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.

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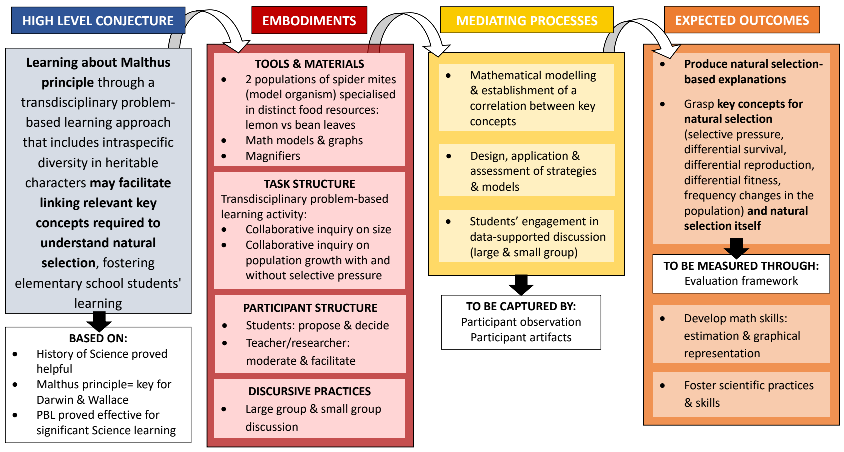
