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# Investigating the effect of context-based teaching approach on learner interest and performance in science

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**2009-10-14T10:09:55Z**
http://hdl.handle.net/10539/7351

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# APPENDIX A

**Information for participants and Consent Form**

01 August 2006

Dear Grade 11 Student
Progress Combined School

**Information for participation in the context-based teaching research project and consent form.**

I am currently studying for a Master of Science degree in Science Education at the University of the Witwatersrand in Johannesburg. As part of my thesis, I am investigating the effect of context-based teaching on learner performance, interest and attitude towards the learning of Science. As such I will be involved in the actual teaching in the classroom. This letter is to request your participation in this project.

In this phase of the project the focus will be on the teaching and learning in the classroom where a context-based approach will be used to teach the topic on sulphur and sulphur compounds. The teaching approach is such that raw coal and prepared braziers would be used inside the classroom. Questionnaires and tests will be written during the teaching phase. This would be followed by interviews at the end of the topic to establish attitudinal changes towards the learning of Science if any.

All data collected will be used for research purposes only. Possibilities of reporting research findings in appropriate conferences or educational journals do exist. I assure you that anonymity and confidentiality will be protected in all written and verbal reports by making use of pseudonyms for the school, teacher and the students. Upon completion of the project, all data will be archived and securely stored at the University of the Witwatersrand for a period of five years. The findings of the study will be communicated to you upon request.

Please note that if consent is not granted I will respect your decision. Therefore you together with any other students not participating will be assigned to the other Science classes where the implementation of the context-based module will not be occurring. Furthermore, any text that you may produce will not be used in the study and you will not be forced to fill in any questionnaires nor will you be asked to sit in any interview. Please note that at any point during the study, you may withdraw your consent without any penalty or prejudice.

Looking forward to hearing from you.

_____

T. R. Khosa

**CONSENT FORM (STUDENT)**

I, _____ (please print full name), a student in Grade 11 give consent to the following:

1. Taking part in the research study on context-based teaching. YES [ ] / NO [ ] (please tick).

2. Take part in the answering of questionnaires and sitting for interviews where necessary. YES [ ] / NO [ ]

Signed: _____

Date: _____

# APPENDIX B

# Questionnaire

## ***Section A***

Complete the following questionnaire by ticking in the appropriate box containing your best answer.

| | Strongly agree | Agree | Disagree | Strongly disagree |
|---|---|---|---|---|
| 1. Aw! I can't wait for the Science period. Learning Science is very interesting | | | | |
| 2. Science helps me to think | | | | |
| 3. I like Science because it's fun | | | | |
| 4. I do well in Science as compared to the other subjects | | | | |
| 5. I find Science useful in my life | | | | |
| 6. Eish! I wish we were made not to do Science at school. It is difficult. | | | | |
| 7. Science is the most boring subject of all at school | | | | |
| 8. If it was not for Science, my reports will show passes all the time. | | | | |
| 9. I hate the way we do Science at school. I wish there was a better way. | | | | |
| 10. I think I would understand Science better if it is linked with what I do in my everyday life | | | | |
| 11. If I had a choice, I would stop doing Science | | | | |
| 12. I always do not see the benefit of doing Science | | | | |
| 13. I am not pleased with the way I perform in Science. It is always poor. | | | | |
| | | | | |
| | | | | |

## ***Section B***

Complete the following questionnaire by answering the questions below.

1. Do you find Science interesting or not? Explain your answer.

_____
_____
_____
_____

2. How is your performance in Science? Good or Bad? Why? Explain in detail.

3. Does Science become easy to understand when the teacher talks about the things you do and see everyday? Explain.

4. Tell us what you think needs to be done to make Science more interesting.

# APPENDIX C

**The Module used in the Study**

# CONTEXT-BASED MODULE
# GRADE 11

# SULPHUR AND SULPHUR COMPOUNDS

## CONTEXT:
**THE BURNING OF COAL**

**Prepared by: Tinyiko R. Khosa**

# BURNING OF COAL

Many communities in Soweto burn coal in winter in order to try and keep their houses warm. Although the burning of coal occurs almost everywhere, much of it occurs in informal settlements where there are no alternative means to either warm the shacks or cook, using electricity. It is a common practice in the Pimville and Kliptown areas to use braziers to keep houses and shacks warm in winter.

The burning of coal has negative effects on the two communities. The smoke that covers the skies between five and six in the afternoon always causes poor visibility on the road that links Pimville and Chiawelo. Some of the accidents that occur during the winter season on this road can be attributed to motorists being unable to see the road clearly. Most of the people in the community have been complaining that the smoke that they inhale from the braziers has a choking effect. This affects their respiratory systems. Others in the community have to paint their houses at least once every two years as their painting seems to fade much more quickly.

