

Case study Norway case 1

School : B (primary school)

Theme: Science – microorganisms

Dates of lessons:

March 26-27th 2015

Age of students: 10-11 (grade 5)

Data sources:

- Pre- and post-interview with 1 teacher
- Lesson plan
- Student tasks and other written material used during the lessons
- Observation sheets
- Audio transcripts: two sessions, teacher pre-interview, teacher post-interview, student interview, student q-sorting
- Pictures from the lessons

School : S (primary school)

Theme: Science – microorganisms

Dates of lessons:

March 21-22th 2015

Age of students: 12-13 (grade 7)

Data sources:

- Pre- and post-interview with 1 teacher
- Lesson plan
- Student tasks and other written material used during the lessons
- Observation sheets
- Audio transcripts: two sessions, teacher pre-interview, teacher post-interview, student interview, student q-sorting
- Student workbooks
- Pictures from the lessons

Context

School B is an international school in the city center of a medium sized Norwegian city. The school covers the years 2 to 11 (corresponding to grades 1 to 10 in the Norwegian system). One of the teachers has been in the Famed project throughout the project. This teacher teaches at primary level. Another teacher has been at most cluster meetings and continued taking part and supporting the project even after she took over the position as principal at school B. In addition, a third teacher who teaches at lower secondary level has been at some cluster meetings.

The number of students is 250. The number of teachers is around 20 with and in addition, there are about 15 teaching assistants.

The teacher conducting the observed lessons in her science class has her teaching degree from UK. She has been teaching for 7 years, teaching all subjects except music and Norwegian, from Year 1 and up to Year 6. At the time of the interview, she was teaching five mathematics and three science lessons a week, each lesson 45 minutes long.

School S is a primary school, grades 1-7. The school is in an area of a medium size city in Norway. The number of students is close to 600 and the number of teachers around 35. Most students and teachers in this school are born in Norway, with very few immigrants with foreign language background. Two teachers from this school have been working with us in the Fasmed project throughout the project period. One of them teaches science and is part of this case analysis; the other one teaches mathematics and is part of case 2.

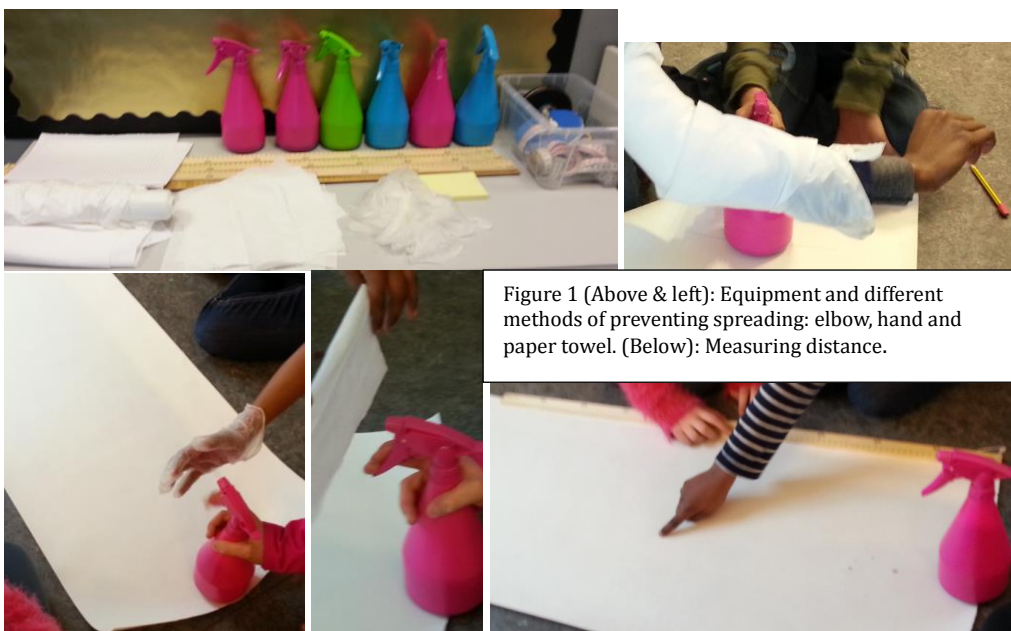
The teacher conducting the lessons at school S was primarily teaching science. At the time of the interview, she was teaching 11 one-hour lessons science each week, and at the time solely in grade 7.

The lessons

This case describes a series of lessons first developed at one school and subsequently redesigned for a different group of students at another school.

Planning of the first lesson started at a Fasmed cluster meeting. The idea was to work together on designing a lesson in science at school B. One of the school B teachers would deliver the lesson while the whole group of Fasmed teachers and didacticians observed it. For this purpose, an observation scheme was developed at the cluster meeting. After the lesson, the group would meet to reflect upon the session. Based on this reflection one of the other teachers would redesign the lesson for use at school S.