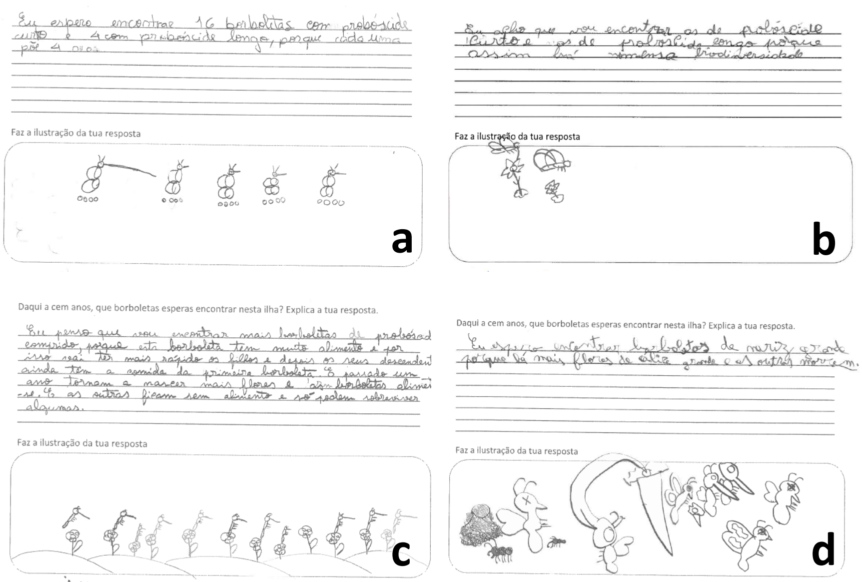
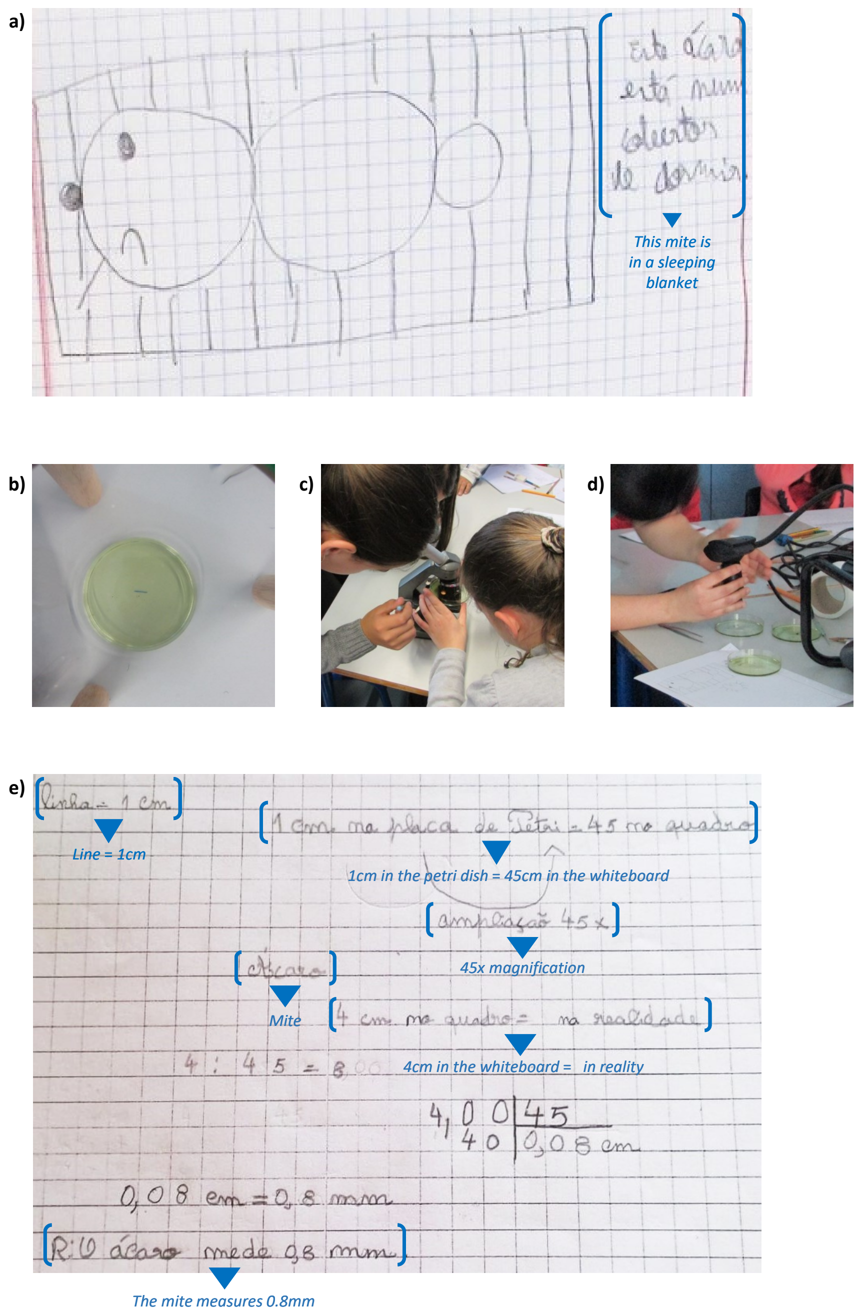
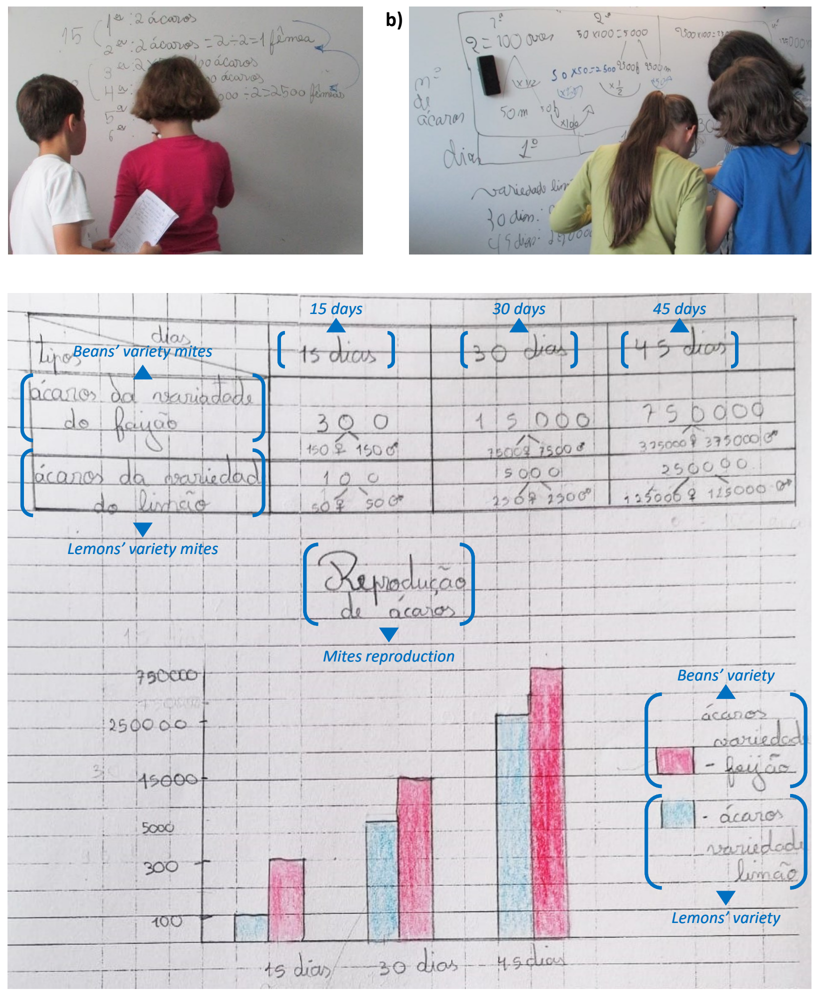

