This report sums up the hazards that the use of blackboards in Ghanaian schools causes. The main focus will be on the effects on the health of students and teachers that are known. Both the coating of the blackboards and the use of chalk will be looked at.

HEALTH HAZARDS THROUGH THE USE OF BLACKBOARDS IN GHANAIAN SCHOOLS

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CONTENTS

INTRODUCTION

This report is to look into the use of black boards in Ghanaian schools. It will first look into the use of old batteries as a substitute for black board paint and list the health hazards and then look into the use of chalk and the hazards of chalk dust.

Black boards are the number one teaching aid in Ghanaian schools. However, there are some threats that come with the usage of them. Unlike in Europe, where schools get pre manufactured black boards that are mounted to the wall or stand in the classrooms, Ghanaian schools mostly have black boards that re just painted on the wall. Normally a layer of concrete is applied to have it stand out just a little bit and this is then painted with black paint. This paint is not provide by the government and out of necessity, the schools paint their black boards with a paint made from old batteries. Furthermore this coating has to be renewed at regular intervals, making this not a one-time threat but a constant danger in Ghanaian classrooms.

In addition to this, many teachers and students complain about the use of chalk. This report sums up the findings about the hazards of chalk dust and possible diseases caused by them.

BATTERIES AS BLACKBOARD PAINT

OVERVIEW

According to Mr. Evans Kodjokumah, teacher at the Vakpo Adomi R/C JHS, the students have the task to repaint the black boards at roughly two month intervals. Every time the chalk drawings cannot be erased very well anymore or not at all, a new coat of paint has to be applied. Since no other means are provided by the government the teachers have the students bring used batteries from home that have been used in e.g. torchlights. They use all cell-type [dry cell] batteries they can get, though they prefer the D-Cell batteries, since these give the most paint per battery. [1]

THE PROCEDURE

When it is time to paint the black boards again, two or more students have the task to organize it. All the students are asked to bring some used batteries to school. On the given day the procedure is as follows:

STEP ONE: OPENING THE BATTERIES

In the first step the students assigned to the task take the batteries outside and crack the shell. This is done through hitting them with a stone or on the ground or with a machete (Figure 1). One cap of the battery is removed to expose the inside of the battery. On this occasion, three D-Cell batteries were used. The students wear no protective gear.

Figure 1

STEP TWO: REMOVAL OF THE CHEMICALS

In the second step, the students use their bare hands to remove the chemicals from inside the battery. They bend open the cylinder until it tears at the side. The shell and the rod inside are not of interest and thrown away. The black powder is then dumped into a small bowl (Figure 2). In this step the hands and arms of the students are for the first time directly exposed to the inide of the batteries.

Figure 2

Figure 3

Step Three: Mixing the paint

In the next step, the students pour some water into the bowl and break up the pieces of chemicals with their hands to mix them with the water until all chemicals are diluted and the paint is ready to use (Figure 3).

Step Four: Painting of the blackboard

As a last step, the students take any small piece of cloth or even the duster that is normally used to wipe chalk from the board to paint it. When they use the duster, they dip it into the bowl and only get little of the paint on their hands. If they use a cloth however, they soak it in the paint until it is dripping and then use it to apply one or more coats of paint to the black board (Figure 4, Figure 5). If they do it this way, they get a lot of paint on their hands. Once they finished this procedure, the black board has to dry and is then ready to be used again.[1]

Figure 4

[1] Procedure of repainting the black boards, observed and documented on March 20th, 2015

Figure 5

EXPOSURE

Throughout the process of preparing the paint and painting the black board, the students get both the powder of the batteries and the dissolved chemicals mostly on their hands and arms, but also on other body parts and their clothes. Some of the paint also drips or spills on floors, walls, chairs and tables. After finishing the students wash their hands with soap and water, but not especially careful or longer than usual.[2]

When writing on the blackboard or cleaning it with a duster, teachers and students get particles of the paint on their hands. Especially in the first week after painting the black board this effect is visible. Teachers and students normally wash their hands when they have finished writing or cleaning, however, other items like clothing or teaching materials are touched in the meantime and not everybody washes their hands after every exposure to the paint.

