materials.

However, other institutions and companies can also use Unilogin for their services if they want to make it easier for users to log in to their platforms.

The *user portal* is actually the main structure, and thereby our digital ecosystem:

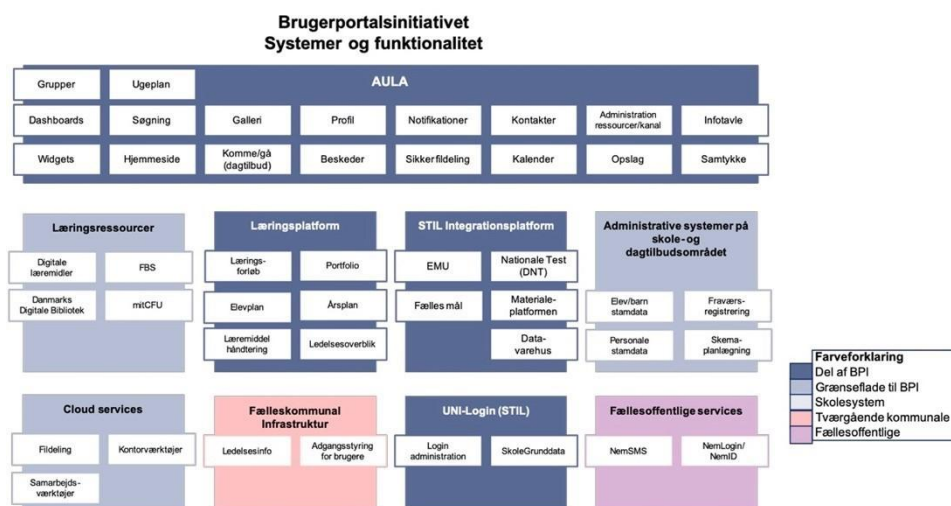


Figure 2 The following is an overview of the User Portal Initiative in Danish. The image illustrates the relationship between the various efforts within the initiative.

A core stakeholder in the Danish ecosystem are the schools and the agents who operate in the production and use of data within this context. Data created by students and teachers in schools is accessed by Municipalities, Research, Teachers, School leaders, IT-staff and Parents, caretakers, families. The following list describes communication channels which use and distribute the students' learning data:

- Results from graduation exams
- Annual grades
- Results from national well-being measurements
- Results from national tests

- Standardized academic tests, such as word order reading tests (ordstillelæsningsprøver - OS), sentence reading tests (sætningslæseprøver - SL), text reading tests (tekstlæseprøver - TL), Controlled Drawing Observation (Kontrolleret Tegne-lagttagelse - KTI), MAT tests 1-9, IL test (Læseforudsætninger og læseforståelse i indskolingen), dyslexia test, English test,
- Student productions (such as essays, drawings, creative products, digital productions, recorded presentations, etc.),
- Results from assignments (dictation, skill calculation, problem-solving), results from student self-assessment,
- Observations (Recorded teaching observations, diagnostic observations of individual students (such as recording student behaviour in special schools),
- Registration in class logs, etc. Structured observations (such as leadership, guidance counsellors, or other colleagues).
- Behavioural data: (Attendance registration, Timeliness with task submissions, Usage patterns with the use of learning platforms and digital learning materials)

Many of the above-mentioned datasets can be accessed through www.uddannelsesstatistik.dk, which is hosted by the Ministry. The connection between the following actors is actualized through the above-mentioned data-categories and data-communications channels.

One of the important drivers in the Users portal initiative was to develop the cooperation between school and parents to support the students learning and well-being. Parents can access data and communication with the school through the platform, Aula on their phone or laptop. They get access a various amount of data about their child.

Future competencies teachers, students and schools

The following section is based on discussions among school stakeholders during Dialogue Lab 2, focusing on the future competencies that teachers, students, and schools need in order to participate in the collective development of education that leverages the potential of smaller digital datasets to create a more engaging, playful, and meaningful learning experience.

Future students' competencies

According to the stakeholders, future students need strong communication skills and the ability to collect, understand, and interpret data meaningfully. They must develop a circular understanding of data, working through iterative processes of problem definition, data collection, analysis, and refinement, which fosters higher-quality outcomes in learning.

It's also about making the data meaningful for the students. Setting up interesting tasks, like going on a treasure hunt to find data! To do that, we need to find a good question that we can gather

data around in order to answer. Once we have the question, we can design our evaluation and investigate. This is what we need to learn – and this is where the iterative process comes into play.

The most important thing is that what students develop is authentic, and that their investigations lead to actions that make sense to them and their everyday school life

Practical experience and repetition are essential to mastering these competencies. Students must also learn to recognize the limitations of data and use it constructively to enhance their learning environment. Engaging tasks, such as treasure hunts for data, can make the process meaningful, encouraging students to design evaluations and act on findings.

Ultimately, students should focus on authentic projects where their investigations lead to actionable insights that resonate with their daily school experiences.