HIGH LEVEL CONJECTURE
Learning about Malthus principle through a transdisciplinary problem-based learning approach that includes intraspecific diversity in heritable characters may facilitate linking relevant key concepts required to understand natural selection, fostering elementary school students' learning
BASED ON:
History of Science proved helpful
Malthus principle= key for Darwin & Wallace
PBL proved effective for significant Science learning
EMBODIMENTS
TOOLS & MATERIALS
2 populations of spider mites (model organism) specialised in distinct food resources: lemon vs bean leaves
Math models & graphs
Magnifiers
TASK STRUCTURE
Transdisciplinary problem-based learning activity:
Collaborative inquiry on size
Collaborative inquiry on population growth with and without selective pressure
PARTICIPANT STRUCTURE
Students: propose & decide
Teacher/researcher: moderate & facilitate
DISCURSIVE PRACTICES
Large group & small group discussion
MEDIATING PROCESSES
Mathematical modelling & establishment of a correlation between key concepts
Design, application & assessment of strategies & models
Students' engagement in data-supported discussion (large & small group)
TO BE CAPTURED BY:
Participant observation
Participant artifacts
EXPECTED OUTCOMES
Produce 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
TO BE MEASURED THROUGH:
Evaluation framework
Develop math skills: estimation & graphical representation
Foster scientific practices & skills


Faz a ilustração da tua resposta
a
Faz a ilustração da tua resposta
b
Daqui a cem anos, que borboletas esperas encontrar nesta ilha? Explica a tua resposta.
Faz a ilustração da tua resposta
c
Daqui a cem anos, que borboletas esperas encontrar nesta ilha? Explica a tua resposta.
Faz a ilustração da tua resposta
d

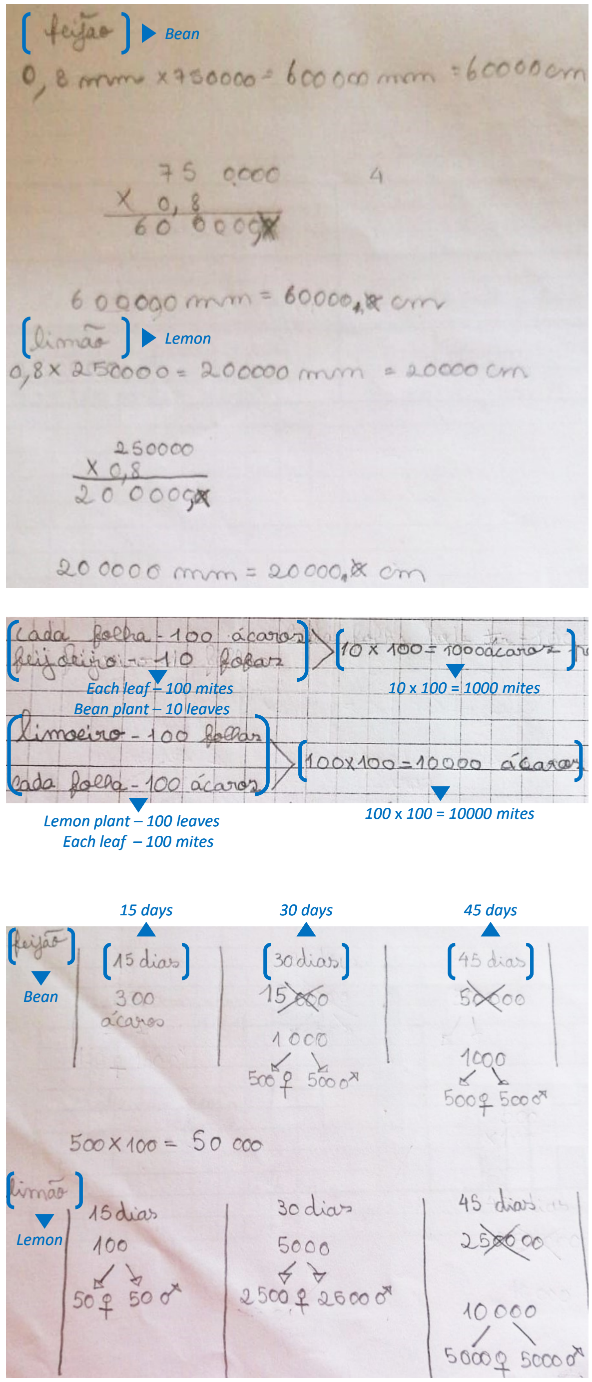

a)
This mite is in a sleeping blanket
b)
c)
d)
e)
Line = 1cm
1cm in the petri dish = 45cm in the whiteboard
45x magnification
Mite
4cm in the whiteboard = in reality
0,08 cm = 0,8 mm
The mite measures 0.8mm