The subject of these lessons was science; the theme of the lesson were “microorganisms” and how to prevent the spreading of these organisms. The school B students had studied microorganisms for 4 weeks prior to the first Fasmed lesson. They knew about useful and harmful microorganisms and what these organisms need to live. They had learned about food hygiene and keeping safe in the kitchen. This particular session was about the spread of microorganisms through the air. What does it mean to ‘catch a cold’, or ‘give someone the flu’? Students were supposed to explore how far a sneeze is spread and if there is a way we can prevent it spreading. The experimental part of the lesson asked for the students to perform ‘sneezing’ experiments using spray bottles filled with water coloured with food colouring, paper towels, paper roll, rulers and tape measures. They were to measure how far the drops of coloured water could travel when different methods of preventing it was employed, see Figure 1 below. Results would be recorded by the students on the Smartboard and by using bar graphs on large paper sheets.



The first day lesson at school B can be divided in three parts; an introductory part which mainly concerned what microorganisms are, an experimental part where students carried out their experiments and made graph plots on large paper sheets, and a final part where results were collected and briefly presented. Towards the end of the lesson, the students were asked to answer some questions on the Socrative student feedback system. A full presentation and discussion of the results from the Socrative was done the day after.

The lesson started with the teacher informing the class that they had received a letter from a boy who had caught a cold and was anxious about passing it on to his grandmother. He wanted advice on how to prevent his cold spreading. The teacher led a class discussion about what it means to catch a cold. Suggestions/hypotheses from students during the questioning were recorded on the interactive white board. The teacher would choose answers from different students to illustrate the different points to be made, to move the lesson forward in the preconceived direction. The teacher asked students to discuss in the groups. The teacher asked students to respond to other students responses; "Can you add anything further?", "What do you think of this idea?" In this way, the teacher was establishing student knowledge about the concepts of microorganisms and related diseases. Students wrote individually on mini whiteboards during the questioning, giving the teacher information about individuals and the group about where they are in their understanding. By carefully planned questioning, the teacher guided the students from knowing about what microorganisms are, including different types of microorganisms, to knowing about which diseases the different types may cause, and finally towards how to prevent microorganisms from spreading.

The students had to make hypotheses about what would be the most effective methods to prevent spreading, and thereafter perform experiments in groups to test the hypotheses. For Socrative, the teacher asked four questions to assess pupil understanding. The students would answer these questions individually: "What's the best way to prevent a sneeze travelling? Why do we cough and sneeze? What kind of microorganisms travel in a sneeze? How fast do you think a sneeze can travel?"

At school S, the theme ran over three days. At this school, the theme was put into a real life contexts by the principal asking for help to reduce sickness among the teachers (Figure 2).

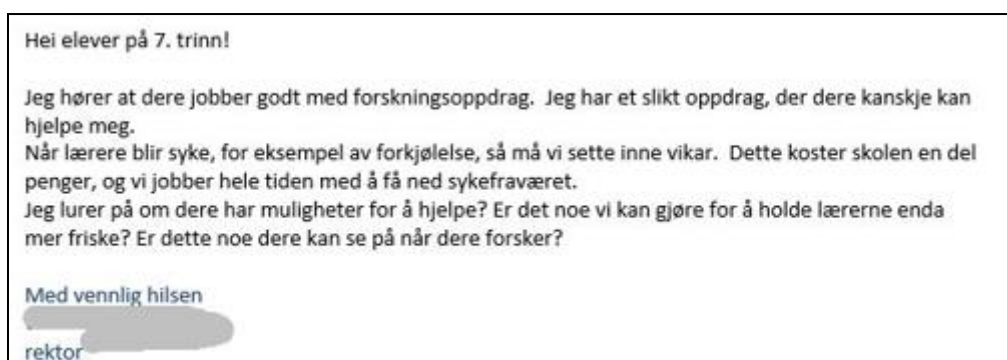


Figure 2. Letter from the principal at school S to the students in grade 7.

The students had performed the same type of experiments like in school B to see what may be the best way to prevent spreading of microorganisms. For the observed lesson, the students worked in groups of 2 or 4 to make a graphical representation of their results. The lesson, like the one at school B, can be divided in three parts. The first part consisted on establishing what the subject for the lesson would be and establishing vocabulary for data handling and analysis. In the second part students worked in groups, putting their data into the Excel spreadsheet and experimenting with different graphical representations of their results, discussing and arguing agreeing on which representation to choose. In the third and final part, some groups presented their results in front of the class. The presentations and further discussions would continue the next day.

