EXPLORING THE POTENTIAL OF DIFFERENT TEACHING AIDS IN THE CONCEPTUAL DEVELOPMENT OF STUDENTS IN THE CHEMISTRY SUBJECT IN SECONDARY SCHOOLS: USING DIDACTIC POSTERS AND LOCALLY AVAILABLE MATERIALS

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ABSTRACT
One major problem in the teaching and learning process of Chemistry in Mozambique in Mozambique is the inadequate provision of teaching aids and laboratory resources. This study is based on a constructivist approach and describes the results of a teaching strategy that uses locally available materials to stimulate students' conceptual understanding and learning process. In this work there was used a mixed methodology research approach based on qualitative and quantitative methods. Two groups of students were taught, the experimental group with the new teaching resources and the control group with the conventional methods. Overall the results show a successful implementation of the teaching strategy that can be used to motivate school teachers to explore their environment and search for everyday materials and objects that can be used for teaching chemistry.
Keywords: potential of didactic posters, locally available materials, chemistry teaching, constructivist approach.

INTRODUCTION

Different studies revealed that student's poor performance in science subjects in many African countries is linked to lack of financial resources, inadequate teaching aids, shortage of basic materials and equipment (Nieuwoudt et al., 2007; Hattingh et al., 2007).

Despite recent changes in school curriculum emphasizing experimentation and problem solving, so called "doing science", no significant improvement of students' performance has been achieved, because teachers did not adapt their teaching strategies. There is a need to develop innovative teaching materials to support contextualization of science teaching (Hattingh et al., 2007; Dlamini, 2008).

In the large majority of Mozambican schools there are no minimal teaching materials or aids, not even books. The teaching of chemistry is limited to the use of blackboard, chalk, eraser and student handbook, thus the teaching of chemistry is very theoretical and not attractive, contributing to students' academic poor performance (Mendonça, 2006; Kuleshov and Sacate, 2007). These findings were corroborated by chemistry and biology teachers during a Training Program, who stated that science teaching is constrained by inappropriate conditions that vary from the lack of adequate infra-structures, laboratory equipment and supplies, to overwhelming classrooms, time allocated to laboratory sessions and pressure to finish the extensive syllabus (Cossa and Uamusse, 2014).

Interviews and lessons observations in Maputo city schools revealed that students faced difficulties in understanding the concepts of chemical bonds and chemical reactions, especially the chemical properties of substances and the factors influencing the reaction rate. The present study focus on exploring combined innovative teaching strategies, locally affordable materials and didactic posters, in the teaching and learning process of Chemistry.

THEORETICAL FRAMEWORK

The conceptual framework used in this research is underpinned by the constructivist theory. The central characteristic of constructivist learning theory is the idea that the development of understanding requires active engagement of learners (Jenkins, 2001) and learners discovery all knowledge about the world through their own activity (Tholo, 2008). According to Rankhumise and Lemmer, 2008, the challenging task of science educators is to select appropriate teaching strategies and techniques that will enhance the learning of the correct meaning and usage of scientific concepts.

In a study based on a constructivist approach reported by Uamusse et al., 2008, locally available indigenous technologies were used to teach chemistry concepts and processes and the results showed a significant positive performance of students. Previously, a successful intervention on understanding chemical equilibrium concept also based on the constructivist theory was successfully described (Akkus et al., 2003). Therefore, these studies reinforce the findings by Hattingh et.al, 2007, that doing practical work is not significantly dependent on

whether teachers have physical resources (eg. Laboratories, science apparatus or portable laboratory stations), those who are motivated to do practical work will find ways to do so even in the poorest schools.

In the last educational reforms, the Ministry of Education places an emphasis on learner centred curriculum in science subjects, moving away from content driven curriculum (MINED, 2004). For the successful implementation in the chemistry syllabus taking into account the current school conditions in Mozambique, chemistry teaching should include the adoption of interactive teaching methodologies that privileges the use of affordable and easily accessible materials from everyday life, providing opportunities for learners to develop problem solving skills and a critical thinking, through their active involvement in knowledge construction.

