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Why are Soils Different? an IBSE Approach

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Abstract
This didactic project, is focused on topics dealing with the soil formation, directed to students in the age range 10-14 years in the Italian school. The lab addresses the topic by proposing a multidisciplinary activity, connecting natural sciences, geography and technical education. The activity carried out using the IBSE approach, stimulates the formulation of questions and actions to solve problems and understand phenomena.

1. Introduction
During the International Year of the Soil [1], the University of Camerino started a project carried out by science teachers now PhD students in “Teaching Earth Science”, in collaboration with some local schools in the Marche Region (Italy).
Why choosing the soil? Because the topic is part of the science program of the Italian school although it is not always addressed in detail. Therefore, the idea was to create teaching material "ready to use" to facilitate the teaching of those teachers not specialized in earth sciences. This topic is also multidisciplinary, it allows connections with biology (investigating soil fauna or the plants growing on different agricultural soils), connections with chemistry (parsing the pH of soil samples) with environmental education (when approaching the concept of soil as a limited resource.)
Moreover the IBSE approach contributes to stimulate active learning, to promote collaboration among students and to enhance students’ motivation, increasing knowledge and competences even for the students with learning difficulties or less prone to attention and study dedication. However, in spite of established validity and wide spread use, in Italy and in the schools of the Marche regions IBSE is still scarcely. [2].

2. Description
The activity is a lab on soil formation using the IBSE approach.
The laboratory is based on BSCS 5E Instructional Model (Bybee, 1997) and is a structured IBSE [3], where the teacher gives the question to be investigated and the clues to solve the question.
The activity aims to study interactions between different pedogenesis parameters like the climate and the parent rock.
The experimentation is preceded by the administration of a pretest on soil formation.
The students have to inquire to the *IBSE question: "why are soils different"?* They carry out their through the analysis of totemic objects and through paper- based information's.
The aims of carrying out the lab are:
- to understand which and how many variables influence the formation of soils.
- to know the various soil's layers and the chemical elements and compounds responsible of the different soils colors.
- to work in group and cooperate for a common solution.

2.2 Materials
The totems are made of polystyrene, covered with cement and acrylic painting. (*h 30cm, l 10cm, L15 cm)*. They represent the progressive soil formation. Twenty totems, divided in five groups each of four totems. The first totem of each group, shows the parent rock not altered. (Fig.1a) Then the second totem shows the upper part of the rock is fractured and the formation of clay minerals start.((Fig.1b). The third totem shows the increase in soil formation and the presence of the first pioneer plants. (Fig.1c). The forth totem finally shows an evolved soil and the presence, eventually, of well differentiated horizons. (Fig.1d).

(Fig.1)

In particular, fig. 2 shows a calcareous parent rock, with a clay-rich humus-poor soil, typical of Italian countryside. Fig.3 shows a calcareous sand stone parent rock, with a red soil typical of the mediterranean climate. Fig.4 represents the basaltic rock forming a soil rich in clay and humus, typical of volcanic areas. Fig.5 the totems representing a basaltic parent rock and a lateritic soil typical of tropical and sub-tropical humid climates. Fig 6 shows a calcareous parent rock with well differentiated soil horizons, typical of temperate-humid continental climates. [4].


(Fig 2)

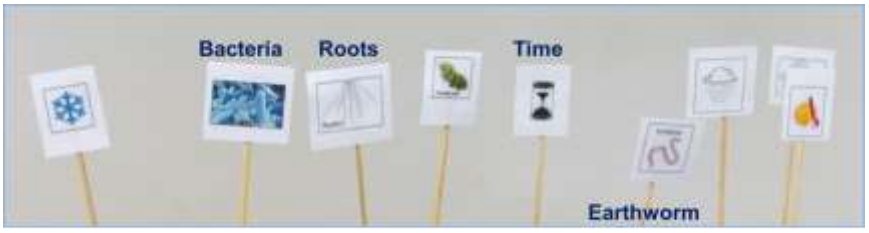

(Fig 3)


(Fig 4)


(Fig 5)


(Fig 6)

The students are also provided of symbols representing weathering and living components. They are located on a stick, to be inserted in the totems during the activity (fig.7).
Some paper documents accompany the lab materials, providing information about: the various types of soil, a reminder to the rock classification and in particular to the description of basalts, limestone, sandstones and clays, the description of soil layers with images, some info on pedogenesis.

