THE IMPACT OF PERFORMANCE ASSESSMENT ON SCIENCE EDUCATION AT PRIMARY SCHOOL

Ann Mutvei[1] and Jan-Eric Mattsson[1]
[1] School of Natural Sciences, Technology and Environmental studies, Södertörn University, Sweden

Abstract: The new curriculum in Sweden for primary and secondary school contains more distinct educational targets. Science education at school now has to be linked to the students own experience and shall develop critical thinking of the student. This is supposed to the ability to review arguments and to develop their ability to argue in situations where knowledge of science is of big importance. To achieve the required knowledge, students have to train abilities or skills before the assessment. In order to assess the required knowledge and to view the development of a student, the teacher has to accomplish several practical assessments and training occasions. The new curriculum expects the teacher to design learning situations where the students get the possibility to have relevant training before the performance assessment. The earlier Swedish curricula had a stronger emphasis on theoretical knowledge whereas the new curriculum highlights the ability to use knowledge.

Keywords: teaching evolution, tacit knowledge, science teaching

INTRODUCTION

The new curriculum in Sweden for the primary and secondary school contains more distinct educational targets. The political background was among other things, the poor Swedish results in PISA and TIMMS. There had also developed a strong opinion against what was regarded as a modern school without any demands on the students and a wish to return to a school focused on knowledge. Also the ROSE project, focused on the interest in science education, showed that a very low number of Swedish students were interested in this field. Important parts in the political agenda was the improvement of teacher training programs focused on subject knowledge, better evaluation programs, teacher certificates, inspections of schools and new curricula. The new curriculum for the primary school contains three important parts concerning the studies of the different subjects. These three were; the aim of the subject in the school context and in society, the core content of the subject and the knowledge requirements to reach a specific level at the assessment performance. Further, the assessments are linked to the usage of knowledge both in a specific subject context according to the assessment criteria, but also in other contexts outside school rather than remembering facts.

BACKGROUND

Science education at school now, according to the curriculum, has to be linked to the students own experience and development of critical thinking of the student. This aim is supposed to enhance the ability to review arguments and also to develop the student’s ability to argue in situations where knowledge in science is of great importance. The performance assessment according to the curriculum shall be used to evaluate if the student have achieved the capacity to use knowledge in discussions within scientific contexts.

The student's practical investigations and documentation of these are important parts in science education. To achieve this required skill, students have to train before the assessment. In order to assess the required knowledge and to view the development of a student, the teacher has to accomplish several practical assessments and training occasions. This is an important change compared to earlier curricula. The teacher was earlier supposed to concentrate on teaching but the content of the lessons was not described in the curriculum. The new curriculum expects the teacher to design learning situations where the students get the possibility to have relevant training before the performance assessment. Thus, the role of the teacher has changed from being a performer in the classroom to becoming a designer of learning situations. This includes also the situation when the performance assessments are made, they shall not only assess the abilities of the student but also stimulate to further studies. The earlier Swedish curricula had a stronger emphasis on theoretical knowledge whereas the new curriculum highlights the ability to use knowledge.

In our positions as lecturers at teacher training programs we have observed several obstacles of different nature, diminishing the learning outcome in science teaching. We identified some of these as important and relevant to deal with in the pre-service training as we thought this would help our students in their coming profession.

In a recent quality report from Skolinspektionen (Swedish Schools Inspectorate 2012), concerning teaching in years 1–3, similar problems have been identified. Almost all students regard science as interesting subject, they feel satisfied with the classroom climate and the visited lessons where described as peaceful with supportive teachers. More negative is that some parts of the core content are absent and that there is a focus on biology at the expense of chemistry and physics. This does not mean a higher quality in biology; the teaching is mainly concentrated on observations and learning of concepts without deeper understanding. Further, the students rarely practice scientific methods, they need help to understand the content and the quality varies between schools and also within schools.

We were also interested in how teachers did when they had to explain things they didn't know so much about. Teachers often claim a lack of knowledge as the reason why they don't teach science properly or even try to teach. On the other hand we had a feeling, out of what we had seen visiting schools and when we met teachers at in-service courses, that many of them expressed tacit knowledge used in informal or spontaneous learning situations.