## Activity 1.

A burning brazier and pieces of coal are provided to you. Use this and your own experience in discussing the activity given below. You are expected to work in groups of five and discuss the following:

1. Discuss how a brazier is made.
_____
_____
_____

2. Try and give as much description as possible (e.g. the smell, colour etc) of the smoke formed when a brazier is made.
_____
_____
_____

3. Examine the piece of coal in front of you. What colour is coal?
_____
4. What do you think gives coal its colour? _____
5. Does coal dissolve in water? _____
6. What do you think coal is made of? List as many elements as you can.
_____
_____
_____
_____

7. What **harmful effects** do you think the burning of coal has on the environment and how can we minimize it? You will be working in groups to answer this question. A chart will be given to you to prepare a presentation on your discussion.

## Activity 2

1. What do we call the process when substances burn in oxygen?
   _____
2. What do we call the products formed when substances burn in oxygen?
   _____
3. Let's now examine the substances that coal is formed of. What products are formed when **these** substances burn in oxygen?
   _____
   _____
   _____
   _____
4. Can you write down chemical equations showing how these products are formed as the substances burn in oxygen?
   _____
   _____
   _____
   _____
5. The substances formed in 4 above are able to dissolve in water. Write down chemical equations showing how these substances dissolve in water.
   _____
   _____
   _____
   _____
6. The substances formed in 5 above are acids. Draw a flow chart showing how acid rain is formed when coal is burnt.

## Activity 3

Practical Demonstration: Fountain Experiment

1. Prepare sulphur dioxide by allowing sodium sulphite ($Na_2SO_3$) to react with diluted sulphuric acid.
2. Collect the gas into a round-bottomed flask with a glass tube inserted into a stopper.
3. Insert the glass tube into a bowl of water containing an indicator.
4. Observe what happens.

5. Write down a chemical equation showing how sodium sulphite reacts with diluted sulphuric acid. _____
6. Write down a chemical equation showing how sulphur dioxide reacts with the water in the bowl. _____
7. Make use of the textbook and your own observations to write down the characteristics of the sulphur dioxide gas.
   _____
   _____
   _____
   _____
   _____

**WHAT HAPPENS TO OUR PAINTS???**

Sulphur dioxide has the ability to react with certain substances and in the process change their colours. In chemical terms, we say that sulphur dioxide has the ability to **reduce** and **oxidize** other substances.

When sulphur dioxide **reduces** other substances, it does so by **giving them electrons**. In this case, we say that sulphur is acting as a **reducing agent**.

When sulphur dioxide **oxidizes** other substances, it does so by **taking away electrons** from them. In this case, we say that sulphur is acting as an **oxidizing agent**.

Thus sulphur dioxide can act as **both** an **oxidizing** and a **reducing agent** depending on the situation.

**Introduction to the Reduction-Oxidation Potential Table! The teacher explains clearly how oxidation and reduction occurs through the gaining and loosing of electrons.**

**Reducing action of sulphur dioxide:**

$2MnO_4^-(aq) + 5SO_2(g) + H_2O(\ell) \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 4H^+(aq)$

$Cr_2O_7^{2-}(aq) + 3SO_2(g) + 2H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + H_2O(\ell)$

**WHY THE DUST IN THE AIR? Is it only soil particles?**

When sulphur burns in air, one of the products formed is **hydrogen sulphide** gas. This gas further reacts with sulphur dioxide in the air to form **sulphur** particles which appears as soil dust in the air. In this reaction, sulphur dioxide **oxidizes** hydrogen sulphide into **sulphur** and **water**. Thus sulphur is the oxidising agent in this reaction.

**Activity 4.**

Let's write down the following for the reaction of sulphur dioxide and hydrogen sulphide using the **reduction-oxidation potential table**:

1. Oxidation half reaction: _____
2. Reduction half reaction: _____
3. Net chemical equation: _____
4. Oxidizing agent: _____
5. Reducing agent: _____
6. A reducing agent is a substance that _____
7. An oxidizing agent is a substance that _____

**Activity 5.**

Hydrogen sulphide only acts as a reducing agent. Let's look at how it is able to reduce permanganate and the dichromate ions. The use of the **reduction-oxidation potential table** is also important here.

**Experimental Demonstration: Preparation and the reducing action of hydrogen sulphide**

1. Place 10g of iron (II) sulphide with diluted hydrochloric acid.
2. Is there any smell?
3. Allow the gas to pass through solutions of potassium permanganate and potassium dichromate and observe what occurs.
4. List from your observation and using textbooks, the characteristics of hydrogen sulphide.