At the beginning of the lesson, time was spent on guiding the students towards the proper use of statistical scientific vocabulary, like what does it mean to register data? What does it mean to process the data? What does it mean to analyse? In this way, the teacher established student knowledge about the concepts of registering data, processing data, analysing data. They also talked about graphs, establishing student prior knowledge of coordinate systems, axes and appropriate vocabulary for this.

The task given to the students for group work was to use Excel to generate two different types of diagrams to present their data. Next, they were supposed to explain which of those two alternative representations they would prefer, giving reasons for their answers. The students registered their data in Excel, structured, processed and analysed their data. At the end of this lesson, they presented their analysed data and preferred graphical representation in front of the class.

The lesson continued the day after with discussion on the rationale behind the preferred graphical representations. The students, in-group, had to provide arguments on the strengths and weaknesses of each graph representation, and of each way in preventing the microorganism spreading. The students wrote their arguments on mini whiteboards before presenting them in front of the class. The lesson ended with discussion on how to compose a letter as an answer to the principal. Two examples of such letters are given below (Figure 3).



Figure 3. Letter from two groups of students to the principal.

Analysis

Understanding

As mentioned previously, at the beginning of the first day lesson at school B, the teacher established the students' pre-knowledge on the concepts of microorganisms and related diseases before she moved the lesson further towards investigation. Examples of the questions were "What are the three types of microorganisms?", "What conditions do microorganisms like to live in?", "How can viruses spread?" By the moment the students started the experiment, they had understanding on different types of microorganisms and how they can create diseases. In addition, they had some ideas on how to prevent spreading, like shown on figure 4 below:

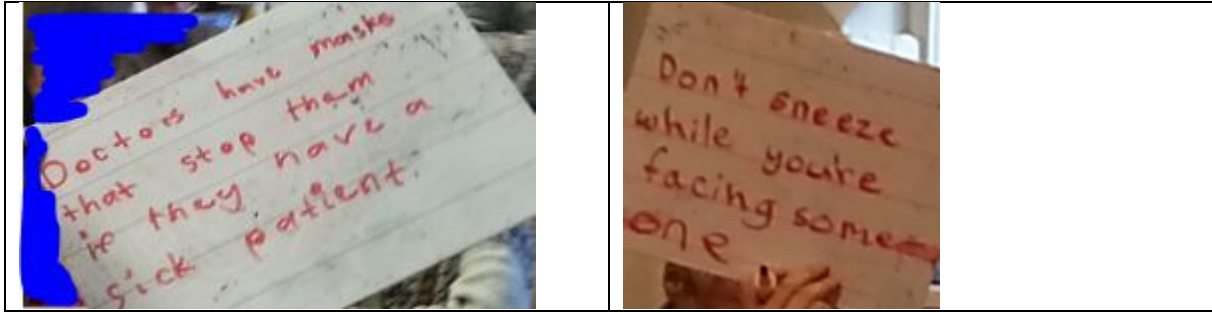


Figure 4. Examples of students' ideas on how to prevent spreading; written on mini whiteboard.

We can categorize the overall understanding the students acquired during the work in this topic, both in school B and school S, as follows:

- a) Understanding of scientific inquiry skills
- b) Understanding of scientific concepts
- c) Understanding of mathematical concepts and their applications

a) *Understanding of scientific inquiry skills*

By understanding of inquiry skills we mean students understanding on how the process of inquiry is to be done, and the factors that influence its success. Essentials in this regard are e.g. on how to formulate hypothesis, perform the experiment, present and discuss the results. In school B: Through the teacher's incitement, the students came up with different suggestions of methods to prevent the spreading of microorganisms: elbow, hand, closed mouth, tissue, stay alone and masks. The students then were asked to predict which method was supposed to be most effective; and put a post-it on the board. As shown in figure 5 below, most students predicted that tissue was the most effective one. By doing so, the 5th graders students were trained in formulating hypothesis in an age-appropriate way.

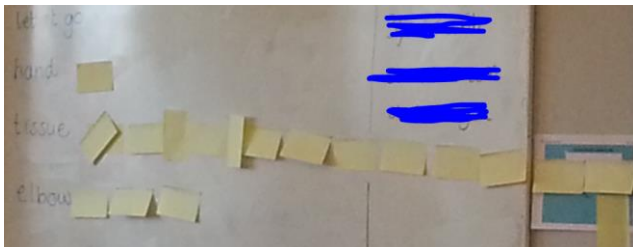


Figure 5. Students' hypothesis before the experiment.

