ACTIVITY BASED LEARNING OF CHEMICAL REACTIONS AT THE SECONDARY LEVEL

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In the present study activity based learning method was employed in learning chemical reactions at the secondary level in an SC/ST dominated rural school. For effective participation of students in learning chemical reactions, activities like group exercise, group work, quiz, seminar and projects were carried out. The students were also encouraged to participate in presentation of concepts of chemical reactions. Friendly environment was created for expression of thoughts and interaction of students during the teaching–learning process of chemical reactions.

Key words: *Chemical reactions, activity based and meaningful learning.*

Introduction

NCF 2005 says that the education system does not function in isolation from the society of which it is a part. Hierarchies of caste, economic status and gender relations, cultural diversity as well as the uneven economic development that characterise Indian society also deeply influences access to education and participation of children in school (NAS, 2012). Thus the students belonging to ST and SC communities, the rural and urban poor, and disadvantaged sections of religious and other ethnic minorities are educationally most vulnerable (NCF, 2005 and Tulasi, 2005). Reports indicate that relative learning achievements of the students belonging to ST/SC communities especially of rural back ground are very low as compared to that of the other categories and it appears that these students have no sufficient ideas to construct the knowledge because of their social and economic background (NAS, 2012).The constructivist approach of learning is based on the idea that learning occurs when a learner actively constructs a knowledge representation in working memory (Evangelisto, 2002). According to this theory the learner is a sense maker whereas the teacher is a cognitive guide who provides guidance and modelling on authentic academic tasks (Senapaty, 2012). Role of the teachers is to create environment in which learner interacts meaningfully with academic material resources fostering the learning processes of selecting, organizing and integrating information (Fosnot, 1996). All children are, whatever their backgrounds have tremendous potential and if opportunity is given to them they produce wonderful results (Sharma, 2013). Therefore, keeping the aforesaid in view, present study has been carried out using 5 Es (explore, engage, explain, elaborate and evaluate) model of constructivist approach (Barufaldi, 2002). The findings of the study related with learning of chemical reactions in a

SC/ST dominated rural secondary school are presented and its implications are discussed.

Sample

The present study was carried out during field work of the researcher (from 17 July 2012 to 18 October 2012) at Government Senior Secondary School, Shivdaspura located in a SC/ ST dominated area of Jaipur district of Rajasthan state. This school is a Hindi medium school and has professionally qualified teachers. General observation of teaching learning process in this school revealed that teachers were running the process in traditional way. Even in certain classes it was observed that students are simply reading the chapters in front of their classmates. Rajasthan State Government has adopted NCERT curriculum in which main focus is on Activity-based Learning method, i.e., learning- by-doing method. A general interaction with the teachers revealed that learning by doing method is not feasible in SC/ST dominated rural schools as students do not have attitude to learn. This was taken as a challenge and accordingly teaching learning process was initiated in Class X on the topic Chemical Reactions using aforesaid approach.

Process

The first important task in initiating the process was to develop student friendly class room. Since the study was carried out in a rural school which was located in a SC/ ST dominated area, therefore, to develop student friendly class room, it was necessary to know about learners especially on the issues of their background, socio-economic problems and attitude.

Development of Student-friendly Class Room

The information/knowledge about learners were collected through personal interaction in the form of general conversation and interview. The information was also collected using a questionnaire which comprised of the following questions:

- Write about your family background.
- How many brothers and sisters do you have and what is your sequence in them?
- Which behaviour of your parents do you like the most and why?
- Which behaviour of your parents you don't like?
- In your family whom you like most and why?
- Why do you afraid of your teacher?
- Any incident from your life after which you feel afraid of your teachers.
- Why do you hesitate in expressing yourself?
- What do you want to be in your life and why?

Students were given friendly treatment and therefore, they openly shared their views on the above aspects related with them. This information helped the researcher in developing learning environment in the classroom. The common problems of the students were linked with their family environment as it does not encourage them properly for learning. Secondly, in most of the cases there was no one to motivate the students for learning. Though the teachers of Shivdaspura School were good enough to encourage the students for learning but in traditional ways only.

It was also observed that students were suffering from teachers' phobia. However, the phobia about teachers in the students about asking

questions and expressing themselves was based on the following prejudices:

- Teacher will become angry.
- Teacher will say something and he/she may insult them.
- Whatever they are going to express may not be proper.
- Friends will make fun of him/her on committing mistakes.
- Sometimes when their teacher asks questions, they hesitate to answer because they think that their teacher may get a bad impression of them if they could not answer properly.

Considering all the aforesaid issues, student friendly environment was a pre-requisite condition and therefore, all the facts related to their problems were discussed and they were motivated to interact with field investigator. They were also encouraged to discuss their problems. They were assured that the discussion will remain confidential. By these experiments, faith of these students of rural background could be gained.

