4.4 Case study 4 (Sweden)

Concept focus	Natural selection – evolution of legorgs
Inquiry skills	Planning investigations
Scientific reasoning and literacy	Scientific reasoning (data entry and observation skills)
Assessment methods	Classroom dialogue Teacher observation
Student group	**Grade:** lower second level; three classes – one grade 8 and two grade 9 classes **Age:** 14-16 years **Group composition:** mixed ability and gender **Prior experience with inquiry:** Some prior experience with inquiry

This case study details implementation with three lower second level classes. Adaptations were made to account for this level of prior knowledge, and to overcome difficulties due to insufficient quantity of Lego®. One class utilised computer simulations as a complementary process. Assessment focused on *planning investigations* and *scientific reasoning*, with classroom dialogue and teacher observation used to good effect.

(i) How was the learning sequence adapted?

The **Natural selection** SAILS unit was implemented in three separate classes, in lessons of one-hour duration. As the classes were of lower second level students, the teachers made several adaptations to the unit. In addition, the schools had a very limited supply of Lego® and so in some cases the students did not assemble legorgs. The students worked in groups of 4-5 students (in 2 classes) and individually (in 1 class). However, in all cases the original tables were used for recording of data.

In one class the activity was introduced with a short Swedish movie about evolution: https://www.youtube.com/watch?v=UbqZOTK9EAU. After watching the movie, the student picked coloured objects from jars (since there was a limited supply of LEGO® bricks). They documented the colours and put the "genes" back into the pool. This was continued until ten different legorgs had been produced (Generation 1). In the second generation, the genes from the five first legorgs were placed in different jars and the same gene picking procedure was performed. This was then continued up to generation 5. When all students had finished, the students presented their results using the original tables and there was a whole class discussion about the selection processes observed and how they relate to natural selection in a real-world context.

The students then used the simulation software provided at http://www.jcd.biology.sdu.dk/ to simulate 25 generations. From this simulation, they discussed the concept of fitness.

In another class, the students used actual LEGO® bricks for the activity, but they created an alternate measure of fitness – stability – instead of movement. The then scored the fitness of their legorgs on a scale from 1-5, where 1= cannot stand by itself and 5 = stands steady.

(ii) Which skills were to be assessed?

The activity was used in order to assess students' skills in *planning investigations* and their *scientific reasoning* (data entry and observation skills). For assessment of these skills, the teachers:

1. Made observations when students performed the activity;
2. Listened when the students presented their results;
3. Collected data tables (i.e. Generation table and Gene pool tables) and written conclusions

(iii) Criteria for judging assessment data

The teachers made observations about how well the students:

- Planned and conducted their investigations (which in this case was very much to follow detailed instructions),
- Collected and documented data (the primary focus of this activity),
- Communicated their results.

(iv) Evidence collected

Teacher's opinions

The learners enjoyed the activity and they did not find the practical parts very difficult. In particular, the students expressed that they, by performing the activity, really understood how chance influenced the evolutionary process.

This activity, as well as the scientific concepts used, is more advanced than is usually taught in lower-secondary school in Sweden. Therefore, the teachers had to make some quite extensive modifications of the original design. Basically, this means that: (1) The activity was mainly used to illustrate the concept of natural selection, while other concepts like genetic drift were left out; (2) fitness was simulated, in order to avoid the use of statistical methods; and (3) the primary focus of teachers' assessment was students' skills in (systematic and accurate) data collection. The teachers noted that the activity could have been used in order to assess students' conceptual understanding, if the activity had been an integrated part of a teaching sequence about evolution and/or genetics, but not in this case when it was a stand-alone activity and most of the students lacked prior knowledge in this area.

Sample student artefacts

Some examples of tables completed during the lesson are shown in Figure 1 (Generation table) and Figure 2 (Gene pool tables). Examples of students' written conclusions are shown in Figure 3 and Figure 4.

Table 1. Generation table.