We had also discovered poor knowledge in the main principles of evolutionary theory. Although many students know words or concepts like random variation, natural selection, adaptation etc. they do not use them in appropriate ways.

In the pre-service training it is important to know how science could be taught at school and to give opportunities for the becoming teacher to practice in similar ways as they are supposed to design learning situations with their students in the future.

THEORETICAL FRAMEWORK

Biology is often “taught” outdoors but this activity is often delimited to observations often transformed to numerical values. Why is biology, which always has an evolutionary foundation, almost always about facts and not about processes? If processes occur they are usually taught as concepts that should be memorized not as dynamic models with several interacting forces (Alters & Nelson 2002, Skolinspektionen 2012).

Out of our experiences presented in Background, three questions surfaced covering the main parts of our concern: 1) How is science in general taught in the classroom, 2) is there a structure of the tacit knowledge among teachers and is there a strategy for expressing it by them (Parker & Heywood, 2000) and 3) how do we get teacher students to be more evolutionary in their thoughts? These were questions not primarily to establish thorough research on, rather ideas that could be investigated in order to find the core of the problems.

Like Alters & Nelson (2002) our general experiences from teaching, in different fields of science like biology and chemistry but also in behavioral and educational sciences, was that the main obstacle almost always were the students’ prior conceptions regardless how well-founded they were. This problem arises in all learning situations, not only of evolutionary theory.

METHODS

Classroom study

In the first case the learning situations in a class of 23 students in year one were recorded by Iphone simultaneously as notations of the activities were made. The time in minutes spent on different types of activities was summarized. These observations were used to evaluate the actual leadership of the teacher in the classroom and outdoors.

Tacit knowledge

During a course for teachers in primary school the participants wrote reflections about problems of knowledge of concepts, processes, relations etc. and problem solving when students posed questions they were uncertain about. These reflections were analyzed in order to reveal how they in practical situations expressed tacit knowledge.

Evolution

In order to create a better understanding of the basic principles of evolution we tried to use TED-talks from the internet in a course in chronological perspectives for primary school teacher students. If the students first watched a lecture on scientific method related to evolution followed by another strict evolutionary lecture we thought they would achieve tools for analyzing other talks. The ambition was to make the students aware of the fact that also prominent researchers may slip into a more entertaining costume when talking to non-specialists. In order to make it possible to compare different talks we divided the student in ten groups of about five in each. All groups were instructed to watch same two TED-talks, first Lotto & O’Toole: Science is for everyone, kids included (2012), followed by Elaine Morgan says we evolved from aquatic apes (2009).

After this the groups was given one talk each to critically watch and discuss. We chose a packet of talks called *Ancient clues*, containing 5 different talks by Enriques (2012), Goodall, (2002), Leakey (2008), Pääbo, (2011) and Zeresenay (2007).

After having watched the lectures the students had discussions on the course web which was followed by the teachers and later studied. The occurrence of concepts from the evolutionary theory and the manner of writing in the lines of the students were analyzed

RESULTS AND DISCUSSION

Classroom study

In total 585 minutes of science teaching were observed. The numbers of registered minutes were larger as many activities occurred simultaneously. For example, if the teachers were talking when the students were making drawings both activities were registered. In total 972 minutes were registered in the classroom and 156 minutes outdoors.

In the classroom a minor part of the activity performed by the teacher alone and almost all activities is performed by the students (Figure 1).

