

4.5 Case study 5 (CS5 Portugal)

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| Concept focus | Investigating the living conditions of snails, woodlice and a fungus |
| Inquiry skills | Developing hypotheses Working collaboratively (teamwork) |
| Scientific reasoning and literacy | Not assessed |
| Assessment methods | Classroom dialogue Teacher observation Self-assessment Worksheets |
| Student group | Grade: 8 th grade (lower second level); two classes Age: 13-14 years Group composition: co-ed, mixed gender groups; 24 and 25 students per class Prior experience with inquiry: None |

In this case study, students investigated the living conditions of snails, woodlice and a fungus – bread mould – over three lesson periods. Students developed hypotheses by discussing their ideas, and then planned investigations and tested their hypotheses. In the final lesson students completed their worksheets and performed self-assessment on their skill in *working collaboratively*. A further focus for assessment was on *developing hypotheses*. The teacher observed students throughout the activity, gave constant feedback, and assessed the final products.

(i) How was the learning sequence adapted?

A theoretical framework was carried out with the help of pictures/images of abiotic factors of terrestrial ecosystems and their relationship with the biotic component. This session was very interactive, with guiding questions and took 50 minutes. Significant changes in the proposed activity have not been made, however we used snails, the woodlice and a fungus (bread mould). The living conditions of these three elements were investigated.

To formulate a testable hypothesis the students were given three sub-questions to help them with their investigation and to help them to formulate hypothesis:

1. Question to be answered:
2. What do you think will happen?
3. Why do you think this will happen?

Students from two different classes worked in groups, with groups of 3-4 students in one of the classes and groups of 4-5 students in the other class. The teacher defined the groups according to the alphabetical order of students' names.

Three sessions were used with 50 minutes each. One lesson focused on engaging with the task, one lesson was dedicated to *developing hypotheses*, *planning investigations*, discussing ideas and testing hypotheses and the final lesson was used to finish the worksheet and perform self-assessment.

(ii) Which skills were to be assessed?

Skills to be assessed were *working collaboratively* (teamwork) and *developing hypotheses*. A teacher assessment guide was prepared for assessment of these inquiry skills, identifying the target themes and associated indicators for these skills (Table 1). The teacher gave constant feedback (formative assessment) throughout the activity development, and assessed the final products.

(iii) Criteria for judging assessment data

The teacher expected the students to stay curious about the methodology and be simultaneously apprehensive. The assessment was particularly formative, showing which concepts/terms/processes were more or less understood, and the students attitude towards new situations as well the skills to perform in a group. Students were more curious about the inquiry methodology. They accepted the assessment, but not everyone understood that formative assessment it is a mean to achieve learning.

Table 1: Teacher's assessment guide

| Dimensions | Themes | Indicators |
|--|--|---|
| Researching conjectures/ Developing hypotheses (Analysis of the product considering these two parameters together with written feedback given to students) | Substantive knowledge | Shows scientific knowledge about the subject |
| | | Appropriate scientific language to ... |
| | Reasoning | Shows cognitive skills that allow the analysis of information |
| | | Relates different information, knowing how to retrieve and work with that information |
| Performance in a team (interpersonal skills observed and recorded in the observation grid) | Empathic listening | Does not interrupt when others speak |
| | | Seeks to understand others points of view |
| | Assertiveness (exhibits and keeps his point of view) | Defends his point of view |
| | | Talks with kindness |
| | Interpersonal support | Helps the colleagues with difficulties |
| | | Gives positive feedback to colleagues |
| | | Encourages the colleagues that are less interventional |
| | Conflicts management | Uses strategies to solve negative conflicts |
| | | Tries to include the colleagues' points of view in a coherent whole |
| Tries to listen to all points of view | | |
| Teamwork performance | Teamwork structure | Defines the work's objectives |
| | | Distributes tasks among all group members |
| | Teamwork dynamics | Tracks the development of the group work |
| | | Considers and tracks the time |

Within the context of formative assessment, we propose four-level assessment criteria, organised into four positive description levels (emerging, developing, consolidating and extending), as shown in the rubric in Table 2. The teacher will not be able to assess all students groups simultaneously; instead teamwork can be assessed at several points throughout the school year. We suggest that the teacher should focus on one working group per lesson.

Developing hypotheses

Students should develop a hypothesis, which includes a justification for that hypothesis and provides a link to the research question. When assessing this skill, the teacher needs to identify the level of scientific knowledge, cognitive skills and evaluate the student's ability to use scientific language.