During the experiment, the students develop understanding on how to make accurate measurements using ruler and how the execution of the tests would affect the results. For instance, they found out that if the tissues were double or triple folded then it would be more effective than single layer tissue (School B, classroom observation). They also understood how to do measurement (e.g. where to put the "zero" and how to read the ruler, School B, classroom observation), what it means to observe and to record the results, e.g. "To record means to write down so that we can, yeah, so that we can see where we are" (student utterance, School S, classroom observation). Further, based on the observation, the students were successful in recording their measurement results first in tables then in graphs. In school B bar chart was used; in school S different types of graphical representations were used.

Moreover, by using Socratic the teacher in School B asked the students to compare the results of their experiments and their prediction/hypothesis. The question was: "Was your prediction correct? What made you make your prediction?" The answers showed that the students understood that

results do not necessarily have to match the prediction, which is very important in scientific inquiry; see examples of answers below:

“Yes, I was correct”

“No, my prediction was the elbow” (while the result showed that tissue was most effective)

“My prediction was not correct”

“no it was wrong because a hand is one of the worst” (this student predicted hand)

“My prediction was correct, I made the prediction because a tissue is bigger”

“I was correct because my dad uses tissues all the time”

“No our prediction was not correct but it was good”

They also understood that they had to discuss why their prediction was correct or not. The answers showed that the students had different ideas about that. Further, the classroom observation showed that none of the students became upset because their prediction was not confirmed by experiment. This was a positive attitude towards inquiry.

b) *Understanding of scientific concepts*

The main scientific concepts that the teacher wanted the students to learn intervention period were that microorganism can be spread through air, and that there are methods of prevention; some methods are more effective than other. The understanding was documented from the students' answer of the questions on the Socratic which were discussed the next day in relation to the graphs. For instance, below are examples of answer from the question: “*What’s the best way to stop a cold or flu virus spreading? Explain why you think so*”

“The best way is to use tissue, but if you don’t have you can use your elbow. But you should throw it in the bin after you have used the tissue”

“I think a tissue will be the best because it can’t get through”

“Tissue because it is big so it can cover your whole mouth”

“To try to block you mouth from preventing cold and flu spreading”

“a tisho because the backaria stays on the tish and dos not spraid”

“elbow and tissue because it travel lowest”

Note that the last statement clearly showed the student’s understanding of the effectiveness of prevention method based on the evidence from the experiment.

In School S, the students were older (grade 7). In addition to establishing the most effective way of preventing spreading of microorganisms, they had to argue on pro- and cons of each method. Example of student answer is given below in Figure 6: “The tissue is best, because it (microorganisms) does not spread as fast. The inconvenience is that one does not have it (tissues) all the time. The advantages is that one can change with a new one (once it is used)”.

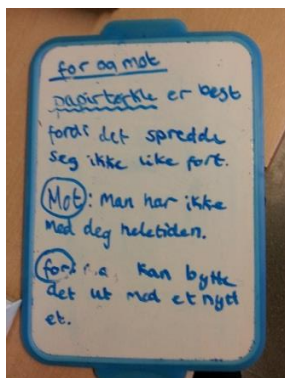


Figure 6. School S, day 2, discussing the methods, example of student answer.

c) Understanding of mathematical concepts and their applications

Included in this category the understanding of what table, diagrams/ graphs tell you, how to choose correct scales and measurement units (cm, m), how to label the graphs, number sense (big, small, bigger/smaller than) and representation of numbers (decimals in school B, decimals and percent in school S). Further, ability to use the language of statistics and statistical terms, including vocabularies like register, process and analyse, e.g. using spreadsheets (school S).

In school S, by discussing on the different graphical representations, the students got to a better understanding of the strengths and weaknesses of each representation, see example below which says “Bar chart is much clearer than the line diagram. Bar chart is much better in giving overview. The line diagram shows changes over time.” What the student meant by the last sentence was that the line diagram, on the other hand, was a better tool (than the bar chart) to represent a variable that changes over time.

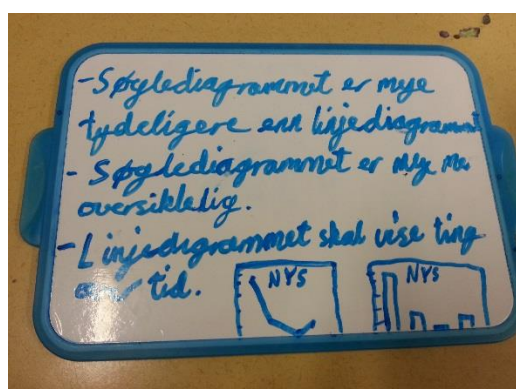


Figure 7. Bar chart vs. line diagram (school S, classroom observation).

Another argument for using bar chart is that “bar chart is clearer because the bars are independent of each other and bar charts are meant to be used to show data in form of letters (not numbers), such in this case” (student presentation, School S).

