The heuristic "V" in high school using soap as central topic

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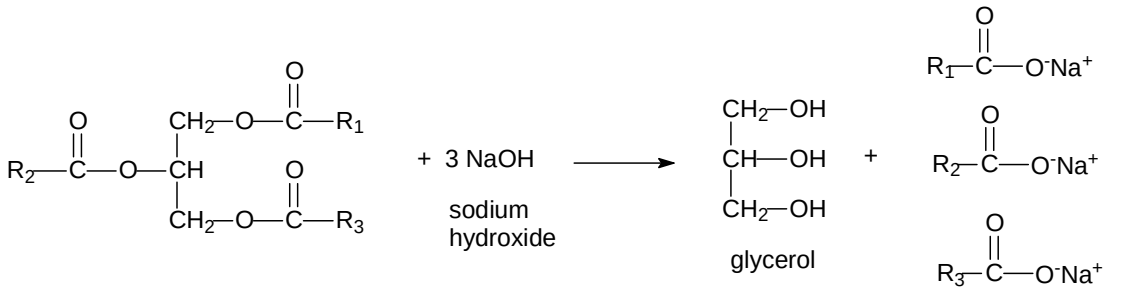
SUMMARY

The understanding of certain concepts of chemistry was developed in experimental classes of high school students. Soap was used as motivating topic in the following experimental activities: production of alcohol-base soape, and degree of decrease and measurement of surface tension. The technique of the heuristic "V", developed by Gowin, was chosen as methodology for the learning orientation. The concepts studied were saponification reaction, enthalpy of reaction, superficial tension, surfactants, hydrogen bond and van der Waals forces. The work was developed with students of the 1st and 2nd years of high school. The diagrams in "V" made reference to the central subject, object and occurrences, theories, principles and concept, registration, transformations and cognitive discernments. The process was considered efficient, in that it stimulated the students to accomplish and understand the experiments, instead of simply reproducing them, thereby reinforcing the interest for discoveries in the chemistry study.

INTRODUCTION

Surfactants are substances that, even in small concentrations greatly reduce surface tension of water or the interfacial tension of two immiscible liquids. This surfactant property is due to the presence of hydrophilic and hydrophobic groups in the same molecule (BORSATO et al. 1999, LYNCH et. al., 1999). The surfactants was obtained through the saponification reaction, which is a especial case of hydrolysis where esters are changed into glycerol and the corresponding anionic surfactant by reaction with an alkaline hydroxide. Obtained this reaction, soaps as cleansing agents have been know about 2000 years (BORSATO et. al, 1999, MORRISON & BOYD, 1992). The chemical reaction as follows:



Where R_1, R_2 and R_3 are chains that vary from 12 to 18 carbon atoms and may contain double bond, depending on the origin of the triglycerides. The chemical process for preparing soap helps us to understand the concepts related to heat of solution, and heat of reaction better. The properties of the surfactant agents such as solubility in water, micelles formation, detergent power and foaminess are part of students routine. These properties are related to concepts of surface tension, hydrogen bond, van deer Waals forces and number of atoms in the carbon chain that are some of the some topics considered in chemistry teaching. A form of approaching these chemical concepts in high school teaching is through the use of the heuristic "V". Gowin developed this method to help the students and teachers to understand the nature and the objectives of the experimental work in sciences (NOVAK, GOWIN, 1984) The "V", as heuristic resource, helps the students to recognize interaction between the already known and new knowledge they have produced, and that they intend to understand. Therefore, the method helps the students to understand the process of construction of the knowledge structure and the forms by which human beings produce it. Ebenezer (1992) gives a thorough description of the process applied to chemistry. A good theory of learning is one that seals the concepts and the proportional learning and, according of AUSUBEL et al, (1978) learning is significant when new information is acquired by a deliberate effort of the apprentice in tying the new information to important concepts or propositions that already exist in this cognitive structure. Contrariwise in memorization the new knowledge is acquired only by memorization and does not interact with what already exists . The students must be helped in recognizing (i) which events are observing(ii), which concepts they already know that ling with these events, and (iii) which worthwhile registrations can be done. With the objective of discussing concepts that make the students understand better the world that surrounds them, we used the method of the "V" to relate those concepts with their routine.

EXPERIMENTAL ACTIVITY

The activities were accomplished in and appropriate laboratory, with protection equipment safety, because sodium hydroxide, used in the saponication, is extremely corrosive and has high solution enthalpy. In accomplishing the activities with the high school students (1 sty and 2nd year), the group was formed by an instruction student of the 2nd year of the course of Degree in Chemistry, two guiding researchers of the Course of Chemistry of Universidade Estadual de Londrina, and teacher responsible for the discipline in the School.

Preparing the soap: Weigh approximately 540 g of bovine suet and melt 55-60^{o}C heating with Corning hot plate. Separately add, slowly and with constant agitation, 100 g of sodium hydroxide solid previously dissolved in 300 mL of water (don´t ever add water in the solid sodium hydroxide). Then, add 430 mL of ethyl alcohol and shake vigorously. The reaction liberates a lot of heat. Continuous stirring until dough becomes transparent. Then it is poured into molds for cooling and solidification. After, measure the pH dissolving 1,0 g of soap in 100 mL water. If the pH is very alkaline (above 9), is necessary to wait for some time until the end saponification.