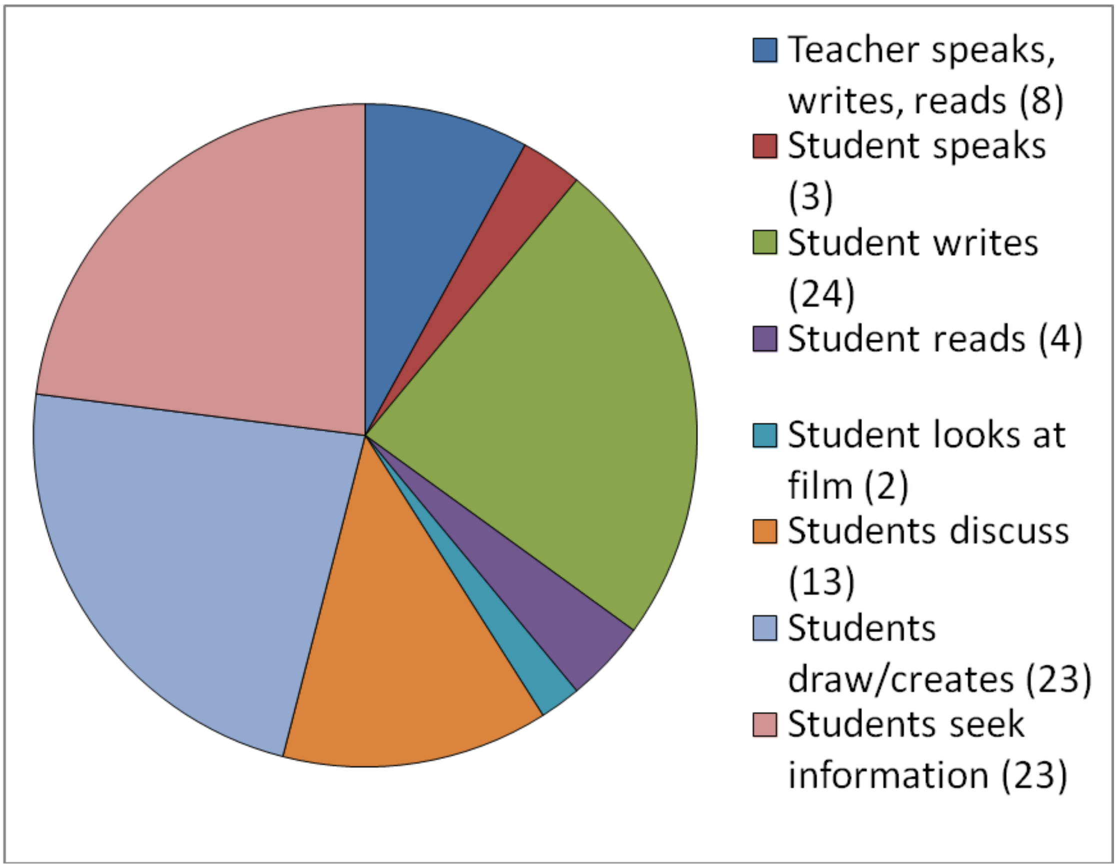

Figure 1. Percentage of time used for different activities in science teaching in the classroom

One third of the time is used for strict individual activities of the students and only 13 % to collective activities. Most of the time (46 %) is used for a mix of individual and collective activities (Figure 2).