A sector diagram had the advantages of showing the differences, but since the numbers were in %, then it was difficult to know the distance (e.g. in cm) (student presentation, School S). Examples of the graphs are given in the paragraph below.

Technological issues

Interactive whiteboards were used in both schools as part of the lessons. The teacher in School B uses the smart notebook to set up her lessons and finds this to be very convenient. The students were used to this, and as part of the recording of their results, the group would go to the smartboard and fill in their part (Figure 8).

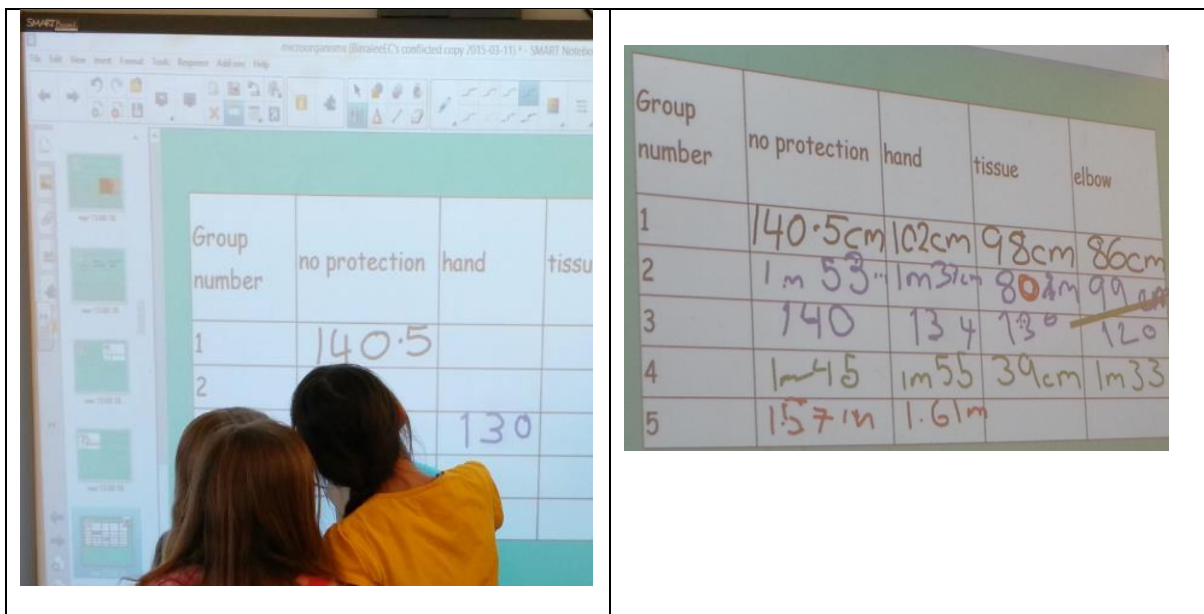


Figure 8. Students at school B recording results at the Smart Board.

Students at school S also recorded their results in a table in the Smart Board, see Figure 9.

Gruppe nummer	ingen beskyttelse	hånd	papirtørkle	albue
1	103cm	8cm	0cm	30cm
2	106cm	15cm	0cm	25cm
3	130cm	13cm	90cm	50cm
4	175cm	13cm	0cm	10cm
5	122cm	27cm	0	0

Figure 9. Student results from School S.

The use of interactive white boards differs from school to school and from one teacher to another. The boards seem to be a convenient way of planning the lesson by programming tasks and activities that can easily be recalled on the board by the teacher. It also seems to be easy for students to relate to this technology.

In School B the Socrative feedback system was used as part of the formative assessment. The students then have to access internet, as Socrative is a web based program. At this school this did in this particular lesson not cause any problems. Quite often however, wifi access and internet connection causes delays and pauses whenever teachers are trying to engage students in using those services. This may be a good reason for a teacher to avoid using such technology. The availability of internet-connecting devices may also be a problem, even if today most students have their own smart phones. However, it is not, and should not be, mandatory for school children to have private smart phones, Ipads or PCs for use at school. The teacher at school B told us about the high usability of the interactive white boards, and the main problems that occur:

The major issue that we've had here is with the internet stability, that's been very up and down. Sometimes it's been a bit of a frustration when everything's clonked out in the middle of the lesson or you know that sorts of thing. But I do try to use it regularly. The Smart Board

is on all day every day when I've got lessons in there. I use it for all sorts of things. My teaching has come on loads since I've had that. Finding motivational things and different ways of showing the kids concepts or all sorts of things with the Smart Boards. So that I think that has been the absolute best technology that we could have got. (pre interview, p. 7)

The teacher at school B told us that a positive thing she had learned during the project was finding out about Socrative and the other types of clicker systems, like Kahoot, and she said this had been really well liked at school and really easy to implement. After first learning about it, she had used those a lot since. (post interview, p.1 and also several places throughout the interview). E.g. she said:

I have worked with graphing and interactive resources with the kids before, but I haven't used any of the tools that we've discussed in the seminars. I haven't used any of them before we started this project. Kahoot or Socrative or any of this, the DESMOS or any of the other graphing programs so it was all completely new. Which was great. (...) the Kahoot and Socrative they can transfer across a lot of subjects and there's already a lot of content available for those online. I think they're more useful on the long term basis, actually. That's all been very new and positive. (post interview, p.2)

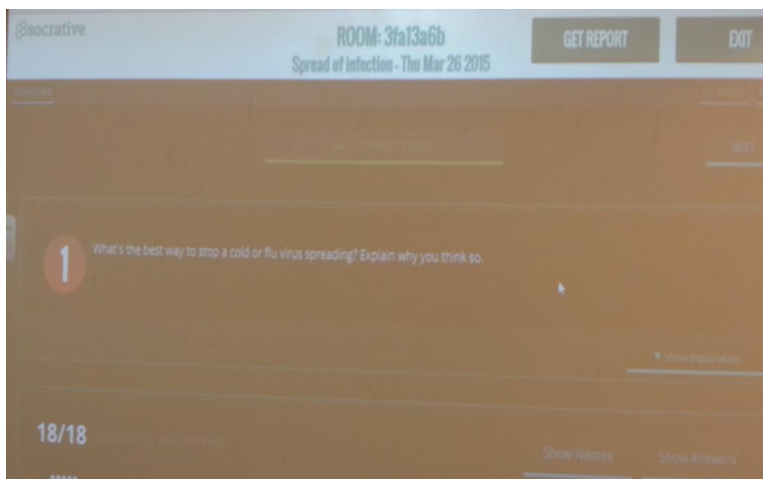


Figure 10. School B. Screenshot of Socrative web site.

A challenge, especially with Kahoot, is the countdown option for answering (time limit for feedback, and the number of points correspond with how quickly you answer). It might be a stressful and disturbing factor. During student interview at school B, one student expressed the following:

Because if we haven't learnt it yet then the teacher usually uses your score to know how much you know about it, but it also kind of annoying because you have no idea what to do usually and you're just guessing most of the time. Well not for you, (giggles) but most of us (student interview, p.4).

Also at school S, interactive white boards have been introduced all over. The teacher told us "And we have had Smart Boards installed in all classrooms, for example, and this will lead to students being more competent in the use of digital media." (pre interview S, p. 7). She said that "I am using digital technology on a daily basis. And we can see now, that we are totally dependent on having the visual world available (..) So it will be very special if I have to have a day without using the smart board" (p. 9).

In School S the students worked in Excel to register data in tables and use those data to generate two different graphical representations. Students told us in the interviews that their main use of computers had been for making presentations and texts. They were used to making Power Point

presentations. They would also use computers for finding information on the internet. For writing in mathematics as well as for making big posters, they had found it better to use pencil and paper. So far they had not used computers or technology in mathematics, but after the observed lesson where they were working with making diagrams, they said they could see the advantage in using like spreadsheets to make diagrams. By having it on the computer, they said it also helped them in their understanding. «You can make, like line diagrams and such things. Can explain it, like we did in this lesson. That is good, it makes it easier to remember. You see it, and remember the name of the diagrams, and can explain what they are good for, which diagram is better for different situations” (student interview, p.4).