   _____
   _____
   _____
   _____
   _____

**1. Permanganate ion**:
Oxidation half reaction: _____
Reduction half reaction: _____
Net chemical equation: _____

**Dichromate ion**:
Oxidation half reaction: _____
Reduction half reaction: _____
Net Chemical Reaction: _____

**2. Colour Changes:**

| **Ion before $H_2S$ Addition** | **Colour before $H_2S$ Addition** | **Ion after $H_2S$ Addition** | **Colour $H_2S$ Addition** |
|---|---|---|---|
| $MnO_4^-$ | | | |
| | | $Cr^{3+}$ | |
| $Fe^{3+}$ | | | |

**3. Colour Changes:**

| Ion before $SO_2$ Addition | Colour before $SO_2$ Addition | Ion after $SO_2$ Addition | Colour $SO_2$ Addition |
|---|---|---|---|
| $MnO_4^-$ | | | |
| | | $Cr^{3+}$ | |

## SULPHUR DIOXIDE CAN BE USEFUL

Sulphur dioxide is used in industries to produce sulphuric acid in large quantities. This process is called **contact process**.

### The Contact Process

**Stage1**: Sulphur dioxide is formed by heating concentrated iron pyrites in oxygen.

$$4FeS_4 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$

**Stage 2**: **Sulphur dioxide** is made to react with **excess oxygen** by passing it through layers of **vanadium oxide** to form **sulphur trioxide**. The **vanadium oxide** acts as a **catalyst**.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

What is a catalyst?

_____

_____

**Stage 3**: Sulphur trioxide is dissolved in water in the presence of concentrated sulphuric acid because sulphur trioxide dissolves readily in sulphuric acid.

$$SO_3 + H_2O \rightarrow H_2SO$$

The concentrated sulphuric acid is drained into reservoirs.

### Characteristics of sulphuric acid

1. **Sulphuric acid** is an **oxidizing agent** for a number of metals. Thus it makes such metals **to lose electrons**. When metals such as iron lose electrons and are ionized, the process is commonly known as **rusting**.
   **Examples:**

   $$\mathbf{Fe + 2H_2SO_4 \rightarrow Fe\ SO_4 + SO_2 + H_2O}$$
   $$\mathbf{Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + H_2O}$$

2. Sulphuric acid forms **hydrochloric acid** when it reacts with **chlorides,** e.g.

   $NaC\ell + H_2SO_4 \rightarrow NaHSO_4 + HC\ell$ : $NaHSO_4$ is called sodium bisulphate

3. Sulphuric acid forms nitric acid when it reacts with nitrates, e.g.

$$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$$

4. Sulphuric acid also acts as a **dehydrating agent,** eg

$$CuSO_4.5H_2O \rightarrow CuSO_4 + 5H_2O$$

$$C_{12}H_{22}O_{11} \rightarrow 12C + 11H_2O$$

## CAN SULPHURIC ACID BE PUT TO GOOD USE?

Sulphuric acid has many uses. This is the reason why it is manufactured in large quantities in factories. The following are some of the uses of sulphuric acid.

1. Electrolyte in car batteries
2. Recovery of gold, copper and uranium from their ores
3. Purification of copper through electrolysis
4. Dissolving metal ores from mines
5. Cleaning metal surfaces for welding and galvanizing
6. Manufacturing of explosives and fertilizers

## WHAT IS THIS SULPHUR WE ARE TALKING ABOUT?

1. It is a yellow powder
2. It exists as a molecule of eight sulphur atoms bonded together, $S_8$.
3. It exists in more than one crystalline form. This phenomenon is called **allotropism**. The three crystalline forms of sulphur are: **orthorhombic sulphur**, **monoclinic sulphur** and **plastic sulphur**.

Some of the content used in this module has been adapted from:

Heyns, G.F., de Villiers, G., Gibbon, D.B., Jordaan, A.S., Naidoo, L.R. and Fowler, W.G. (1989). Physical Science 2000 Standard 9. Pretoria: NASOU

# APPENDIX D

**Learner Interview**

# Learner Interview

Post intervention interview

1. What do you think made you choose Science when you got to Grade 120?
2. Do you regret having chosen Science? Why?
3. Tell me a little bit about your attitude towards learning Science before we had the lesson on sulphur and sulphur compounds.
4. Has your attitude changed now?
5. What could have been the main reason according to you for the change or no change?
6. Did you understand the lesson on sulphur and sulphur compounds easier (better) compared to the other lessons you had before?
7. What do you think made it easier or not for you to understand the lesson?
8. Do you think anybody can succeed (pass) in Science or only a specific group of people? And who are they?
9. Do you think Science is fun or boring?
10. What do you mean by Science being fun or boring?
11. Some learners are saying that only boys are good at Science. What is your take on this?
12. What do you think your teacher should do in his teaching to make it easier for you to understand what is taught?
13. The general performance of learners in the test given to you at the end of the lesson on sulphur and sulphur compounds was poor. Why do you think it was so?
14. Most learners are saying that Physical Science is the subject that they fail most. Why do you think it is so?
15. How would you describe a good Physical Science teacher?