Table 2: Assessment criteria for CS5

| Skill | Emerging | Developing | Consolidating | Extending |
|---|--|--|--|--|
| 1. Working collaboratively (teamwork, interpersonal relationships and group functioning; emotional literacy) | Observes and accepts the colleagues' proposals in the group work, but gives no suggestions; merely accepts what the colleagues are doing (due to difficulties in interpersonal relationships). | Participates in the group work, but only makes one or two suggestions that add little value to what was already done (due to difficulties in interpersonal relationships). | Participates in the group work and gives positive suggestions contributing to a productive group dynamic. | Participates in the group work and significantly contributes to a productive group dynamic, creating positive personal interactions (allowing the improvement of others and raising the work level). |
| 2. Formulating a hypothesis | Formulates hypotheses that are not consistent with the planning or that are not eligible for investigation. | Formulates hypotheses that are consistent with the planning of the experiment. | Formulates hypotheses that are consistent with the planned experiment and are based on the research questions. | Formulates hypotheses that are consistent with the planned experiment. Those hypotheses are based on the research questions and identified variables. |

Working collaboratively

Students should be able to work with diverse teams. They should produce ideas based on views from all team members. They should take into account and deal with disagreements. They need to manage time and workload and agree procedures. When assessing this skill, the teacher needs to decide if students involved in teamwork show interpersonal skills (which allow them to properly work in group with other colleagues) and teamwork skills (regarding the way they structure the group work and the dynamics they create within the group), as outlined in the teacher's assessment guide (Table 1). This skill can be assessed through teacher observation, using a registration grid, in which the teacher notes the number of times that certain behaviour is observed. At the end of the activity, an optional questionnaire was filled in by individuals from the team (Figure 1). Analysis of the self-assessment questionnaire revealed that most of the students said all they wanted to say; they knew how to listen to others' opinions and felt understood by their colleagues. (Table 3).

At the end of the activity, an optional questionnaire was filled in by individuals from the team (Figure 1). Analysis of the self-assessment questionnaire revealed that most of the students said all they wanted to say; they knew how to listen to others' opinions and felt understood by their colleagues.

Table 3: Registration grid for assessment of working collaboratively

| Behaviour | Student x | Student y | ... |
|---|-----------|-----------|-----|
| Does not interrupt when others speak | | | |
| Questions the colleague regarding what he is saying | | | |
| Defends his points of view | | | |
| Talks with kindness | | | |
| Challenges a more quiet colleague to speak | | | |
| Congratulates the colleagues when they present a positive idea | | | |
| Assumes an active role in order to solve conflicts between colleagues | | | |
| Defines/clarifies the work's objectives | | | |
| Defines/distributes/negotiates tasks among colleagues | | | |
| Draws attention to time | | | |
| Faced with distractions draws the group's attention to the work | | | |

Name: _____ Class: _____ Date: _____

1. Did you say what you wanted to say? (E.g. All of the time... Most... Some... Hardly at all...)

2. Did anything stop you saying what you wanted to?

3. Do you think the others understood what you said to them?

4. How do you know if they understood you or not?

7. Did you argue?

8. How did you settle any argument?

5. After talking, did you change any of your views?

6. How did you feel towards other members of the group who held very different views to you?

| | |
|----------------------|---|
| 9. Order of speaking | 10. Order of listening and took notice of other's views |
| Spoke the most | Listened the most |
| | |
| Spoke the least | Listened the least |

Brian Matthews (2006) Engaging Education, Open University Press, London, England

Figure 1: Instrument for students' self-assessment of working collaboratively

(iv) Evidence collected

Teacher opinion

During the activity implementation the students showed uncertainty and requested the teachers' presence to help them answering the questions and to confirm that the answers they intended to give were correct. The teacher believes that the students appear to be unfamiliar with formative assessment. The teacher considers that the students' answers are in accordance with that observed

in the classroom. The students' difficulty was in transferring the group's ideas to the paper (i.e. to write in the worksheet their answers).

Students felt that they were directing the investigation by themselves, by formulating the hypothesis and discussing what made more sense to them. They were also disoriented and nervous. It was noted that they were not sure what they were doing. It looked that they were not used to conducting inquiry activities. The teacher noticed that some students wanted to know what others were doing. The students were mostly wondering if what they were doing or writing was correct. They were afraid to take risks and were more concerned with products than with the procedure(s).

Few students realized that during the teamwork discussion and testing in practice the hypothesis, they were building evident learning and developing communication skills, among others.

Student artefacts

Group A: Research about the fungus living conditions

Group A investigated the living conditions of a fungus (Figure 2). Most of the questions shown in Figure 3 are relevant. In question 2, using the word "create" the students show difficulties expressing what they intended to say. The explanation for the more frequent reason for appearance in locations with humidity is very narrow, with no scientific consistency (Figure 4). Students are unable to correlate the presence of abiotic factor (water-wet) with its biological need to grow from spores (scientific knowledge) that are invisible to the naked eye, but only perceived when the mould appears. It seems that it is through "spontaneous generation!"