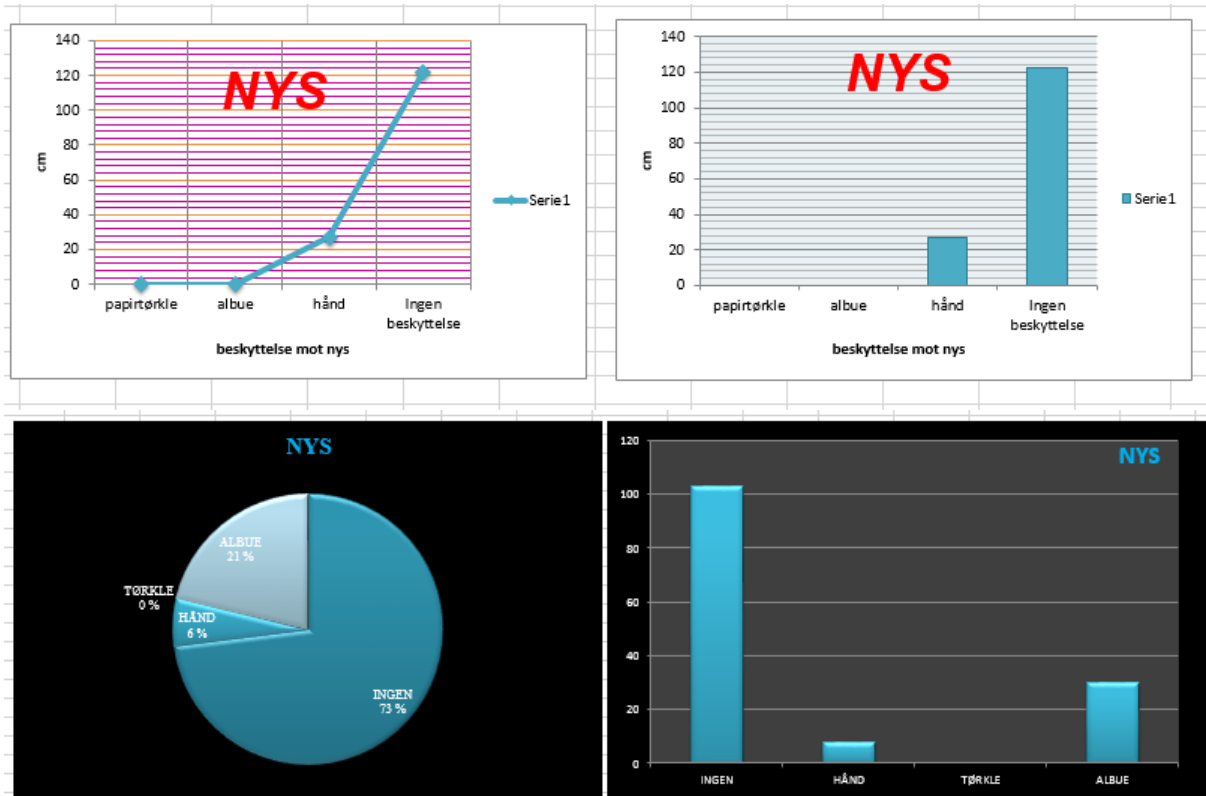


Figure 11. School S. Each group had to give 2 different graphical representations

Based on the q-sorting activity and subsequent conversations with students, we found that students from school B had ambiguous opinions about the usefulness of technology in science education lessons. Their comments to the statement “I do not like using technology in science” were: “That’s wrong”, “It depends”, “It depends on the person”, “It depends on the type of technology. I prefer...”, “Yes. It depends on the topic of science” (transcript of student q-sorting, p.10). To the statement “Using technology in science is difficult” they answered: “That is so wrong”, “It depends”, “It’s mostly depends, I think”, “I put that in the depends, but mostly leaning on disagreeing” (transcript of student q-sorting, p.11). Students from school S had mainly the same conclusions. They were reflected and in particular they highlighted the importance of variation in teaching methods. E.g, as a comment to the statement “I understand better if I use technological advices in the science lessons”, one student said: “I don’t think it is much difference, actually, thus I put that in depends/don’t know. It is a bit this and that with the book and computer and devices we have” (transcript of student q-sorting, p.12). Based on their experience, the students feel that the learning outcome with use of technology depends on subject, topic, kind of technology used and on each individual. Figure 12 shows Q-sorting results from one of the students at school B.

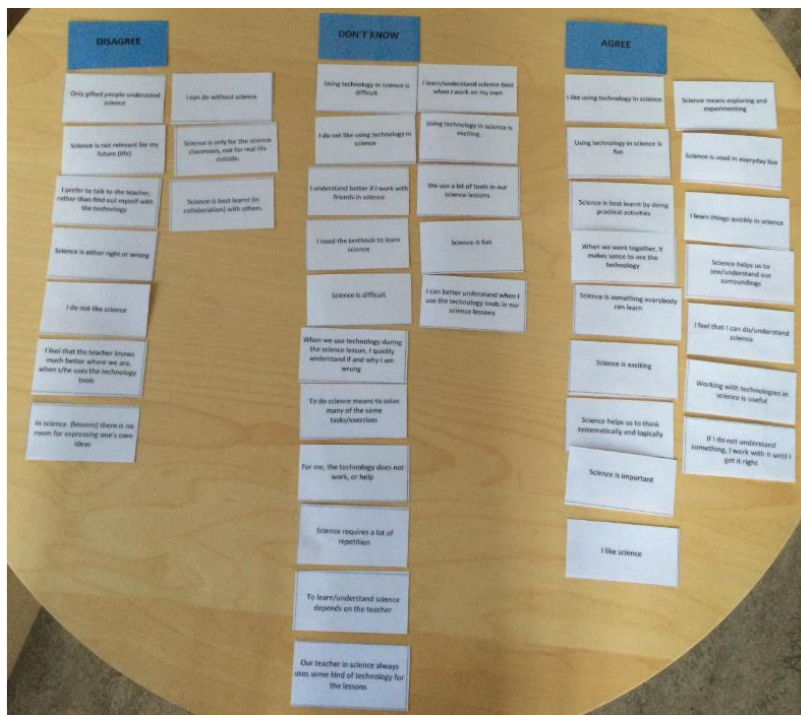


Figure 12. Q-sorting results from school B (1 of 4 students).