Hence, this research proposes the development and joint use of different teaching methods and demonstrates their effectiveness in the teaching - learning process of Chemistry. Didactic posters and laboratory work using locally available materials were combined in a teaching strategy that focused on student centered activities.

RESEARCH METHODOLOGY

The study took place in a public junior secondary school in Maputo city. A mixed approach involving both qualitative and quantitative methods was used. Document analysis, classroom observations, semi-structured interviews, closed and open-ended questionnaires were employed.

Prior to intervention, the current school chemistry syllabus and textbooks were analyzed, and school teachers were interviewed. The results indicated that students face major difficulties in understanding the topic of chemical bond and chemical reactions. Teachers also pointed out the lack of appropriate teaching resources as a main cause for students' poor performance.

Two classes of grade 9 students were selected; the sample consisted of one hundred and seventeen (117) pupils and six (6) chemistry teachers. One of the classes was used as the control group and taught with conventional methods and the class used as the experimental group was taught with the developed methods.

Written pre and posttest were administered to the sample before and after intervention. The researchers produced the new teaching materials consisting of didactic posters and selected everyday materials for the chemical reactions that were employed for teaching the experimental group, while traditional teaching methods (exposition, blackboard, chalk, and eraser) were used to teach the control group.

An elaborated didactic poster example is shown in figure 1. Two chemical experiments were performed using eggshells and vinegar to demonstrate the influence of surface area and concentration on the rate of a chemical reaction. Prior to intervention, students were instructed to collect eggshells from their households. During the lessons, in the experimental group, there was an interaction between students, presenting and discussing their views on the subject.

RESULTS

During classroom observations and interviews, it was observed that teachers rarely or never used didactic posters and low-cost materials in the teaching and learning process. Teachers were unanimous in stating that the chemistry syllabus was extensive and they used expository methods to summarize the content and conclude the program.

Lack of financial resources for practical demonstrations of the phenomena and students' lack of interest in chemistry were also pointed out as main constraints.

The pre-test aimed to determine students' level of understanding and skills on basic concepts on the subject matter. Test results showed that there were no significant differences in the responses of the two groups (Table 1).

The post-test was intended to see the changes on the responses of students after the application of different teaching methodologies in the classroom.

The results obtained indicated that there were noteworthy differences in the responses of the two classes, the percentage of positive responses was higher in the experimental class (Table 2).

During the teaching of the experimental group, students were able to apply their prior knowledge in the classroom, they also showed interest in discussing the topic and asked for similar interventions in the future.

The didactic posters facilitated the demonstration of the chemical structures of the compounds, chemical bonds and the steps of atomic changes during chemical reactions were easily visible for students understanding. One more advantage of didactic posters is that, teachers prepare them before lessons and can save the time they would need to write chemical reactions on the blackboard and use this time for more interactions and classroom discussions. On the other hand, the use of easily accessible materials enabled the implementation of experiments with minimal costs, for example eggshells are discarded everyday in households and restaurants.

The effectiveness of the methods used (η), in this research was calculated based on the following formula by Kuleshov, 2007 :

$$\overline{K} = \frac{\sum_{i=n}^{N} n_i}{nN}$$

Where ni is the number of characters assimilated by the student i, n is the number of characters (elements) of the concept, in this case the number of questions that the test contains and N is the number of students who participated in the test.

Experimental class

$$\sum_{i=n}^{N} ni = 692$$
$$n = 16$$
$$N = 55$$
$$\overline{K}_{\exp} = 0.786$$

Control class

$$\sum_{i=n}^{N} ni = 651$$
$$n = 16$$
$$N = 62$$
$$\overline{K}_{con} = 0.656$$

The coefficient of effectiveness in the given case was calculated as the ratio between

$$\eta = \frac{\overline{K_{ex}}}{\overline{K_{con}}}$$

$$\eta = \frac{0.786}{0.656} = 1.198$$
$$\eta > 1$$

The results of the calculations of effectiveness coefficient (η > 1) demonstrate that the methods used in this research produced positive results and pedagogical experimentation took place successfully.