Future teachers' competencies

The stakeholders at the Dialogue Lab 2 agreed upon that future teachers need to empower students to engage creatively and collaboratively in collecting, analysing, and using data to enhance their learning experiences. Teachers should facilitate opportunities for students to pose meaningful questions, design data collection processes, and explore the insights that emerge. This fosters curiosity and helps students see data as a tool for understanding both their academic performance and their learning environment.

Collecting data with students is a good practice and should not be a mere formality. It should be genuine, and teachers, together with students, should be curious and take it a step further once the data is analysed, for example, by discussing it in student councils or in ways that can have an impact and enhance understanding for everyone.

Students should actively participate in gathering data that matters to them, working in communities to make the process authentic and engaging. Teachers can guide students to analyse and interpret data critically, encouraging them to address biases, consider context, and think beyond the numbers. For example, students might explore how factors like noise levels in the classroom reflect their enthusiasm and collaboration rather than just disruptions.

By integrating creativity and innovation into data practices, teachers can help students take ownership of the process, using the insights gained to inspire meaningful actions—whether through discussions in student councils or changes in their own learning approaches. This equips students with essential skills for navigating the digital age, fostering their ability to use data effectively in both school and life.

Future schools' competencies

To ensure that teachers and students can jointly explore and develop the pedagogical and academic potential of smaller digital datasets, the stakeholders agreed upon, that school system must rethink its approach to data collection and use. Currently, large-scale, externally imposed

data collection often feels meaningless and demotivating for both teachers and students, as it rarely aligns with their needs or provides actionable insights.

It would be beneficial if municipalities conducted data collections in collaboration with teachers, just as teachers should conduct data collections with students. Data collection could be done in a much smarter way to make it more meaningful for both teachers and students. One might consider who these data collections are intended for. (quote: teacher on dialog lab 2)

Several stakeholders agreed upon, that teachers should engage students in meaningful, small-scale data projects that connect directly to their learning and well-being. This not only makes data more relevant but also fosters student engagement and ownership. Test data, for example, should be critically assessed to ensure it reflects genuine academic progress rather than fleeting moods or external pressures. Instead of focusing narrowly on test-taking skills, schools should prioritize a well-rounded education that includes student well-being. Small, student-generated datasets could be instrumental in identifying ways to make school a more enjoyable and engaging place.

For this to succeed, the system must value and integrate student-generated data, ensuring it is meaningful to both students and educators. Developing collaborative data practices within schools, with a focus on relevance and impact, can help create a more engaging, playful, and meaningful learning experience.

Conclusion

The stakeholders at Dialogue Lab 2 emphasized the need for future competencies across students, teachers, and schools to fully leverage the potential of smaller digital datasets in education. For students, the focus is on developing strong communication skills and a circular understanding of data through authentic, iterative processes. Students should engage in meaningful, hands-on projects that connect data collection to their daily lives, fostering critical thinking, collaboration, and actionable insights.

For teachers, the emphasis is on empowering students to take ownership of data collection and analysis. Teachers should foster creativity and collaboration, guiding students to explore data critically and constructively while connecting findings to their academic performance and well-being. The integration of student-generated data into broader school processes is vital for creating a more engaging, playful, and meaningful educational environment.

Conclusion

As described in this case study, some of the participating teachers had prior experience and thoughts about teaching with and about data before participating in the dialogue lab and the teaching interventions created as part of this project. Notably, these participants teach at schools recognized as pioneers in this aspect within the Danish education system.

As the experiments unfolded during the project and collaboration between teachers and project participants led to new initiatives, teachers gradually exhibited a deepened understanding of the role of students' data production in fostering both computational thinking and empowerment. This understanding began to intertwine with efforts towards creating a more enjoyable school environment.

In interviews from the interventions, students demonstrated an understanding of how data could enhance both learning experiences and well-being in school by expanding the scope of assessments to encompass aspects relevant to their daily lives. Additionally, students acknowledged limitations in the types of data collected, indicating a willingness to engage in improving data collection methods to strengthen their well-being in school.

Students exhibited a general awareness of ongoing digital measurements of their academic performance and well-being, expecting teachers to utilize data to enhance teaching practices. They contrasted traditional teaching methods, perceived as static and uninspiring, with more dynamic and engaging approaches involving design and technology, which allowed for greater collaboration and influence over the learning process.

Throughout our experiments, we have focused on challenging conventional methods of measuring student progress, aiming to explore how digital measurements can actively engage students and foster a more inclusive learning environment. Central to our investigation is the feasibility of involving students in the data measurement process, thereby fostering an environment that values their collaborative interactions, shared objectives, and, ultimately, prioritizes student well-being.

Guidelines for equitable, meaningful use of data in education

Teachers

Teachers can enhance the quality of the every-day learning-environment in the classroom by implementing experiments with small data about the learning environment produced by the students (data on the immediate physical and psychological environment) with a focus on computational empowerment and well-being. To do so teachers need to emphasise on empowering students to take ownership of data collection and analysis and foster creativity and collaboration, guiding students to explore data critically and constructively while connecting findings to their academic performance and well-being.

Teachers should be able to use technologies effectively – to explore and find meaning in them together with the students. This includes making, creativity and innovation.

