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The closing down of schools due to the Covid-19 pandemic and the consequences for science education

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Abstract

Because of the outbreak of the Covid-19 pandemic in the year 2020 many countries closed down education on all levels. The students are supposed to conduct their studies at home with digital support from their institutions. In science teaching, with laboratory work, field studies and other types of practical work as important parts of the studies and also the reflective parts, usually often in dialogue form, are suffering. At home the student seems to lack ability for a deeper understanding, especially as teachers showed an increased tendency to base their grading on written texts. This creates a general lower degree of understanding outside the classroom as texts easily may be copied without content knowledge. In the classroom the presence of, not only the teacher, but also other students, stimulate or trigger the wish of deeper understanding. Thus, the teacher has to behave otherwise when working in the digital word compared to in the classroom. Based on interviews with teachers and out our own experiences we here present some basic problems of science teaching in a pandemic world and how they may be solved. Thus, some principles for the design and structure of homework tasks useful for teachers will be presented. The suggestions presented will hopefully promote deeper understanding of learning processes and their environmental dependence.

Keywords: Covid-19, school close down, home studies, science education, science teaching

1. Introduction

More than fifty years today, the lectures attended by the senior author at upper secondary school were interrupted by a teachers' strike. During some weeks the students collectively arranged their studies at school, without any support from teachers, based on the textbooks. The students, between them divided the responsibility of the different subjects. In most cases it worked out fine, in the beginning also in mathematics. But after one week, a new area was introduced; *calculus*. Although a dozen students worked together with their textbook, they didn't understand neither the ideas or the practice of calculus, although they attended a program with focus on mathematics. Without their teacher they were lost and nothing new was learned. Today the situation is similar due to the outbreak of the Covid-19 pandemic and students have lost the social culture of their class rooms. The teachers have lost their class rooms and have to find new roles. The students are supposed to conduct their studies at home with different levels of digital support from their institutions. In science teaching, where laboratory work, field studies and other types of practical work are important parts of their education, this often is more problematic than in other subjects. Further, students often also are supposed to do their studies single-handed, in contrast to the, often so important, collective activities performed at school or in the field. But, not only these typical characteristics of science teaching are hard to maintain and often are totally lost. Also, the reflective parts, usually in dialogue form, with fellow students and teachers, suffer. Here we present some identified explanations to the shortcomings of the changes towards distance teaching and how they may be avoided. This also includes some critical reflections on the present state of the science education at all levels.

2. Common design and general outcome of home studies

There are some general differences between education at institutions and at distance, regarding the designs course content and structure. The tasks and also the evaluation and grading of the students, compared to the ordinary procedures at school differs. These differences seem to have great impact on learning processes and the quality of the knowledge achieved.

2.1 Differences in the design of home studies compared to the design at institutions

The home studies often are based on various tasks, including the collection and presentation of data and texts introduced by relatively short virtual lessons. In some cases, the teachers created tasks



similar to those found in textbooks, e.g., concept checks, inquiries, self-quiz, [cf.1]. The presentations of the tasks often are presumed to be presented in written text, quoting course literature or web-sites, more rarely students are forced or promoted to respond in their own words. Thus, the answers usually are correct, although they give none or only very poor information about the real understanding and learning. Teachers experience a difficult situation, generating low quality teaching. But there are exceptions: "I've learned loads. Teaching at distance gives me new opportunities to develop pedagogically" [2]. But most reactions are negative. The close relations of the classrooms are lost, technical problems disturbed the work, the possibility to "see" the students and feel the atmosphere are also lost. This highlights the importance of social interaction and physically close relations in the classroom [3]. A special problem in science studies are the limited possibilities of doing experiments and practical investigations at home [4].

2.2 Differences in learning outcome of home studies compared to those at school

Compared to the classroom, the home of the student, seem to lack the ability to stimulate deeper understanding. This effect is further pronounced as teachers show, at least in Sweden, an increased tendency to base their grading on written texts mainly produced by reproductions. This method leads to the creation of a general lower degree of understanding compared to the situation in the classroom, as texts easily may be copied without content knowledge. Thus, it is possible for the students to present adequate texts without apparent understanding of the scientific content. The possibility to put questions to the teachers and to discuss the content of lectures are restricted in the digital environment and diminish the possibilities of achieving a deeper level of understanding [5].