CAUTION: During the procedure, if any part of the body comes in contact with the aqueous solution of NaOH, with sulfuric acid or even with the obtained soap, wash it immediately with abundant water. If the contact happens on the eyes, wash them with a lot of water and seek medical care.

CONSTRUCTION OF KNOWLEDGE: SOAP OBTAINING

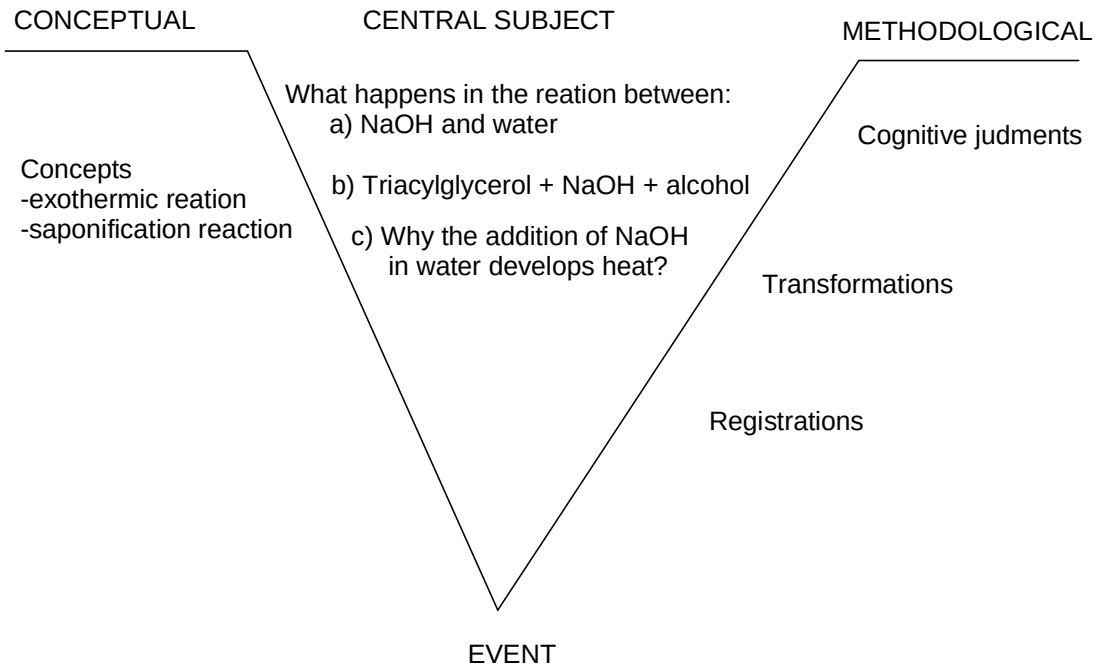


Figure 1. V diagram of soap preparation

Effect of soap on surface tension: Prepare with the formed soap an aqueous 1% solution. In a glass with water, carefully place a needle on a match on the surface. Remove the match from the water and soak in the 1% aqueous solution of soap. Place the match close to the needle. Repeat the experiment with aqueous solution of coconut soap or liquid detergent and compare results.

Measuring the surface tension: (GLASSTONE; LEWIS, 1966) This is done by the drop weight method (..). With the obtained soap, prepare an aqueous 1% solution by shaking until completely dissolved. If necessary, filter to clarify. Using a burette, measure the number of drops in 5 mL of distilled water. Repeat the operation for three consecutive times and calculate the average. Using the same burette, verify the number of drops in 5mL of the 1% soap solution. Repeat for three consecutive times, and calculate the average [the burette must be rinsed completely, with several portions of water, in order to remove all traces soap]. With the following equation, calculate the surface tension of the aqueous solution of soap and compare it with the surface tension of pure water, that is 72,0 mN/m (dynes/cm) at 25^{o}C (LIDE, 1996)

$$\gamma_1 = \gamma_2 (n_2 \times d_1) / (n_1 \times d_2)$$

where:

γ_1 = surface tension of the prepared solution

γ_2 = surface tension of water to 25°C (72,0 dynes/cm)

n_1 = number of drops in 5 mL of the aqueous solution of soap

n_2 = number of drops in 5 mL of pure water

d_1 = density of the aqueous solution of soap at 25°C

d_2 = density of the water at 25°C (0,9970 g/mL)

Repeat with 0,1% solution containing another surfactant ad compare the results.

