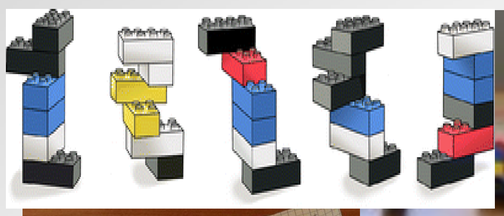
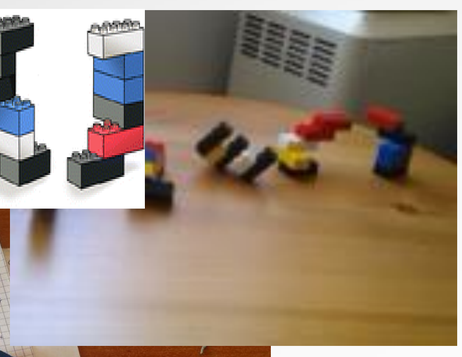
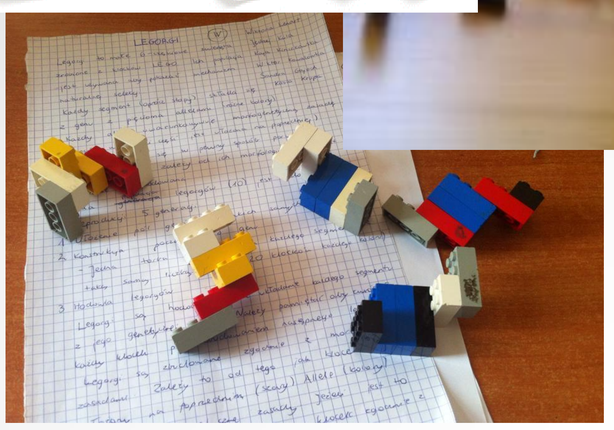
Pilot implementation of SAILS
POLAND

NATURAL SELECTION – USING LEGO CREATURES AT THE LOWER SECONDARY SCHOOL LEVEL.







Level of education/type of school: **lower secondary school**

Students' age: **15 y.o.** Size of the class: **29 students**

Teacher's experience in IBSE: **rarely uses IBSE**

Students' experience in IBSE: **first implementation**

Assessed skills:

a) planning
b) carrying out the experiment
c) analysis of data and presentation of results
d) drawing conclusions

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Assessment criteria and information on how the skills were assessed:

SKILL a) – PLANNING.

- Adapting the method of the natural selection modelling using legorgs.

Tool: Three-level rubric

2 points level	4 points level	6 points level
Student can present the consecutive steps of the natural selection simulation, but without details	Student can create an action plan of the natural selection simulation with legorgs, with a little advice from the teacher	Student can him/herself elaborate an instruction for the experiment based on the English language instruction films, with a proper detailedness of the consecutive phases description.

SKILL b) – CARRYING OUT THE EXPERIMENT

- Adequate data collection, precise setting them together and analysis.
- Use of numerical and statistical methods to obtain well-documented results.

Tool: Students' skills assessment form

Level	Skills
1 (2 pts.)	Group performs measurements, but not always consistently
2 (4 pts.)	Group performs measurements using the same methods sensibly and consistently throughout the experiment.
3 (6 pts.)	Group performs measurements consistently throughout the experiment and can discuss the degree of their reliability and precision.

SKILL c) – ANALYSIS OF DATA AND PRESENTATION OF RESULTS

Tool: Observation sheet

Students' actions	yes	no	points
1. Students discuss the experimental layout and data collection method.	X		1
2. The leader forces his/her solutions up on other group members.		X	1
3. Students collect data systematically.	X		1
4. The 1st generation table (illustrating legorgs gene configuration and their fitness) is laid out properly.	X		1
5. Students fill in adequately the data into the 1st generation table.	X		2
6. The 1st generation 1st gene pool table is laid out properly.	X		1
7. Students fill in adequately the data into the 1st generation 1st gene pool table.	X		2
8. The 1st generation 2nd to 5th gene pool tables are laid out properly.	X		2
9. Students fill in adequately the data into the 1st generation 2nd to 5th gene pool tables.	X		2
10.* Students collect and analyse data for following generations analogically to the 1st one.	X		*
11. A graphical representation of results is created.	X		2

* up to 5 bonus points to be earned for active students for this task.

Total: 15 pts

SKILL d) – DRAWING CONCLUSIONS

Based on the experiment carried out, the students should conclude, that directional (various types of selection) and random (as genetic drift) processes acting on casual phenotypic variability (conditioned by the genetic one) result in changes in allele frequency in populations, and thus in microevolutional changes.

For the correctly formulated conclusion, considering dependence between natural selection and genetic drift in the course of the evolution: 3 points.
or
For the conclusion either considering (i) only the random processes (genetic drift) or (ii) only the natural selection or (iii) identifying the results obtained with real evolutionary processes – 1 point per feature.

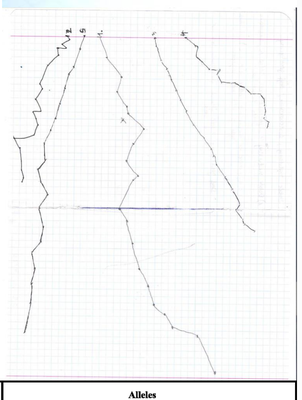
Results

Assessed were groups of students (4 to 6 pupils).

