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Coal and Teeth: Teacher Guide

Ontwikkeld voor scholen binnen Bètapartners

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Klas: 5 vwo
Vak: Scheikunde

1. Teacher Guide: Coal and Teeth

Teaching guide for six lessons. Study time for the students: 10 – 20 hrs

Below you find a time schedule for the inquiry project, 'Cola and Teeth'. The first three parts (1-3) are integrated in the chemistry lessons and the others (4-8) will be done outside the chemistry lessons. The students' first task is to become familiar with the inquiry. Therefore you will give a demonstration and the students will do a guide experiment. After this the students will analyse and judge the research done by Drabe, Niste & Li (2003). These three researchers investigated the neutralizing effect of saliva on carbonated drinks and its role in dental erosion. Some questions arise. How 'fair' and accurate is their research? Are their research results trustworthy? Are their conclusions valid? These are questions that the students will answer by critically analysing the article written by these three researchers. Doing this we expect the students – in a team of two – to perform a better inquiry. As a team they will write a first report on their inquiry. You need to publish the first reports on a website/*elo*. In this way the students can discuss their results with peers, giving and receiving suggestions. They have to use these suggestions to improve their report, when writing their final article. All articles will compete for a research award.

Schedule for the procedure of the 'Coal and Teeth' inquiry project (10-20 hours):

Procedure	**Part of the project**
Start with the task	*1. Understand aim and nature of the inquiry project* *2. Understand the research of Drabe, Niste & Li :* • Predict, observe, explain • Conduct guide experiment • Judge accuracy, reliability and validity
Conduct research	*3. Own inquiry in teams*
Write report	*4. Report*
Send first report	*5. Report* to: teacher All reports on a website/*elo*
Peer discussion	*6. Peer discussion* The peer discussion on: • Accuracy in the inquiry plan • Accuracy in performing the inquiry • Reliability of the results • Validity of the conclusions
Process comments	*7. Teamwork*: Processing the comments received, improve report
Send final article	*8. Report* to: teacher
Receive prize	All final articles on a website/*elo* Jury selects the best inquiry

Before the six lessons

1. An introduction in class of approximately 15 minutes, with:
   A. The aims of the inquiry task
   The students:
   - Gain knowledge on the effect of acids on calcium carbonate and hydroxyapatite
   - Gain knowledge on the effect of saliva on the pH
   - Judge accuracy, reliability and validity in a research
   - Design a 'fair' inquiry, measure accurately, determine whether measurements are reliable and lead to valid conclusions
   - Are part of a *simulated research community* and gain knowledge on peer review in an Internet symposium

   How to achieve these aims?
   1. Do the inquiry task guided by the questions in the workbook
   2. Predict, observe and explain in the demonstration: a raw egg in vinegar
   3. Conduct the guide experiment: cola and chicken bones
   4. Analyse/judge Drabe, Niste & Li's article: "Carbonated drinks and neutralizing saliva: dental erosion"
   5. Formulate own inquiry question and plan the experiments to answer this question
   6. Conduct planned experiments
   7. Write a report about this inquiry and submit the report
   8. Discuss results with peers in an Internet symposium
   9. Rewrite report into a final version or article
   10. Submit final article to an independent jury, e.g. other science colleagues or experts from outside; they select the best inquiry and award a prize

   B. The nature of the inquiry task
   - A scientific inquiry with measuring accurately

   Why is accurate and reliable research so important?
   - You want to acquire knowledge
   - An inquiry should be accurate, reliable and repeatable in order to convince other researchers of the (tentative) reliability of the results

   Why is the inquiry interesting?
   The students can, in teams:
   - Acquire chemical knowledge and knowledge about empirical evidence
   - Critically discuss empirical evidence in their peers' inquiry
   - Win a research award
   - Publish their results on the Internet/*elo* or in the school magazine

   What should be handed in for a mark?
   - The filled student workbook
   - The inquiry plan
   - The participation in the Internet discussion
   - The final article
2. Distribute the printed student materials (**workbook**) and the article of Drabe, Niste & Li (2003)
3. Focus the students' attention on the 'Study Guide' (**workbook p. 25**) and the planning of the project (**workbook p. 5**)
4. Ask the students to make teams of two or three

Lesson 1: Understand what Drabe, Niste & Li (2003) investigated

Introduction

1. Introduce the workbook and the 'Planning', see **Student workbook p. 5**.
   Introduce what the students have to do in the first lesson. Refer to the **workbook 'Study guide'**, **p. 25**.
2. Let the students read the introduction in the **workbook**, **p.3-4**.
   Refer to the list of concepts on **p. 24.** The students can fill out this list bit by bit as the project proceeds.

Demonstration: a raw egg in vinegar

3. Let the students individually predict and write down what will happen when a raw egg is put into vinegar. Ask them why they expect this to happen. Ask them to answer the questions in **2.1, p. 6**.
4. Discuss the predictions (what they expect) and explanations (why they expect this).
   Put the raw egg in the vinegar and ask the students to write down their observation.
   !! Let the students observe, draw conclusions and write their explanation and equation of the reaction after 72 hours!!