Figure 2: Students investigating fungus living conditions

Formulação de hipóteses:

Agora que já decidiu que variável irá investigar, utilize o espaço seguinte para explicitar a(s) questão(s) que pretende responder (ou o(s) problema(s) que tentará resolver).

Questões a responder:

1. Se existir Humidade existe mofo?
2. Será que se criam ^{do} com a existência de Humidade?
3. Será que o mofo pode desaparecer(?) Sem Humidade?
4. O que acontece ao adicionar água.

Formulating hypotheses:

Now that you have decided which variable you are going to investigate, in the space below write the question(s) that you intend to answer (or the problem(s) you intend to solve).

Questions to be answered:

1. *If there is humidity there is mould?*
2. *Does it create if there is humidity?*
3. *Does the mould disappear without humidity?*
4. *What happens when we add water?*

Figure 3: Developing a hypothesis about fungus living conditions

Previsões: utilize qualquer conhecimento científico prévio para responder às seguintes questões.
Tente ser o mais claro possível nas suas respostas.

O que acha que irá acontecer?

Com a humidade os fungos são mais frequentes, logo acho que ao adicionar-mos água os fungos irão ser mais.

Por que razão acha que isso irá acontecer?

Porque acho que é com a humidade que os fungos aparecem.

Predictions: Use any previous scientific knowledge to answer to the following questions.

Try to be as most clear as possible.

What do you think it will happen?

Fungus are more frequent to appear if there is humidity, therefore we think that if we add water there will be more fungus.


Why do you think that it will happen?

Because I believe that humidity is the cause for fungus to appear.

Figure 4: Forming coherent arguments about fungus living conditions

Group B: Research about the snail living conditions.

The “light” factor was also deployed in to the type of light (natural and artificial), which shows that students know that the “light” can be an inaccurate factor (Figure 5). However, in the explanation, they humanise the biological model behaviour and can’t answer the question scientifically (Figure 6).



Formulação de hipóteses:

Agora que já decidiu que variável irá investigar, utilize o espaço seguinte para explicitar a(s) questões(s) que pretende responder (ou o(s) problema(s) que tentará resolver).

Questões a responder:

*Saber quando o caracol se meximenta mais: com luz natural
com luz da lanterna
Sem luz*

Formulating hypotheses:

Now that you have decided which variable you are going to investigate, in the space below write the question(s) that you intend to answer (or the problem(s) you intend to solve).

Questions to be answered:

To know when will the snail be moving more frequently: with a natural source of light, with a lamplight or without light.

Figure 5: Developing a hypothesis about the snail living conditions

Predictions: Use any previous **scientific knowledge** to answer to the following questions. Try to be as most clear as possible.

What do you think it will happen?

We believe that the snail without a natural source of light will be moving more frequently than the snail with a natural source of light or a lamplight.

Why do you think that it will happen?

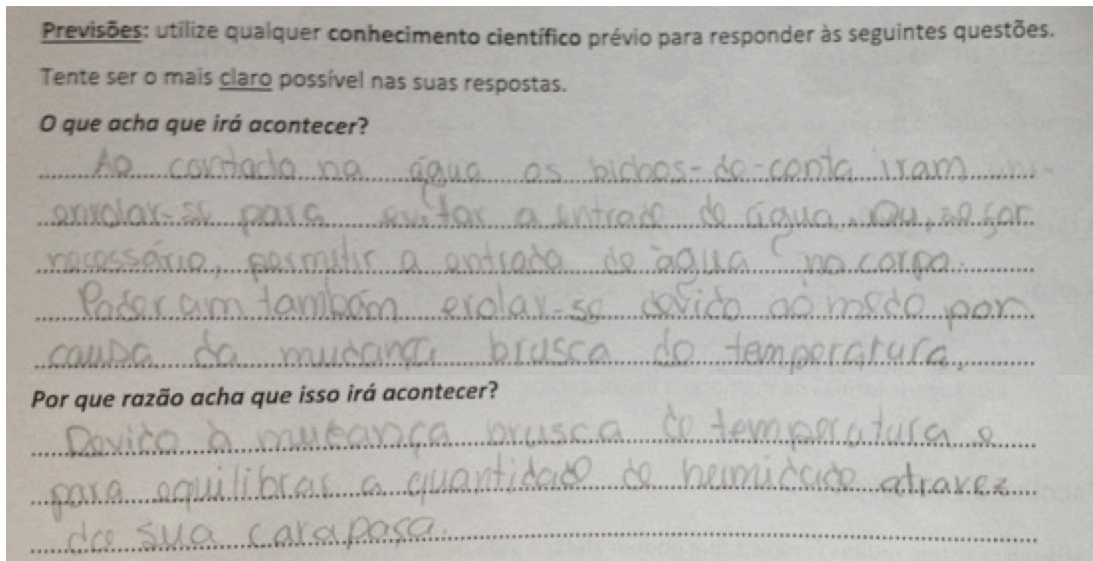
During the day they don't move, because they're afraid of predators (ex: birds, etc.) while during the night they feel safe to move because the predators are asleep, so they can look for food.

