Malthus for kids: The impact of exploring Malthus’ principle on elementary school students’ understanding of evolution by natural selection

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Abstract

While several researchers have suggested that evolution should be explored from the initial years of schooling, little information is available on effective resources to enhance elementary school students’ level of understanding of evolution by natural selection (LUENS). For the present study, we designed, implemented and evaluated an educational activity planned for fourth graders to explore concepts and conceptual fields that were historically important for the discovery of natural selection. Observation field notes and students’ productions were used to analyse how the students explored the proposed activity. Additionally, an evaluation framework consisting of a test, the evaluation criteria and the scoring process was applied in two fourth-grade classes to estimate elementary school students’ LUENS before and after engaging in the activity. Our results suggest that our activity allowed students to effectively link all of the key concepts in the classroom and produced a significant increase in their LUENS. These results indicate that our activity had a positive impact on students’ understanding of natural selection. They also reveal that additional activities and minor fine-tuning of the present activity are required to further support students’ learning about the concept of differential reproduction. We also observed a low level of teleological predictions for both pre- and post-tests.

Hosted file

Develop math skills: estimation & graphical representation

Produced natural selection-based explanations

Grasp key concepts for natural selection (selective pressure, differential survival, differential reproduction, differential fitness, frequency changes in the population) and natural selection itself

Foster scientific practices & skills

TO BE MEASURED THROUGH:
Evaluation framework

• Design, application & assessment of strategies & models
• Students’ engagement in data-supported discussion (large & small group)
• Mathematical modelling & establishment of a correlation between key concepts

EXPECTED OUTCOMES

TO BE CAPTURED BY:
Participant observation
Participant artifacts

TASK STRUCTURE
Transdisciplinary problem-based learning activity:
• Collaborative inquiry on size
• Collaborative inquiry on population growth with and without selective pressure

TOOLS & MATERIALS
• 2 populations of spider mites (model organism) specialized in distinct food resources: lemon vs. bean leaves
• Math models & graphs
• Magnifiers

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PARTICIPANT STRUCTURE
• Students: propose & decide
• Teacher/researcher: moderate & facilitate

DISCURSIVE PRACTICES
• Large group & small group discussion

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HIGH LEVEL CONJECTURE
Learning about Malthus principle through a transdisciplinary problem-based learning approach that includes intra-specific diversity in heritable characters may facilitate linking relevant key concepts required to understand natural selection, fostering elementary school students’ learning

BASED ON:
• History of Science proved helpful
• Malthus principle key for Darwin & Wallace
• PBL proved effective for significant Science learning
b) This mite is in a sleeping blanket

c) The mite measures 0.8mm

d) 

e) Line = 1cm

1 cm in the petri dish = 45 cm in the whiteboard

45x magnification

4 cm in the whiteboard = in reality

The mite measures 0.8mm
b)

Beans' variety

Lemons' variety

Mites reproduction

45 days
30 days
15 days

Beans' variety mites

Lemons' variety mites

Mites reproduction

45 days — 30 days — 15 days

Mites reproduction

Beans' variety

Lemons' variety
a) Bean

\[
35,000 \times \frac{1}{100} = 350 m^2
\]

\[
0.8 \times 2.50000 = 20,000 \text{ mm} = 2000 \text{ cm}
\]

\[
\frac{25000}{2000} = 12.5
\]

Lemon

\[
0.8 \times 2.50000 = 20,000 \text{ mm} = 2000 \text{ cm}
\]

\[
\frac{25000}{2000} = 12.5
\]

b) Each leaf – 100 mites

Bean plant – 10 leaves

Lemon plant – 100 leaves

Each leaf – 100 mites

\[
10 \times 100 \times 1000 = 10,000,000 \text{ mites}
\]

Lemon plant – 100 leaves

Once leaf – 100 mites

\[
100 \times 100 = 10,000 \text{ leaves}
\]

c) 15 days

Bean

\[
\frac{5000}{100} \times 15 = 7500
\]

Lemon

\[
\frac{5000}{100} \times 15 = 7500
\]
Students's average level of evolution understanding per class in pre- and post-tests

**SAT class**

**SBT class**

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<tr>
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<th>Pre-test</th>
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Frequency of students assigned to each coding rubric in both classes at pre and post-tests

- fit test
- equilibrium
- flux
- resource
- differentials
- self-reproduction
- teleological
- developmental

**SAT pre**

**SAT post**

**SBT pre**

**SBT post**