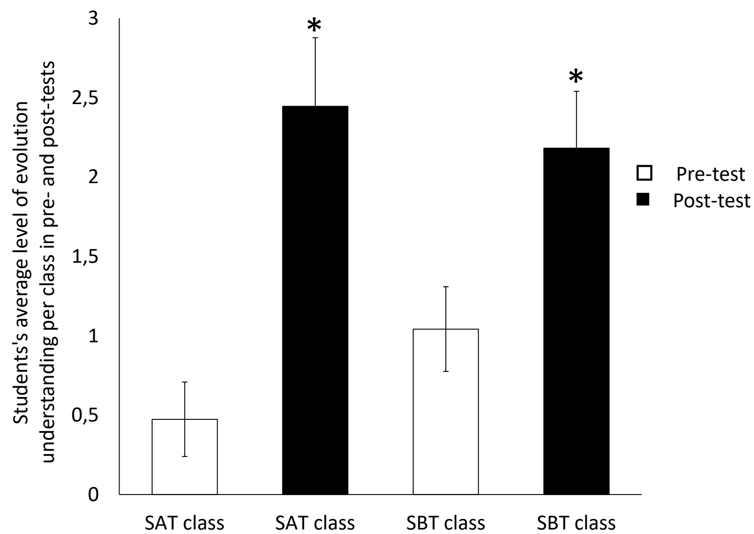

a)
b)
c)
15 days
30 days
45 days
Beans' variety mites
Lemons' variety mites
Mites reproduction
Beans' variety
Lemons' variety
15 dias
30 dias
45 dias
ácaros da variedade do feijão
ácaros da variedade do limão
Reprodução de ácaros

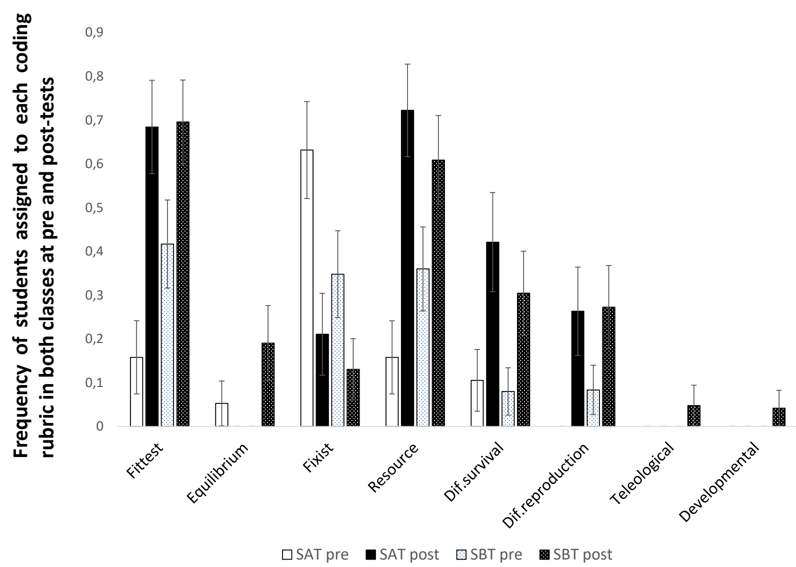
a)

b)

c)


feijão
Bean
0,8 mm x 750000 = 600000 mm = 60000 cm
600000 mm = 60000 cm
limão
Lemon
0,8 x 250000 = 200000 mm = 20000 cm
200000 mm = 20000 cm
cada folha - 100 ácaros
feijoeiro - 10 folhas
Each leaf – 100 mites
Bean plant – 10 leaves
10 x 100 = 1000 ácaros
10 x 100 = 1000 mites
limoeiro - 100 folhas
cada folha - 100 ácaros
Lemon plant – 100 leaves
Each leaf – 100 mites
100x100 = 10000 ácaros
100 x 100 = 10000 mites
15 days
30 days
45 days
15 dias
30 dias
45 dias
300 ácaros
1000
500 ♀ 500 ♂
500 x 100 = 50 000
100
50 ♀ 50 ♂
5000
2500 ♀ 2500 ♂
10 000
5000 ♀ 5000 ♂


Students's average level of evolution understanding per class in pre- and post-tests
3
2,5
2
1,5
1
0,5
0
*
*
SAT class
SAT class
SBT class
SBT class
Pre-test
Post-test


Frequency of students assigned to each coding rubric in both classes at pre and post-tests
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
Fittest
Equilibrium
Fixist
Resource
Dif.survival
Dif.reproduction
Teleological
Developmental
SAT pre
SAT post
SBT pre
SBT post