Formative assessment

In school B, the formative assessment was done throughout the lessons, starting from questioning at the beginning and the use of mini whiteboard to establish the students' knowledge. The mini whiteboard allowed the teacher to get a quick glance of the answers. The teacher found that most students were doing fine in answering those questions (teacher note), showing good understanding of necessary pre-knowledge for the lesson.

Then, the use of post-it to see what students think in terms of hypothesis (see Figure 5). Further, the teacher supervised the experiments, continually running dialog with students to find out where students did well, or when they needed some help. The teacher checked whether the students did the measurement accurately and drew the diagram correctly. The recording on the Smartboard, student presentations, classroom discussion and Socratic (see Figure 4, 8 and 10) were all considered as important parts of formative assessment. The teacher found that the results mostly reflected the hypotheses made by the children (teacher note). Whenever the hypothesis did not match the results, good discussion emerged (teacher note).

Besides, the teacher also encouraged peer-to-peer feedback, e.g. by asking students to comment on each other's answer during the questioning in day 1 or during the presentation of Socratic results in day 2: "What do you think?" "Do you agree with..?" "Which statements do you agree most? Or least?" (School B, classroom observations, day 1 and 2). Self-assessment is also an ongoing activity in this classroom, e.g. by using a kind of traffic light system where they use colours (red if they don't feel they've got it, orange if they think they understand it and green if they think they can do it). The teacher also value the use of technology in connection with formative assessment, e.g. by saying:

I do see the value of using the technology now, especially when you can do a quick thing, go into the report and see, and then come back to that in a follow-up lesson, because it gives you more of a chance to look over and see who is understanding this, and who isn't, in a way you don't get when you're doing a very quick forms of assessment in the classroom on white boards. (post interview, p.6)

She also recognized students' inspiration, when using the technology:

...also if they can just click, also there is an element of competition, too. It is motivating I think and that is a big added value really for me, that you get kids that are often not inspired by reading or writing and doing things that way, to get inspired by the use of technology. (post interview, p.6)

Regarding Kahoot and Socrative, she also sees that it could fit certain topics better than others, and she thinks it is likely to have a long term impact on her teaching practice: "I can use it in lots of different ways, but I think it will probably go a bit up and down as to how often I use it but I can see myself using it for a long term time ahead" (post interview, p.7).

In school S, the dialog at the start of the lesson, establishing students' pre-knowledge and recalling the results from previous lessons is considered as important formative assessment. Further, during the group work the teacher went around and asking questions "Why is this representation better than the other?". By listening to the answer, the teacher could grasp the students understanding and ability to discuss graphical forms (see §Understanding).

The use of mini whiteboard and the student presentation (classroom observation, both in day 1 and 2) were also significant moments of formative assessment; giving ample of opportunities for teacher to find out where the students were and to encourage peer-to-peer feedback. The latter was when the students commented on each other presentations. The conversation around the presentations was highly valued by the teacher: "...then I got so good conversations and the students were high, they discussed and I was actually superfluous. It was absolutely amazing" (post interview, part I, p.3). Regarding the use of mini whiteboards, she said: "I am using those whiteboards actively myself, and I see that it is effective and I would keep that. And in any case not less now after I've been involved in this project" (post interview, part I, p.1). She also ran a Kahoot in the end of her session, but what she valued most regarding formative assessment was the combination of using comparisons based on Excel diagrams, conversations and whiteboards (post interview, part I, p.4). Regarding technology she said:

I have been very eager to add both mathematics and technology in my teaching. I see how motivating it is, and the students are getting high, but what I have to look after, really, is the fact that there should be an added learning outcome by using it (post interview, part II, p.4).

Final remarks

The topic of microorganisms was run in two schools, B and S, as part of the lesson study involving two cycles of design/ re-design, implementation and post-reflection. In both cycles, special attention was given to aspects of formative assessment. We found that through this study the teachers have become more conscious of the importance of formative assessment and in implementing them. A great range of approaches for formative assessment has been employed, digital or non-digital. They were all found to be useful in making students' thinking visible to teachers. The digital ones, such as interactive whiteboards (SmartBoard), Excel and Socrative were found to be convenient and effective as means for presenting (and recording) the results of students' work or answer to questions. There were concerns however, about the dependence on the internet access and stability in using student response system such as Socrative (or Kahoot).