Figure 6: Forming coherent arguments about snail living conditions

Group C: Research about the woodlice living conditions.

The questions focus on only one variable (independent). The forecasts address one more variable (temperature), which was not placed on the research questions. It shows difficulty in understanding

that they cannot test two variables simultaneously and achieve reliability and consistently (



Predictions: Use any previous **scientific knowledge** to answer to the following questions.

Try to be as most clear as possible.

What do you think it will happen?

Woodlice will roll itself up into a ball when they touch the water so that they can avoid it. Or use it if it's necessary. They can also roll up due to the fear of a sudden change of temperature.

Why do you think that it will happen?

Due to the sudden change of temperature and to balance the amount of humidity that gets in through its outer shell.

Figure 8). Students also humanise the biological model when they write "out of fear". They cannot come to a conclusion.



Formulação de hipóteses:

Agora que já decidiu que variável irá investigar, utilize o espaço seguinte para explicitar a(s) questões(s) que pretende responder (ou o(s) problema(s) que tentará resolver).

Questões a responder:

Como é que reagem à água; Quantidade de água que se pode utilizar para não matar, ou que o ser vivo; Alterações do corpo ao entrar na água; Quantidade de água necessária à sobrevivência do bicho-de-conta.

Formulating hypotheses:

Now that you have decided which variable you are going to investigate, in the space below write the question(s) that you intend to answer (or the problem(s) you intend to solve).

Questions to be answered:

How do they react to water; Amount of water that we can use to avoid killing and/or prejudice the woodlice; Changes in woodlice body carried out; Amount of water so that woodlice can survive.

Figure 7: Developing hypotheses about woodlice living conditions

Previsões: utilize qualquer conhecimento científico prévio para responder às seguintes questões. Tente ser o mais claro possível nas suas respostas.

O que acha que irá acontecer?

Apresentando na água os bichos-de-conta irão enrolar-se para evitar a entrada de água ou, se for necessário, permitir a entrada de água no corpo. Poderão também enrolar-se devido ao medo por causa da mudança brusca de temperatura.

Por que razão acha que isso irá acontecer?

Devido à mudança brusca de temperatura e para equilibrar a quantidade de humidade através da sua carapaça.

Predictions: Use any previous scientific knowledge to answer to the following questions.

Try to be as most clear as possible.

What do you think it will happen?

Woodlice will roll itself up into a ball when they touch the water so that they can avoid it. Or use it if it's necessary. They can also roll up due to the fear of a sudden change of temperature.

Why do you think that it will happen?

Due to the sudden change of temperature and to balance the amount of humidity that gets in through its outer shell.

Figure 8: Forming coherent arguments about woodlice living conditions

(v) Use of assessment data

With each group, the teacher analysed the formulated questions, focusing on the most significant aspects and more "confused" for a given investigation. With the students help the teacher makes a systematization of work performed and requests students to reformulate and rewrite the questions and the scientific explanations to be presented to the whole class.

This methodology allows the teacher to rethink his own practice as an agent in the process of teaching and learning. The teacher consider that these lessons are more difficult to plan but more effective because allow the transposition of acquired knowledge to the daily experiences.

The assessment was based on students' attitudes when they were performing the practical activity and then in the written worksheet. The teacher consider that formative assessment is extremely important for her future action - What to do now? What to improve? How to do it? These activities enable students to successfully reach the summative assessment. They are not just activities to test knowledge. These are activities that enhance the construction and improvement of knowledge and attitudes.

(vi) Advice for teachers implementing the activities

In this activity teachers should:

- promote teamwork,
- give oral feedback to the working groups,
- allow students to share their achievements with the whole class.

Before implementing an activity, teachers should know and understand very well the inquiry structure and philosophy. In addition, they should determine in advance the goals that they want the students to achieve and should outline several types of objectives (with different levels of cognitive request).

It is very important for the teachers' observation to have checklists and other instruments, which will allow him to assess the students' behaviour and attitudes throughout the activity. The teacher must also list the kind of issues emerging in class, enabling reflection on the structure and coherence of the produced guiding document. The teacher will have to be very sure about what s/he wants students to achieve and this needs to be clear in the worksheet. Inquiry activities are also promoting cognitive and procedural concerns in teachers. These activities require persistence, time, motivation and self-knowledge of the teachers themselves.