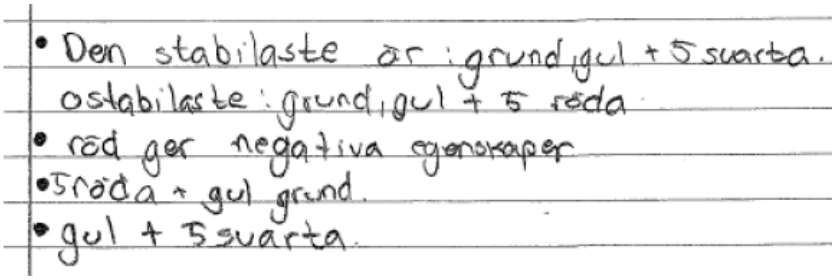
Generation No.	1					
Legorg no.	note allele (color) for each of the 5 genes in the legorg and measure fitness					
	Gene 1	Gene 2	Gene 3	Gene 4	Gene 5	fitness
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Figure 1: Example of student performance (Generation table)

Table 2. Gene pool table (one table per gene per generation)

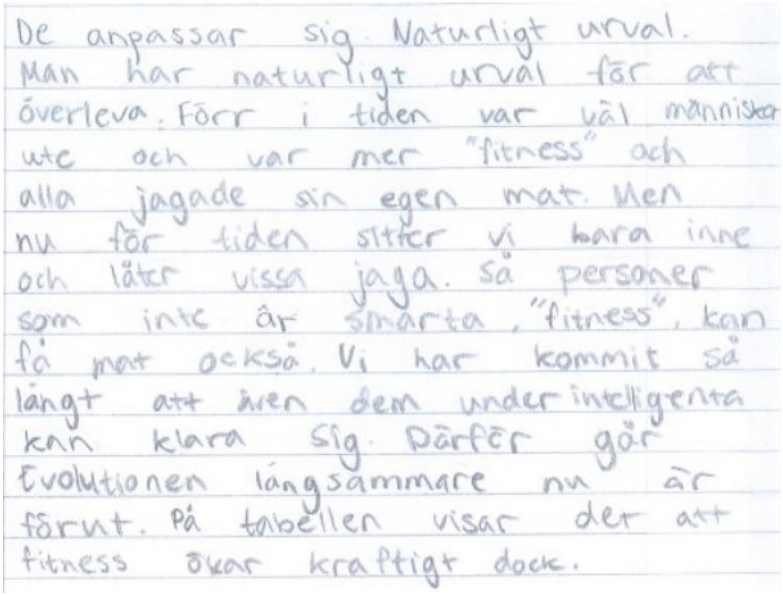
Generation No.	2	Alleles				
Gene No.		note legorg's fitness in column of the animal's allele (color)				
Legorg No.	fitness	Yellow	Red	Black	Blue	White
1		0	1	2	1	1
2		0	1	2	1	1
3		1	0	0	1	3
4		1	1	2	0	1
5		1	1	1	2	0

Figure 2: Example of student performance (Gene pool table).



The most stable is: base, yellow + 5 black
Most unstable: base, yellow + 5 red
Red gives negative features
5 red + yellow base
Yellow + 5 black

Figure 3: Example of student performance (conclusions from investigation).



They adapt. Natural selection. You have natural selection to survive. Long ago man was out hunting and I guess more "fit" and everyone hunted their own food. But nowadays we only sit inside and let a few hunt. So people that are not all that "fit" can still get food. Even those who are less fit will survive. Therefore, evolution has slowed down. In the table, however, the fitness increases fast.

Figure 4: Example of student performance (conclusion from simulation of fitness).

(v) Use of assessment data

Students were given informal feedback while performing the activity and through whole-class class discussion after the activity. Assessment data was not used for summative purposes. As a stand-alone activity, the teachers did not use assessment data for their own planning or evaluations.

(vi) Advice for teachers implementing the unit

Since the students had some difficulties with the concepts used in this activity, the main advice from the teachers would be to integrate the activity more closely into regular instruction about genetics and evolution. And to remember to buy some additional LEGO®!