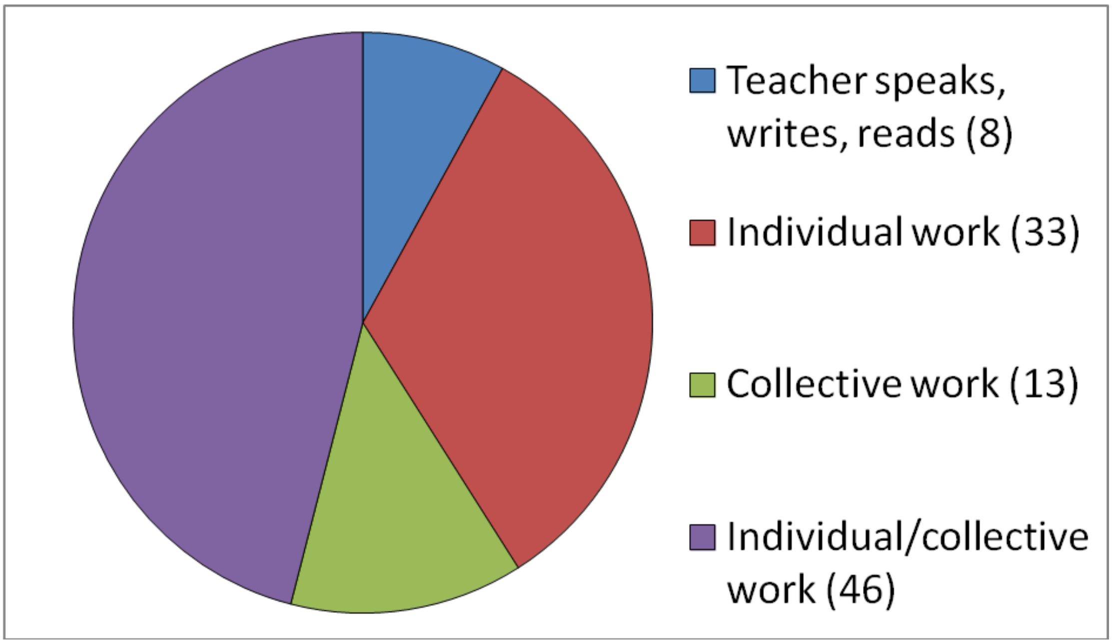

Figure 2. Percentage of time used for teacher, individual and collective activities in science teaching in the classroom

The outdoor activities were of much shorter duration but the pattern was similar (Figure 3). The teacher uses a small part of the time and the students activities seem to be of a fairly free character.

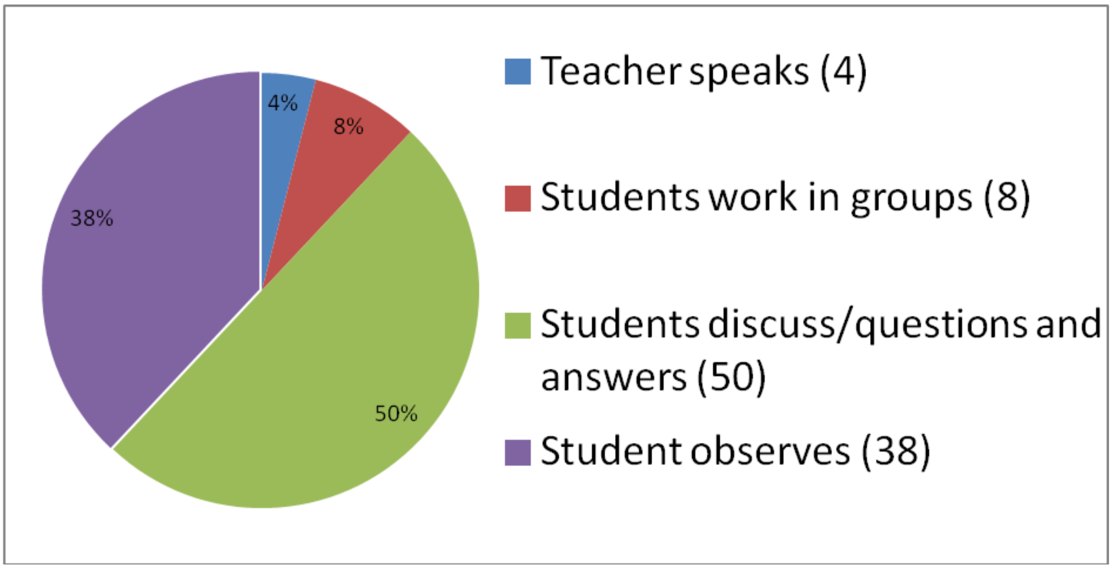

Figure 3. Outdoor activities

The result supports the view of Skolinspektionen (2012). The outdoor education is not directly related to theory but is concentrated on observations and questions. Also in the classroom the leadership of the activities probably is weak as the time of teacher dominance is limited.

This supports the opinion that the design of science learning situation has to be developed.

Tacit knowledge

The reflections contained a large number of ideas how to do when you initially thought you didn't know how to explain when you got impossible questions. In Table 1 the most common problems and their suggested solution are listed.