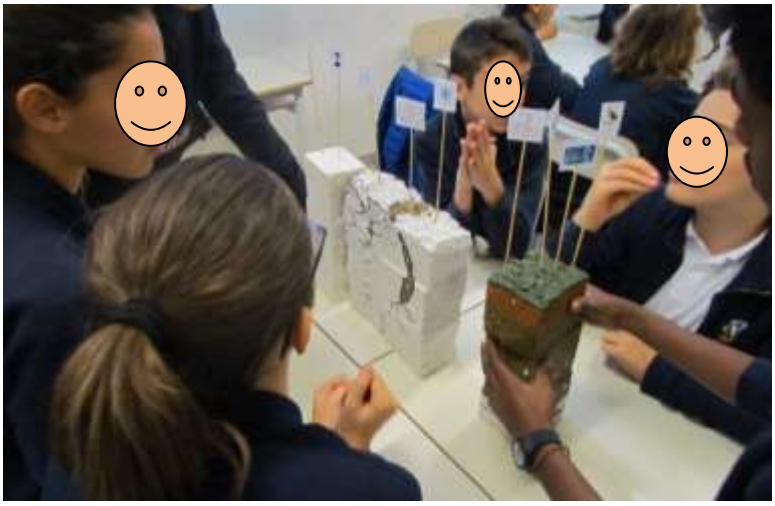


(Fig.7)

2.3 Experimentation

The activity was tested on several classes with a class used as a control, where the same topic was proposed using a video and a power point.
The students were divided into five groups to cooperate in the IBSE question inquiry. The groups are heterogeneous in composition.
The totems were provided to the groups randomly.

All the IBSE activity is carried out by the teacher/PhD whereas the class teacher has the role of observer, evaluating the activity of the different working groups and, only at the end, evaluates the knowledge acquired.
The five working group, each one with a set of totems, have a fixed time to carry out the tasks.
First IBSE phase (*Engage)* 10 min. The pupils, in each groups, observe the totems and discuss the order to give to the four totem provided. They discuss about the meaning of the colors and the drawings in the totems, to find a connection between the four of them (Fig.8)


(Fig.8)

Second and third IBSE phase (*Explore - Explain)* 40 min. During the first 20 min the students read the information on the document provided by the PhD-teacher, to answer the IBSE question "why are soils different"? (Fig.9). In the following 20 minutes min, they observe again their totems and they are asked to fill up an observation worksheet, describing the type of parent rock and the type of soil following their colors. Then they explain what each totem represents and finally they describe what the 4totems, in the sequence represent.


(Fig.9)

Fourth IBSE phase (*Elaborate)* 10 min: Through observation of a general soil profile, students must identify which horizons are present in their totems and draw them. (Fig.10)

(Fig.10)

Fifth IBSE Phase (*Evaluate)* 10 min. After the investigation and the data collected, each group writes to the worksheet the indication of the type of climate in which the soil forms. A representative for each group shows to the class the results and explain which data and clues support the conclusion reached. A general discussion follows about the correctness of the results obtained.
Some days after the activity, a post-test is administered to verify the acquisition basic knowledge on soil formation and the ability to answer correctly to IBSE question, which was first given in the pre-test, then proposed in the lab activity and last repeated in the post-test.

3. Results

The results obtained from the satisfaction questionnaires show that the students were very involved in all activity phases and positively interacting between each other, even those more reluctant to study or to follow the lessons in school. In fact, the worksheets produced during the IBSE activity show attention to the reading of the document, in spite it was full of information and quite long for the allotted time given to students of this age range. This means that the students were interested and they were able to apply successfully the information they read to the interpretation of the totems. The worksheet were filled up accurately. The answers were mostly correct.
The evaluation of the post-test questionnaires suggests a persistency of the knowledge acquired, with 90% of the students showing the correct comprehension of the role of the different factors influencing the formation of different soils (parent rock, climate, living organisms). This is in spite of the fact that the lab activity implied previous knowledge (e.g. climate, rocks) to be integrated with more advanced concepts (the process of weathering for different rocks) and new concepts (formation of soils in different climatic conditions areas of the world).
During the final discussion the students pointed out the most important factor is the time, although this wasn't mentioned previously by the teacher. This is therefore an important extrapolation from the data, independently found by the students. They all indicated the parent rock as determinant to obtain soils of different colors

4. Conclusions

The IBSE activity on soil formation was very well received by the students (10-14 years old) and the teachers of the schools of the Marche Region (Italy) where the Soil Project of the University of Camerino is under experimentation. The teachers of the classes involved were asked to fill up a questionnaire and to answer some questions in informal interviews to give comments or hints about the activities. The data collected on the teachers reveal that they aren't prepared enough to approach the IBSE methods by themselves and to carry out their own activities, but that this experimentation and the availability of some ready-to-use materials will certainly help in encouraging them.
The teachers appreciated especially the cooperative learning and precise timing of the lab activity, because, acting as observers, they evaluated the behaviors of their students from the distance and noticed how precisely they responded to the rules of the activity and how well they carried out the different tasks to solve the IBSE question and how correctly they answered the questions.

Finally, “the soil”, was chosen as a topic because it is very interdisciplinary and suitable to be considered as a thread to connected other subjects, not only among the natural sciences, but also including geography and art, history and technology, and the new entry in the Middle school curriculum, the environmental education

5.References

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