CONCLUSIONS

This research has highlighted the possible strengthens of using didactic posters and locally available materials in the teaching and learning process of chemistry.

The use of the methods proposed by the researchers in the experimental group seems to have induced positive changes in the understanding of concepts and students motivation to learn chemistry. Furthermore, the used didactic means captivated students 'attention and willingness to share their own knowledge, interact with others and acquire new scientific knowledge.

In conclusion, the strategy implemented in this study has a strong potential to be expanded to other chemistry and science topics and can help to overcome the difficulties faced by teachers in teaching science in schools.

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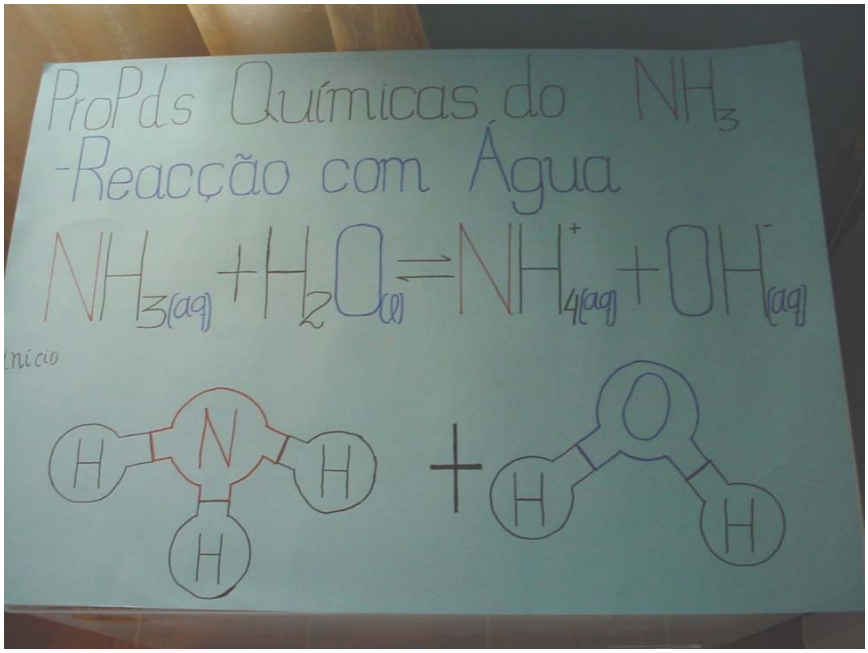

Fig. 1 Representation of a Chemical reaction

Table 1: Pretest results

		Results (%)	
		X_{exp}	X_{cont}
	Yes	100	98.33
	No	0	1.66
	Yes	93.3	83.33
	No	6.66	13.33
	Yes	88.88	80
	No	11.11	20
	R.C	6.66	11.66
	R.D	17.77	16.66
	R.Exo	0	16.66
	R.Endo	8.88	15
	R.Redox	100	83.33
	Mendeleiv	6.66	63.33
	Lavoisier	73.33	18.33
	John Dalton	20	18.33
	Yes	86.66	58.33
	No	13.33	41.66
	Yes	44.44	23.33
	No	55.55	76.66
	Laboratory work	4.4	8.33
	Posters	35.55	13.33
	Experiments with easily accessible materials	4.4	1.66

R.C = reaction of combination or synthesis
R.D = decomposition reaction
R.Exo = exothermic reaction
R.Endo = endothermic reaction
R.Redox = Redox reaction
exp= experimental group
cont= control group

Table 2: Posttest positive results

Question		Results (%)	
		X_{exp}	X_{cont}
	a)	80.0	80.64
	b)	63.63	95.16
	c)	96.36	95.16
	d)	100	95.16
	a)	89.09	30.65
	b)	74.54	46.77
	c)	83.63	38.71
	d)	58.18	58.06
	d')	58.18	72.58
	a)	94.54	91.93
	b)	94.54	93.55
	a)	89.09	77.42
	b)	87.27	70.96
	c)	74.54	30.65
	c')	30.90	4.83
4	a)	86.63	67.74