CONSTRUCTION OF THE KNOWLEDGE: SURFACE TENSION

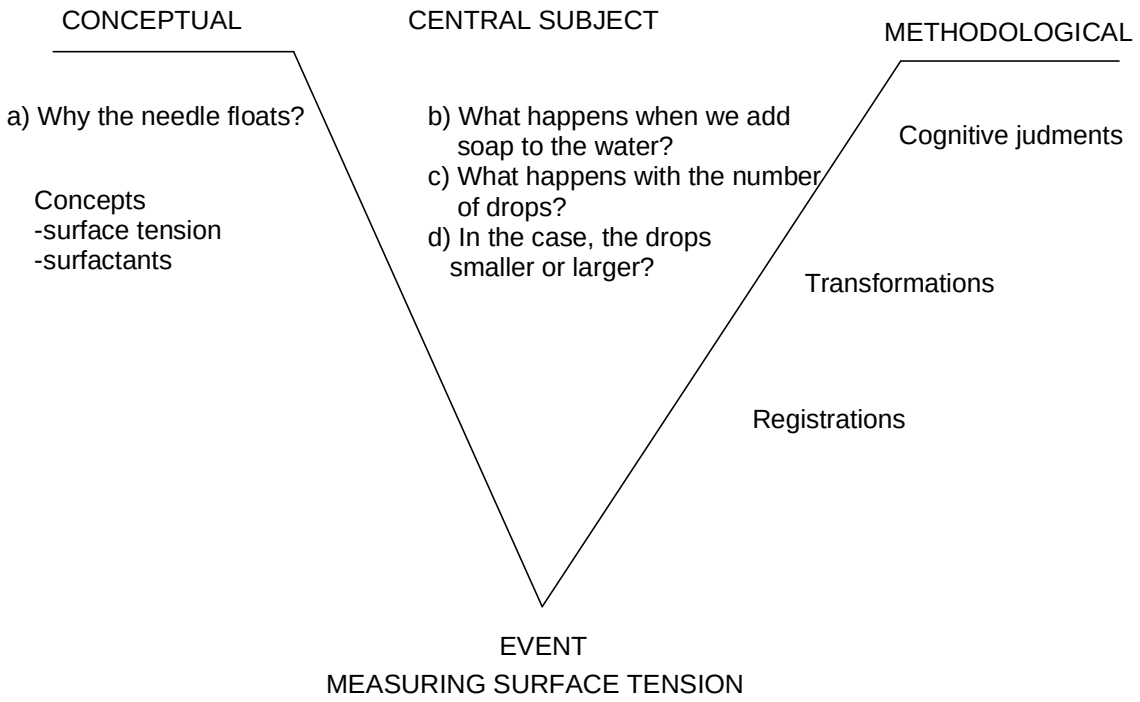


Figure 2. V diagram for measuring surface tension of soape soluction

RESULTS AND DISCUSSION

The experimental activities deal with the process of preparing soap and is effect on surface tension of water. These activities were done in the State School Souza Naves of Rolandia-PR and Colégio Universitário of Londrina-PR. Students in the 1st an 2nd years of High School accomplished the experiments an afternoon period, in small groups. The work was divided in two parts (i) Production of the transparent alcohol soap and (ii) Evaluation and determination of the surface tension.

In the first activity, the preparation of soap the theoretical support was approached in the form of study aid. The soap was obtained through the reaction of bovine suet with an aqueous solution of NaOH, and addition of ethyl alcohol. The "V" heuristic (fig.1) was set up on blackboard of the laboratory. In it, the event was the process obtaining soap (vertex of the "V"). In this first activity, the main concepts were the ones related to exotermic reaction and saponification reaction (on the left side of the "V"). During experiment the students answered questions (central part of the "V"), i.e.: why sodium hydroxide is added to water and not the opposite; why this process liberates a lot of heat; why the reaction of aqueous solution of sodium hydroxide reacts with the triglyceride, liberating heat, what is the function of ethyl alcohol in the process. The students were motivated to look for the answers and discuss them with each other (central parte of the "V"). The statements that told what the students thought to be the answers to the questions were placed in the right part of the "V" (cognitive judgments), as well as the observed transformations, such as the increase of temperature, the change of color, the transparency after the addition of the alcohol and the solidification after cooling.

In the second activity (fig. 2), tests of surface tension were made in which concepts of surface tension, surfactants and hydrogen bonds were approached. The verification of the decrease of surface tension its sinking in the 1% was accomplished with the flotation of the needle on the surface of water and aqueous solution. The measurement of surface tension was accomplished by the drop-weight method. The density was obtained by weighing 10 mL of the solution. The students just as the previous experience, registered in the "V" the answers to the initial questions.

COCLUSIONS

The methodology that was used to developed the activities was very satisfactory, because it was observed that there was a dynamic interaction between the component of thought on the left part of the "V", and the component of performance of the right parte, as the activities proceed. In other words, it showed the importance of interaction between "thinking" and "doing" in the construction of new knowledge.

We observed that the students re-elaborate their knowledge and organize it with the objective of carrying the activities fast as possible, to confirm their discoveries. The students interacted with the activities, they didn´t simply reproduce a summary, as is common in conventional classes, when, without knowing the reason, they make annotations, calculations, graphics and reports several times. Therefore, the "V" diagram is valuable, because it points to knowledge and objects there are in the base of the process of production of knowledge, that students are going to build along time.

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