Work with open-ended tasks, where there are no right and wrong answers, and where the teacher together with the students are curious to investigate phenomena around good school life, digitization, and data collection. If the students need recaps, make them short along the way, where the students' knowledge and skills contribute to the shared learning space.

Students investigate processes takes time, therefore make sure to plan a sufficient number of lessons for the task, where students can immerse themselves in producing, analyzing and use of their digital data about their learning environment and well-being.

Make small experiments in your teaching on your teaching role being curious on the student's perspective and to facilitate students to be creative and find their own answers and solutions.

School leaders

Working creatively, creating, and investigating with small data requires a flexible schedule, where teachers and students can immerse themselves in the various subtasks over a continuous period.

The integration of student-generated data into broader school processes is vital for creating a more engaging, inclusive, and meaningful educational environment. The school culture and the organization of the school therefore should be prepared to meet and take seriously the students and the knowledge they produce through small data.

School-leaders should support the teachers in trying out new teacher roles working with small data on the learning, the learning environment and the well-being of the students.

Teacher trainers

Teacher education must include data-literacy in their curricula.

Data-literacy in teacher education should include use of data on student learning as well as a more exploratory data practices to establish situated investigation of the local learning environment.

Teacher education should educate pre-service teachers to be curious and investigative on production and analysis of data and small data together with the students. This also takes education into didactics and pedagogical practices that support these types of learning environments.

Guidelines for Professional Competence Development for teachers (CPD)

Teachers can develop competencies related to playful learning and using small data through teacher education programs and continuous professional development initiatives.

Specific elements that teacher CPD should focus on include:

Developing Teachers' Own Data Literacy: CPD should include the use of data on student learning as well as more exploratory data practices. Teachers need to develop competencies regarding

digital data about student learning in classrooms and schools in a responsive, inclusive, and meaningful way. They should be curious and investigative about the production and analysis of data.

Facilitating Student Data Literacy and Computational Empowerment: A key focus for CPD is empowering students to engage creatively and collaboratively in collecting, analyzing, and using data to enhance their learning environment. Teachers should learn to facilitate opportunities for students to pose meaningful questions, design data collection processes, and explore insights that emerge. CPD should also cover teaching data literacy to students in a productive, constructive, and critical way, integrating it with computational empowerment. This includes guiding students to analyze and interpret data critically, addressing biases, and considering context.

Pedagogical Approaches for Playful and Open-Ended Learning: CPD needs to educate teachers in didactics and pedagogical practices that support learning environments where students work exploratorily, experimentally, and creatively through open creative tasks. This involves taking on dynamic roles like catalyst, consultant, liaison, and collaboration partner. CPD should help teachers structure tasks in ways that allow students to navigate creative processes and encourage peer feedback. CPD should encourage teachers to be curious about students' perspectives and facilitate students in finding their own answers and solutions.

Offer professional development for teachers, focused on small data, student agency, and emotional safety—paired with peer collaboration and leadership support.

Make space for teachers to try playful, inclusive practices, by adjusting schedules, reducing non-essential workload, and encouraging leadership to value experimentation over rigid curriculum pacing. Shared planning time is key to building teacher cohesion and fostering peer collaboration around inclusive approaches.

Help students understand how digital tools influence what they see and do, through guided activities that explore how apps or platforms shape choices. School leaders can support this by making digital awareness part of curriculum planning and teacher training.

Use small data practices to shift focus from individual deficits to shared reflection and improvement of the learning environment by offering open-ended tasks with multiple ways to engage, express, and succeed—especially useful to motivate and empower students with diverse learning profiles. If, for instance, class-level data is used to identify trends or insights that all students can learn from, this will shift the individual judgement that some students may face.

To do so teachers need to emphasise on empowering students to take ownership of data collection and analysis and foster creativity and collaboration, guiding students to explore data critically and constructively while connecting findings to their academic performance and well-being. Teachers should be able to use technologies effectively – to explore and find meaning in them together with the students. This includes making, creativity and innovation.

Work with open-ended tasks, where there are no right and wrong answers, and where the teacher together with the students are curious to investigate phenomena around good school life,

digitization, and data collection. If the students need recaps, make them short along the way, where the students' knowledge and skills contribute to the shared learning space.

- Students investigate processes takes time, therefore make sure to plan a sufficient number of lessons for the task, where students can immerse themselves in producing, analyzing and use of their digital data about their learning environment and well-being.
- Make small experiments in your teaching on your teaching role being curious on the student's perspective and to facilitate students to be creative and find their own answers and solutions.

| Equity and inclusion considerations

- Collect classroom data in aggregate, focusing on group patterns to reduce individual stigma and create space for shared reflection and collective improvement.
- Let students co-design data tools and activities, giving them voice in what is measured and how, which builds ownership and relevance—especially for those often underrepresented.
- Guide students in interpreting their own data, using structured reflection routines and peer dialogue to help them think critically about learning, behaviour, and classroom dynamics.
- Make well-being data emotionally safe, by setting clear norms, allowing students to control how and when they share, and ensuring feedback leads to supportive action.

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