Homework

5. Ask the students to browse the Internet for information on the composition of a chicken bone as well as on hydroxyapatite. Ask them to write down their findings.
8. **Students should read the article of Drabe, Niste & Li (2003) on "Carbonated drinks and neutralizing saliva: dental erosion"**

Lesson 2 and 3: Guide experiment and judgement of Drabe, Niste & Li 's research

Introduction

1. Introduce what the students need to do in these lessons. Refer to workbook **"Study guide" p. 25**.

Guide experiment: cola and chicken bones

2. Let the students, as teams, first discuss their prediction and why they expect this to happen (**3.1; p. 8)** and then conduct the guide experiment (**3.2; p. 8**)

   The materials needed for this experiment are listed in the workbook p. 8

   If the experiment turns out well then the pH of cola will increase, the acid probably reacts with the hydroxyapatite in the bone.

Judging the research of Drabe, Niste & Li (2003)

3. Let the students, as teams, work on the questions in **4.1 (i) (ii) and (iii)**, **workbook p. 9-10**.
   After that ***discuss accuracy*** **[(4.1 (i)]**, depends on:
   - The scale of the measuring instrument
   - The range of accuracy of the instrument
   - How to read the instrument

   Discuss what to do to find out if a measurement is reliable **[4.1 (ii)]**:
   - Repeat the experiment
   - How many times to repeat, depends on the deviation between the measurements.

   Discuss reliability of a series of measurements **[4.1 (iii)]**, depends on:
   - All experiments should be conducted in exactly the same way
   - The deviation between measurement should not exceed 5%

5. Let the students, in teams, work on the rest of the questions in **chapter 4; p. 10 - 17**.
   Be sure that they get to know and understand the meaning of accuracy, reliability and validity in an inquiry.

Lesson 4: Students' own inquiry project: question and plan

Introduction:

1. Introduce what the students need to do: formulate inquiry question and design an inquiry plan (see **workbook "Study guide" p. 25)**.
   As indicated on **p. 18-19** in the workbook the students are free to choose a certain inquiry, as long as it is related to ionic liquids.

Inquiry in teams:

2. Let the students work out the "inquiry in teams" (**chapter 5, p. 20-21**)
   The students' inquiry questions should be:
   - Unambiguous: contains one problem
   - Relevant: related to the topic 'ionic liquids'
   - Concrete: the question should contain the dependent variable and independent variable

   The student's inquiry plan should be handed in and checked on:
   - Is it related to the inquiry question?
   - Are the experiments not dangerous?
   - Is it too time consuming?
   - Students can vary a lot e.g. use real teeth, repeat Drabe et al. 's experiment, etc.
3. Give the students feedback on their inquiry plans and a go!
4. Remind the students to keep a record of the inquiry (**workbook p. 22**.)

Lesson 5 and 6: Conduction of the planned inquiry

Introduction:

1. Introduce what the students need to do:
   -discuss the teacher's comments on their plans,
   -execute the experiments, and
   -write down their observations.

Conduction of the experiments:

2. Let the students, in teams, discuss the comments on their inquiry plan
3. Let the students, in teams, execute their experiments
4. When the teams conduct their experiments, walk around and pay attention to:
   - Do they always measure in the same way?
   - Do they accurately read the measurements?
   - Do they repeat measurements?
   - Do they write down their observations and measurements?

Further approach in the project

5. Discuss with the students the part in the project "Outside the chemistry lessons", so that all students know what still needs to be done

Outside the chemistry lessons

Check, now and then, whether the teams do the following:

1. Write a first version of their report with the following guidelines (**workbook p. 25**):
   - **Snappy** but relevant title
   - Names of the authors and submission date
   - **Summary** of the inquiry
   - **Introduction** with the reason of or problem in the inquiry guided by theory on the problem, with the **inquiry question** and with a **hypothesis** and the **theoretical assumptions** concerning the answer on the inquiry question.
   - **Experimental design** with a description of the method of investigation, of the way of handling the different **variables** and of the way of handling the **accuracy** in the experimental set-up and the measuring itself.
   - **Results** with a description of the **relevant observations**/ **measurements** that are correctly put into **tables and graphs**.
   - **Discussion and conclusion** with a critical interpretation of your results and with a valid answer to your inquiry question.
   - **Evaluation** with a critical description of the experimental set-up, with suggestions for improvements and further inquiry questions.
   - **Bibliography** with relevant resources like textbooks, websites, magazines, articles.

Further guidelines:

- Use correct **English** and use a layout in **2 columns**.
- Enclose a **picture** or **drawing** of the experimental set-up (max. **100 kb**).
- The report should not exceed **1500 words** (max. **500 kb**).
- **Label** your document with **teamnumber_first name_first name**.
- Add **separately the email addresses of all team members.**

2. **Submit** the **first version** of the report on a website / elo

3. **Discuss** the published report of at least another team in the Internet 'Cola and Teeth' symposium Use the following questions (**workbook p. 24**):

- Are the dependent and independent variable visible in their inquiry question?
- Are their assumptions and theory about their hypothesis relevant?
- Did they manage the control variables well?
- Did they measure accurately?
- Are their results well presented?
- Did they track the reliability of their results?
- Can you approve of their discussion and conclusions?
- Did they write a critical evaluation?
- Did they come up with a relevant bibliography?

4. **Use comments from the peer discussion to improve their first report**

5. **Rewrite their report into a final version: article**
   Again use the guidelines on **p. 24** of the workbook

6. **Submit their final version**.

7. Ask the jury to find the best inquiry.