3. Main factors behind the loss of quality

In the classroom the relations between teachers and students, stimulate or even trigger deeper understanding. The relations to others and the exchange of ideas are most important in the learning processes. Of course, there are contents to be learned, but the learning is a process in relation to others or in dialogue with oneself. Thus, texts and other sources, have to be mentally processed, otherwise they are lacking deeper meaning [6]. Many teachers seem to lack some knowledge about the importance of these factors. In the absence of these stimulating forces the teachers have to behave differently when working in the digital word compared to working in the classroom. Similarly, the students have to understand the importance of the collective processing of texts and experiences in order to understand the reality behind them, which ought to be the subject content. Otherwise, it will be hard to achieve knowledge useful in real life when their studies are finished.

4. How to gain higher quality in the understanding of the subject content

The teaching of most teachers under normal conditions usually gives good results but teaching and examinations during the pandemic reveals some basic misconceptions. Many, teachers as well as students, are obviously not sufficiently aware of the importance of social processes for the learning in the classroom. In a manner of speaking, they are taking them for granted, but do not really acknowledge their importance and fail to use them methodologically.

4.1 How to create tasks useful at home

In order to design high quality homework tasks, the teachers have to use processes including these that are lost when leaving the classroom. This is very important regarding the outcome of the performance of the students. If they shall perform at similar level at home, the factors lost when leaving school must be compensated. One way of promoting this are tasks demanding something more than text replicates. In order to achieve this, tasks have to be non-repetitive and the results should be shared between students in order to achieve knowledge of high quality.

4.2 How to solve tasks at home

As mentioned above, it is through the communication between students in the classroom learning often is achieved. Other views, presentations, misunderstandings, etc., often promote understanding. Thus, If the students always are stimulated to present their own (processed) ideas or ideas by others in their own words, it will increase the level of their understanding. This may be achieved by using the students own written texts on subjects proposed by the teacher. It is also important to use verbal communication. Spoken language is processed by other parts of the brain compared to written and gives other possibilities for reflection. As the internet also is possible to use for verbal communication it is easy for the teacher to participate in discussions with the students.



5. Areas of special importance to be focussed on by the teachers

The problem of understanding calculus in mathematics without a professional teacher, described above has similarities with some areas of other subjects. Here we present some areas where the teachers usually, not only have to present facts or methods but has to directly participate, *in dialogue* with the students in order to reach the pedagogic goals of the curriculum. One way of identifying relevant areas is to study the scientific break throughs of each subject. What happened that changed the views? Further, the age of the students and the level of their studies have to be taken into consideration when planning the teaching.

5.1 Physics

Here the situation often is related to problems in mathematics. The theoretical models of the subject often are mathematical with a high level of abstraction. Thus, it is important to work with different types of presentations facilitating learning by student with different modes of learning. In secondary school simple experiments may be conducted at home.

5.2 Chemistry

In chemistry, the teaching in secondary school partly is based on laboratory work and mathematical methods. The scientifically based understanding, unfortunately, rarely is the main focus. Home studies are a challenge for every teacher. Experiments at school or the university usually are performed collectively in small groups of students which are important parts of the learning. This may be done at home if small groups of students conduct the same experiments simultaneously in digital contact. They may discuss their experiences and together reach a higher level of understanding. This is also relevant for more theoretical tasks which may be solved in cooperation.

5.3 Biology

The Darwinian perspective is essential in all biology but often is distorted by other popular and widespread ideas. Here the challenge is to create tasks revealing the dialectic nature of the science content. Nature is constantly changing without a specific goal due to the activities of the present survivors. Often a small number of individual abiotic factors may create changes. This makes it relatively easy to explain what has happened but almost impossible to predict the future in detail. The teacher may develop tasks where students create their own ideas of how mankind may interact with other organisms to diminish the risk of disturbances. Here it may be possible for small groups of students to make excursions together, keeping distance, and together discuss their observations.

6. Conclusion

In order to achieve learning of high quality, teachers have to preserve the quality factors of classroom teaching and develop tasks maintaining these characteristics when students work at home. From our experience, "Escape room" pedagogy, where groups of students via internet simultaneously under supervision of the teacher solve their tasks, is useful. Other methods may be used but of most importance are teachers prepared to focus on guiding, both individuals and groups of students, in their learning and achieving abilities useful in the future, instead of transferring facts.

7. References

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