In addition particles of the paint fall off the board or are gathered in the duster. It can be assumed that these particles can also be found floating in the air when writing or cleaning or they might be stirred up from the ground and they could be inhaled by teachers as well as students.[3]

[2] Procedure of repainting the black boards, observed and documented on March 20th, 2015

[3] From personal experience and observation while teaching Afternoon Classes at the Vakpo Adomi R/C JHS

CONTENTS OF BATTERIES & THEIR HAZARDS

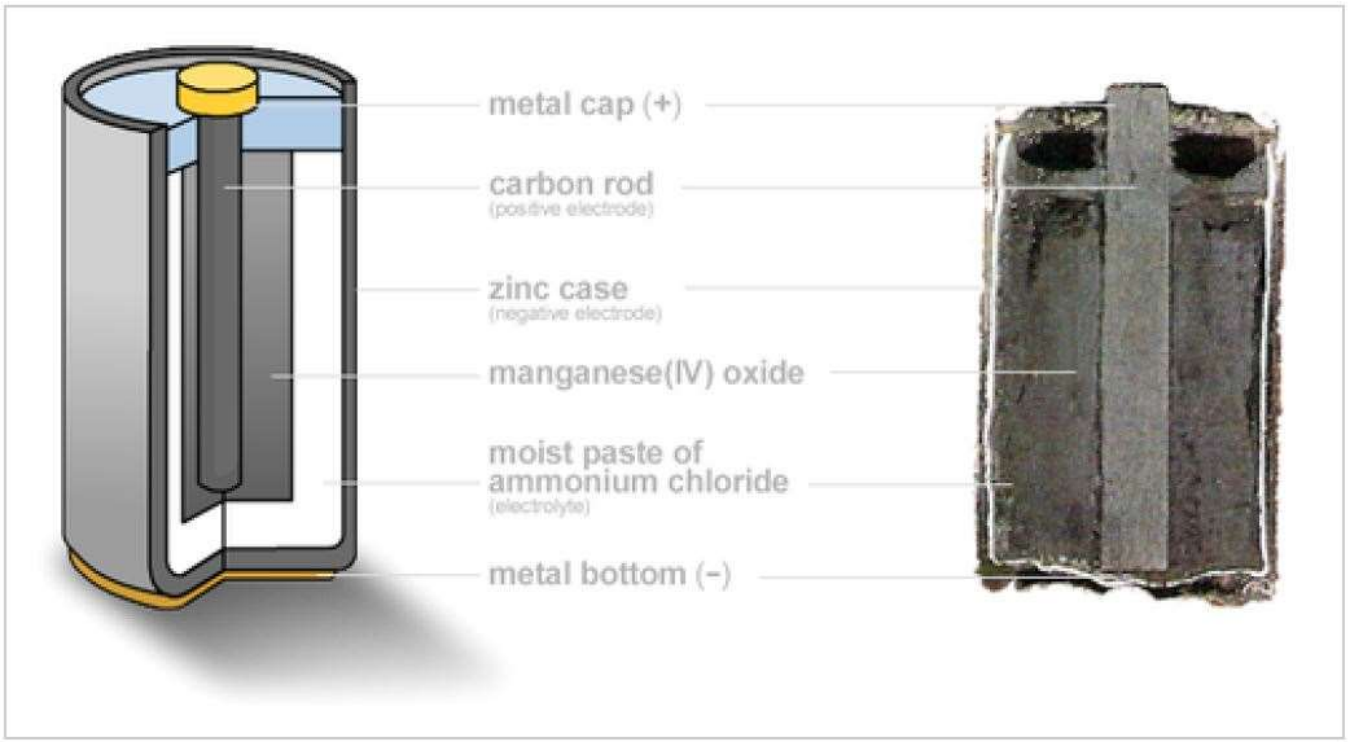
This chapter describes the contents of D-Cell batteries and the chemicals that can be found within as well as the dangers that come with them. Since there are many different types of batteries in use, it focuses on dry-cell batteries and closer on the D-Cell, which is the one most commonly used in the painting of black boards (See: Overview). Alkaline and Zinc-Carbon batteries are the most commonly used dry-cells[4], thus only the chemicals within them will be looked at.

DRY-CELL

A Zinc-Carbon battery follows the setup as seen in Figure 6. In addition to the Zinc and Carbon electrodes it also includes Manganese (IV) oxide and Ammonium chloride, which is sometimes substituted with Zinc chloride. When it is used, the battery also produces other chemicals, as seen in this reaction:

$$Zn\ (s) + 2MnO_2\ (s) + 2NH_4Cl\ (aq) \rightarrow Mn_2O_3\ (s) + Zn(NH_3)_2Cl_2\ (aq) + H_2O\ (l)$$

This adds Manganese (III) oxide [Mn_2O_3] and Diammine Dichloride Zinc (II) [$Zn(NH_3)_2Cl_2$] as well as water [H_2O] to the chemicals included in used batteries of this type. [2] [3]



Cross-section of a zinc–carbon battery.