# APPENDIX E

**Educator Interview**

# Educator Interview

## Post Intervention Interview

1. How long have you been teaching Science?
2. What challenges have you experienced over the years of teaching Science?
3. How did you try to overcome some of these challenges?
4. What kind of assistance do you think you need in dealing with some of your challenges from the school management and/or district office?
5. The burning of coal was used as a context in teaching the chapter on sulphur and sulphur compounds at your school. Did you find the use of context useful in teaching the topic? How?
6. Are you seeing any improvement in learners' conceptual understanding of the topic compared to when no context is used?
7. Do you think this type of approach to teaching can make life easier for teachers and learners?
8. What challenges do you think will face teachers who attempt to use the context-based approach to teaching?
9. Have you personally gained or not as a science teacher during the teaching of the module on sulphur and sulphur compounds?
10. How many teacher-development workshops have you attended this year?
11. What was the focus in these teacher-development workshops?
12. What do you think are the most common needs for science teachers that you can recommend the developmental workshops to focus on?
13. How did you find the research process? Useful or not?
14. Do you have any questions to ask with regard to the research and any other issue around the module that was taught?

# APPENDIX F

**Test**

**Physical Science Test**
**Grade 11**
**Sulphur and Sulphur Compounds**

**Instructions** **Total Marks: 60**

- Answer **ALL** Questions
- Use the **Reduction-Oxidation** potential table where necessary

## Question 1

1.1 What is **allotropism**? (4)
1.2 Write down the three allotropes of sulphur. (3)
**[7]**

## Question 2

2.1 Hydrogen sulphide ($H_2S$) gas is prepared in a school laboratory.
2.1.1 Write down a **balanced chemical equation** showing how hydrogen sulphide is prepared in a school laboratory. (3)
2.1.2 Write down three characteristics of hydrogen sulphide. (3)

***The prepared hydrogen sulphide gas is now allowed to pass through the solutions of potassium permanganate and potassium dichromate.***

2.1.3 Fill in the following table referring to what occurs when hydrogen sulphide gas is passed through the two solutions. Only write down the question number and the and the answer without redrawing the table.

| **Solution** | **Colour of solution before $H_2S$** | **Ion Responsible for the colour** | **Colour after $H_2S$** | **Ion Responsible for the colour** |
|---|---|---|---|---|
| Potassium permanganate | 2.1.3.1 | 2.1.3.2 | 2.1.3.3 | 2.1.3.4 |
| Potassium dichromate | 2.1.3.5 | 2.1.3.6 | 2.1.3.7 | 2.1.3.8 |

(8)

2.2 In all the above reactions, hydrogen sulphide gas is acting as a reducing agent. What is a reducing agent? (3)

2.3 Use the reaction between Hydrogen Sulphide and Potassium permanganate and write down the following:

2.3.1 Oxidation half reaction. (2)
2.3.2 Reduction half reaction (2)

2.3.3 Net ionic chemical equation (4)

**[25]**

**Question 3**

3.1 Sulphur dioxide is passed through a solution of potassium dichromate. Write down the following for the reaction that occurs;

3.1.1 Oxidation half reaction (2)
3.1.2 Reduction half reaction (2)
3.1.3 Net ionic chemical equation (4)

3.2 Sulphur dioxide gas is able to react with hydrogen sulphide gas. For this reaction, which substance acts as

3.2.1 oxidising agent? (2)
3.2.2 reducing agent? (2)

3.3 What is an oxidizing agent? (3)

**[15]**

**Question 4**

4.1 Suphuric acid is manufactured in large quantities in industries. What do we call this process where sulphuric acid is made in large quantities in industries? (2)

4.2 Sulphuric acid is said to have an oxidizing and dehydrating effect. What is meant by dehydrating? (3)
4.3 What substance is formed when sugar is dehydrated by sulphuric acid? (mention the name and the colour) (2)
4.4 Write down a balanced chemical equation showing this reaction. (2)
4.5 Sulphuric acid is useful in many ways. Mention four uses of sulphuric acid.(4)

**[13]**

**Grand Total: 60 Marks**

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