Table 1

Problems identified by teachers in primary school

Problems	*Solutions*
To use concepts correctly	Relate to the students own explanations and experiences in different situations
To see other than simple relations	Discuss the relations in different situations. Don't read, work practically!
To understand processes	Use activities (e.g. cooking and baking) as examples of transforming processes.
To put knowledge in a larger context	Expand the world of the student by new experiences.

The results show how many, a majority of the reflections of 14 teachers have strategies for answering scientific questions although the regard themselves as more or less ignorant. This support what we often find in our courses; students claiming ignorance although they can prove practical (tacit) knowledge. To some extent we think this is a defense; their self esteem in science is often very poor regardless their skills.

Evolution

Primarily, we found that students do not follow instructions. Many of the groups started to listen uncritically to the talk of their own and tried to analyze the first two out of this. Secondary many argued against criticism with arguments like; why should our teachers provide us with poor talks, of course they must be good if they are included in the course. Finally almost no students used evolutionary concepts and most of them showed poor understanding of evolutionary principles. Almost no one referred to the textbook (Guttman 2005).

Teaching evolution is more problematic than we thought. Here we have a dilemma in the trust of the students. They hesitate in being critical against their teachers. It is hard for them to imagine why the teachers should give them poor material even to practice critical thinking?

Another problem was that the student didn't follow instructions. They preferred to start with their own material directly instead of first develop critical thinking. This shows how curiosity may lead to poor learning when not properly guided.

We have to create distinct learning situations, otherwise we get nowhere.

Acknowledgements

We are indebted to Avesta Flärd who made the classroom study.

REFERENCES

Alters, B. J., & Nelson, C. E. (2002). Teaching evolution in higher education. *Evolution,* 56, 1891–1901.

Enriques, J. (2012). *Will our kids be a different species?* TED talk. Retrieved from http://www.ted.com/talks/juan_enriquez_will_our_kids_be_a_different_species.html

Goodall, J. (2002). *What separates us from chimpanzees?* TED talk. Retrieved from http://www.ted.com/talks/jane_goodall_on_what_separates_us_from_the_apes.html

Guttman, B. S. (2005). *Evolution: A Beginner's Guide*. Oxford: Oneworld publications.

Leakey, L. (2008). *A dig for humanity's origin*. TED talk. Retrieved from http://www.ted.com/talks/louise_leakey_digs_for_humanity_s_origins.html

Lotto, B., & O'Toole, A. (2012). *Science is for everyone, kids included*. TED talk. Retrieved from http://www.ted.com/talks/beau_lotto_amy_o_toole_science_is_for_everyone_kids_included.html

Morgan E. (2009). *Elaine Morgan says we evolved from aquatic apes*. TED talk. Retrieved from http://www.ted.com/talks/elaine_morgan_says_we_evolved_from_aquatic_apes.html

PISA. (2014). Retrieved from http://nces.ed.gov/surveys/pisa/

Pääbo, S. (2011). *DNA clues to our inner Neanderthal*. TED talk. Retrieved from http://www.ted.com/talks/svante_paeaebo_dna_clues_to_our_inner_neanderthal.html

Parker, J., & Heywood, D. (2000). Exploring the relationship between subject knowledge and pedagogic content knowledge in primary teachers' learning about forces. *International Journal of Science Education 22*(1), 89-111.

ROSE. (2014). Retrieved from http://roseproject.no/

Skolinspektionen (Swedish Schools Inspectorate). (2012). *"Min blev blå!" – Men varför då?.*. (Skolinspektionens rapport, 2012:4). Stockholm: Skolinspektionen.

Skolverket (Swedish National Agency for Education). (2011). *Curriculum for the compulsory school, preschool class and the recreation centre 2011*. Retrieved from http://www.skolverket.se/publikationer?id=2687

TIMSS. (2014). Retrieved from http://nces.ed.gov/timss/

Zeresenay, A. (2007). *The search for humanity's roots*. TED talk. Retrieved from http://www.ted.com/talks/zeresenay_alemseged_looks_for_humanity_s_roots.html