Figure 6 [2]

An Alkaline battery has a similar setup but uses a different set of materials. However, it doesn't add many new chemicals that aren't in a Zinc-Carbon battery, as seen in this reaction:

[4] [19]Figure 1

$Zn\ (s) + 2MnO_2\ (s) \rightarrow ZnO\ (s) + Mn_2O_3\ (s)$

The only chemical that is not in a Zinc-Carbon battery is Zinc oxide [ZnO]. [4]

The type of battery used at the Vakpo Adomi R/C JHS (See: The Procedure) is a Zinc-Carbon battery.

To summarize the chemicals students could come in contact with:

- **Ammonium chloride [NH_4Cl]**
- **Diammine Dichloride Zinc(II) [$Zn(NH_3)_2Cl_2$]**
- Carbon [C]
- **Manganese (III) oxide [Mn_2O_3]**
- **Manganese (IV) oxide [MnO_2]**
- Water [H_2O]
- Zinc [Zn]
- **Zinc chloride [$ZnCl_2$]**
- Zinc oxide [ZnO]

Out of these chemicals only the **bold** ones will be looked at closer, since they are the ones that end up in the paint and could therefore pose a threat to the health of students. The remaining chemicals might be touched by the students when they prepare the paint, however, they are also included in many other items, some of which are even used to prepare food and thus don't need special attention.

As for Diammine Dichloride Zinc(II), the research didn't produce any information about hazards. Since there are certain legal duties in place for companies to warn about hazards, there don't appear to be any that aren't similar to the hazards of the other chemicals [5].

Health Hazards

In this section the hazards of the different chemicals found in the batteries used to paint black boards are described. The hazards are identified through MSDS's (Material safety data sheet) that are mandatory in many counties and provide extensive information about chemicals, including health hazards [6]; and through their NFPA 704 (Standard System for the Identification of the Hazards of Materials for Emergency Response) signature, introduced by the U.S.-based National Fire Protection Association, that categorizes the health risks of chemicals into five groups [7].

Ammonium Chloride [NH4Cl]

Ammonium Chloride has a level 2 health warning on its NFPA 704 Diamond [8], indicating that "*Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury [...].*" [7]. Furthermore the MSDS states under Potential health effects, that Ammonium Chloride "*Causes eye irritation [...] May cause skin irritation [...] May cause irritation of the digestive tract. [...] May be harmful if swallowed" and "Prolonged or repeated skin contact may cause dermatitis.*" [9]

To sum up, Ammonium Chloride can cause irritations to exposed body parts like eyes and skin and should not be swallowed. In some cases it could cause dermatitis.

Manganese (III) Oxide [Mn_2O_3]

Manganese (III) Oxide has a level 1 health warning on its NFPA 704 Diamond [10], indicating that "*Exposure would cause irritation with only minor residual injury [...]"* [7]. The MSDS indicates that it *"[c]auses slight to mild irritations of [/to] the eyes, [...] skin, [...] nose, mucous membranes and respiratory tract."* and "*Prolonged exposure to manganese containing dust may produce manganese pneumonitis and manganese poisoning. Symptoms include sleepiness, weakness and emotional disturbances. Equivocal studies have shown manganese may decrease fertility in men."* [11]

All in all, Manganese (III) Oxide causes mild irritation to exposed body parts like eyes and skin and also to the respiratory system if inhaled. However, prolonged exposure to the dust may also cause manganese pneumonitis and manganese poisoning, including symptoms like sleepiness, weakness and emotional disturbances.

Manganese (IV) oxide [MnO_2]

Manganese (IV) Oxide has a level 2 health warning on its NFPA 704 Diamond [12], indicating that "*Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury [...]."* [7]. The MSDS also states that the substance is *"[h]azardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation*" and "*The substance may be toxic to blood, [...], liver [and the] central nervous system (CNS).*" [12]

To sum up, Manganese (IV) Oxide irritates exposed body parts like skin and eyes and may even be toxic if ingested.