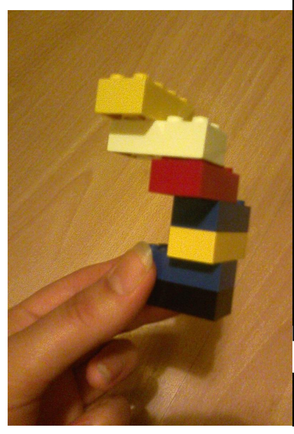
Maximal no. of points to be earned in total: 30
Mark levels: 0 - 8 (unsatisfactory/bad), 9 - 14 (mediocre), 15 - 22 (satisfactory), 23 - 26 (good), 27 - 30 (very good)*

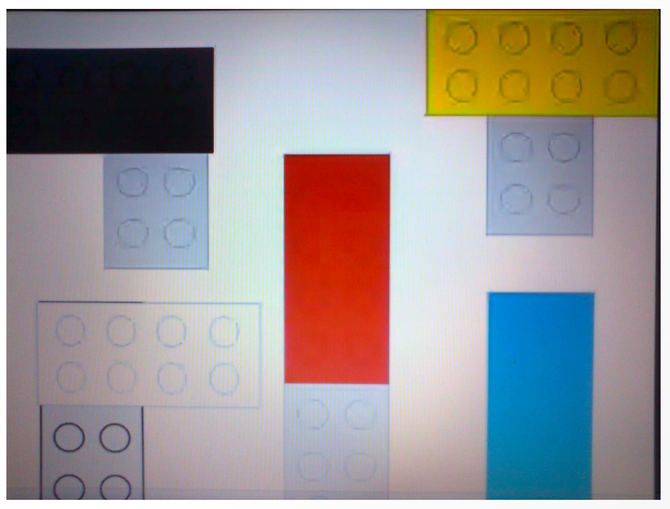
Marks obtained in the skill	a)	b)	c)	d)
very good	11	0	2	0
good	0	11	4	0
satisfactory	0	0	4	1
mediocre	0	0	1	1
bad	0	0	0	9
Mean (mark)	**5.0 (very good)**	**4.0 (good)**	**3.6 (satis-factory)**	**1.3 (bad)**

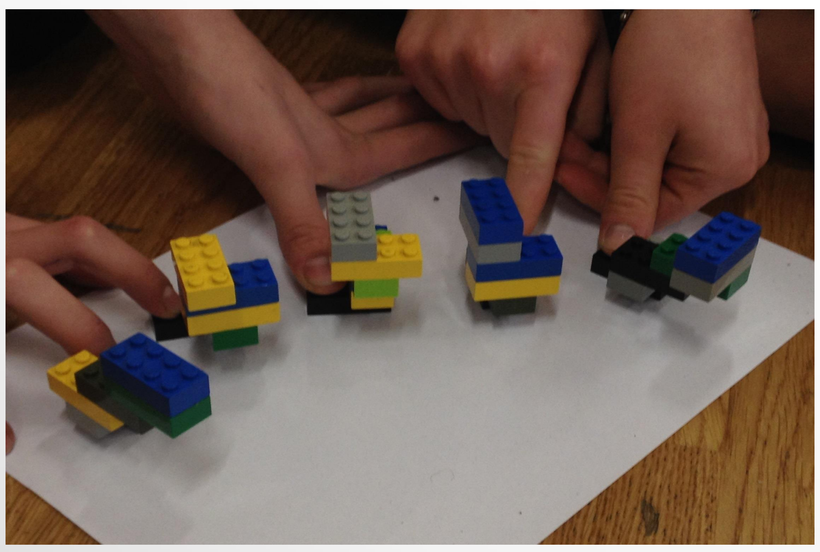
* Polish six-mark system was adapted (in ascending order): 1 ("niedostateczny" = unsatisfactory/bad), 2 ("dopuszczający" = mediocre), 3 ("dostateczny" = satisfactory), 4 ("dobry" = good), 5 ("bardzo dobry" = very good), 6 ("celujący" = excellent, not used in this case).



Generation No.	1	Alleles				
Gene No.	1	note legorg's fitness in column of the animal's allele (color) for this gene				
Animal No.	fitness	Yellow	Red	Black	Blue	White
1	2				2	
2	0		0			
3	1				1	
4	1		1			
5	1					1
6	1			1		
7	1	1				
8	1	1				
9	2					2
10	0	0				
11	1					1
12	1				1	
13	0			0		
14	0	0				
15	2				2	
16	2					2
17	0					0
18	0			0		
19	0	0				
20	0					0
	Σ fitness 16	Σ yellow weight 2	Σ red weight 1	Σ black weight 1	Σ blue weight 6	Σ white weight 6
Relative fitness (rounded)		Σ yellow weight / Σ fitness * 100 = 13	Σ red weight / Σ fitness * 100 = 6	Σ black weight / Σ fitness * 100 = 6	Σ blue weight / Σ fitness * 100 = 38	Σ white weight / Σ fitness * 100 = 38







Comments:

1. Physical simulation of the adaptation as a result of the natural selection, based on legorg 'evolution' is a very attractive experience, but not adjusted to the Polish school conditions.
2. Several lesson units must be devoted to carry out the task, so it seems it is most reasonable to be realized during a block of lessons, facultative workshops, outgoing scientific sessions, scientific camps. Week-long breaks (imposed by the school timetable) between the successive meetings to continue the experiments begun, put the students out of the rhythm, deconcentrate, make the task boring and generally are disadvantageous in terms of the problem solution.
3. The unit is not easily realized in lower secondary school (gymnasium), due to not as rich conceptual apparatus and mathematic skills of the pupils as in higher secondary ones (lycees). This results for the students in lower chances to draw correct conclusions from the experiment.
4. The experiment at its beginning meets considerable attention of the students, but as the time goes, only a few most success-oriented persons are engaged while their colleagues start to build other constructions of Lego® blocks. Tiresome mathematical calculations add up to this effect.
5. It seems, that it is reasonable to introduce the experiment on the 3rd level of education (higher secondary school), to interest the students, but the complete, complex version of the task will not be feasible given the current Polish school reality.

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