Zinc Chloride [$ZnCl_2$]

Zinc Chloride has a level 3 health warning on its NFPA 704 Diamond [13], indicating that "Short exposure could cause serious temporary or moderate residual injury" [7]. The MSDS mentions the following hazards:
"Inhalation: Extremely destructive to tissues of the mucous membranes and upper respiratory tract. Symptoms may include burning sensation, coughing, wheezing, and laryngitis, shortness of breath, headache, nausea and vomiting.
Ingestion: Toxic. May cause irritation or corrosion to the gastrointestinal tract with abdominal pain, nausea, and vomiting. May cause delayed death occurring from strictures of the esophagus and pylorus.
Skin Contact: May cause severe irritation, skin burns and ulcerations. Solutions are corrosive. Symptoms include redness and pain.
Eye Contact: May cause redness, pain, and blurred vision. Splashes from solutions may cause eye damage.
Chronic Exposure: Repeated skin contact can cause varying degrees of problems ranging from dermatitis to ulcerations. Repeated Inhalation can cause occupational asthma." [13]

Zinc Chloride is the most hazardous of the chemicals, since it can cause severe damage to membranes and exposed body parts including symptoms like irritation, burns and ulcerations. It is toxic if ingested and causes respiratory problems if inhaled. Repeated contact or inhalation may cause diseases like dermatitis, ulcerations or asthma. However, contact to this substance is limited since it is mostly used in heavy duty Zinc Carbon batteries [2] and therefore not as readily available as people in Ghana tend to use the cheaper types of batteries.

Conclusion

All in all the chemicals found in Zinc Carbon and alkaline batteries present many hazards. However, the above mentioned dangers are information about exposure to a reasonable amount of the substance in its pure form. Since the students handle a mix of the chemicals and only from time to time, the dose may be smaller and thus the effects not as severe. Only the inhalation of dust could occur for a prolonged period of time. As the dose the students come into contact with is not known, the above hazards only frame the most extreme effects possible. It can be said, however, that all chemicals are hazardous to the human body and that the students shouldn't be exposed to them at all, no matter how small a dose they come into contact with.

Use of Chalk

Research of the K.N.U.S.T.-University in Kumasi, Ghana, reveals, that the black board or chalkboard is used in 85% of classes taught at Ghanaian primary schools and is therefore the most commonly used teaching aid. [14] When the black board is used, it is used with chalk. Another study reveals that airborne particles of different sizes are produced while writing and cleaning on a black board. The amount and size of the particles released greatly varies with the quality of chalk that is used. [15]

As visible in Figure 7, Vakpo Adomi R/C Basic Schools are no exception and the use of black boards also generates great amounts of chalk dust. The effect might be even stronger than in European schools, since the black boards, only consisting of concrete and the black paint, are very rough and low quality chalk is being used throughout the classes. The boards are never cleaned with water, meaning that all particles are free to float around the room or fall to the ground to be stirred up again.

Figure 7

Hazards Of Chalk Dust

To a healthy body, a single exposure to chalk dust is not harmful. However, it can trigger a reaction in those people who suffer from asthma. Prolonged exposure to chalk dust, like teachers experience it, may cause minor respiratory problems and could irritate the eyes. Ingestion is harmless, since all contents of the chalk are considered non-toxic. [16]

Observed Diseases in Anfoega

Mr. xxxx xxxxxx, doctor at the catholic hospital in Anfoega, North Dayi District, gives his observation and opinion about black board related diseases in the district. He registers about 20 persons per month that come to the hospital with any of the following diseases, which he thinks are mostly caused by the black boards: Respiratory tract infections, Pneumonias, Bronchitis, Eye diseases and Allergic Conjunctivitis. Though he cannot give any evidence, he thinks most of the diseases are caused by exposure to the dust of the battery chemicals. In addition he thinks, that the use of better quality chalk could already improve the situation a little bit. [17]

Other Effects

According to Mr. Eric Degboe, there is also another issue next to the health hazards (also observed by him) caused by chalk and paint. As already mentioned both substances also settle on clothes and spoil them. As some poorer families in Ghana can only afford one or two uniforms per student, some would have to go to school with a dirty uniform. The students fear being laughed at and won't go to school at all. The dust from the boards actually makes students miss classes. [18]

CONCLUSION

Overall it can be concluded, that the use of old Zinc Carbon and alkaline batteries poses a serious threat to the health of students and teachers. There is no conclusive evidence to the direct link between the chemicals used and some of the diseases observed, however, all indicators show in this direction and when it comes to the health of students no chances should be taken. Especially teachers can also suffer from problems that are caused by the chalk dust since they are exposed to it over a time period of sometimes 30 years or more.

Interestingly, most projects in Ghana that have seen black boards as a threat and work on replacing them only see the dangers of chalk dust [19] [20] [21]. This could be due to a lack of research into this area. Further studies, including e.g. an analysis of the paint from the batteries, could move even more organizations, companies and institutions to act against the dangers.

ALTERNATIVES

The Azorli Foundation would like to start a project replacing the black boards with white boards (dry-erase boards) in some schools. This would eliminate both the dangers of the battery chemicals and the chalk dust and could improve the learning situation significantly.

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