Medium of instruction was another issue in the teaching learning process as all the students were from rural background and they were not able to communicate in even Hindi properly. Therefore, interaction was made in Hindi and sometimes in regional language also, which was comfortable for the students. Getting the students to learn effectively, following important aspects of effective teaching learning process were also included:

- asking open-ended questions and allowing wait time for responses.
- encouraging the higher-level thinking.
- engaging students in dialogue with the field investigator and with each other.
- engaging students for experimentation and discussion.
- inquiring about understanding of concepts.

Assessment of Previous Knowledge

To assess the previous knowledge and achievement level of the students, pre and post tests were also conducted. Since the topic under consideration was already discussed through traditional method of teaching by regular teacher of the school and there is a topic on physical and chemical change in Class VII, therefore, it was assumed that students have some previous knowledge about the topic (NCERT textbooks 2006). Considering the above facts, pre test on the chemical reactions was administered on the students of sample size 60. After discussing the topic through Activity-based Learning method again a test (post-test) was administered. An analysis of the responses given by the students in pre and post tests indicates that there is improvement in learning of the students about the concept of chemical reactions (Fig. 1 and 2). The relevant data are tabulated below.

Table 1: Percentage correct responses of the learners

Item No.	Pre – Test (Percentage of Correct Responses)	Post – Test Percentage of Correct Responses)
1.	64.86	73.07
2.	21.62	38.46
3.	48.64	53.84
4.	45.94	50.00
5.	13.51	26.92
6.	40.54	65.38
7.	48.64	50.00

8.	27.02	65.38
9.	35.13	38.46
10.	40.54	69.23

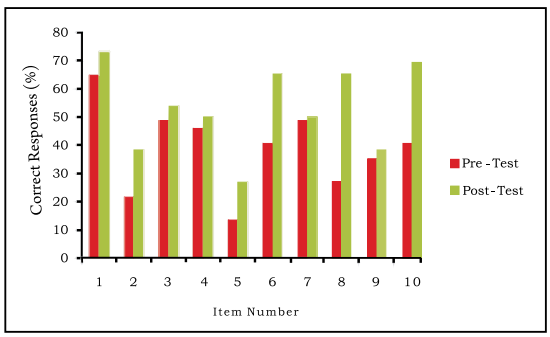

Fig 1: Pre-and post-test data indicating improvement in learning

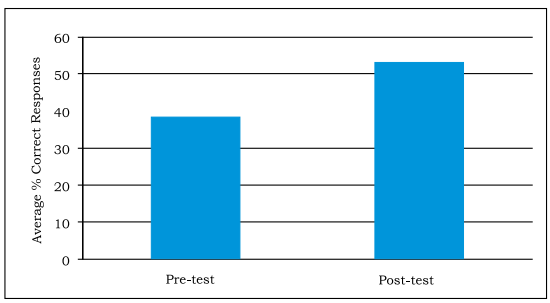

Fig 2: Average of percentage of correct responses of pre-and post-tests

Initiation of Teaching–Learning Process

After developing student-friendly classroom situation, teaching-learning process was initiated on the topic Chemical Reactions in Class X of Government Senior Secondary School, Shivdaspura, Jaipur. The process of teaching learning was initiated in the following way:

First of all, students were asked about some changes occurring in our daily life like vaporization, formation of curd from milk, rusting, pouring water from one pot to another and folding of paper, etc. The students had knowledge about them but they were not able to distinguish them as physical and chemical change. So students were facilitated to perform some activities in classroom.

Learning of Physical and Chemical Change

There were 60 students in this class. So, just to encourage the participation of each and every student, 10 random groups were made and each group was facilitated to perform the following activities and record their observations:

1. boiling of water in a test tube followed by condensation of vapours.
2. burning of Magnesium ribbon followed by collection of end product.
3. addition of Phenolphthalein in aqueous solution of sodium hydroxide.
4. interaction of HCl and Zn metal followed by contact of evolved gas with flame
5. heating of $CaCO_3$ followed by passing the evolved gas in $Ca(OH)_2$ solution.
6. decomposition of H_2O in Volta meter and collection of gases evolved on electrode.

Now observations of the students were interpreted in terms of physical and chemical changes. For it, theoretical background of the changes was made clear by stating that a physical change in a substance doesn't change what the substance is. In a chemical change, where there is a chemical reaction, a new substance is formed and energy is either given off or absorbed. In general, chemical changes are irreversible. It was also discussed that following observations can help us to determine whether a chemical reaction had occurred or not (NCERT Text Books, 2006):

- change in state.
- change in colour.
- evolution of gas.
- change in temperature.

Now students' observations were interpreted one by one as given below:

1. during boiling of water only physical state is changing. No change in chemical composition has occurred so it is a physical change.
2. burning requires oxygen, so in this case magnesium oxide (collected in watch glass) is forming. This is a chemical change because chemical composition has changed.
3. addition of phenolphthalein in aqueous NaOH solution causes colour change, so it is chemical change.
4. in the interaction of HCl and Zn metal a gas is evolved. Since the evolved gas burnt with a noise so it is hydrogen gas. Evolution of gas is also indication of chemical change.
5. heating of $CaCO_3$ evolves CO_2 gas which makes the lime water milky so evolution of gas and change in colour of lime water are indicating chemical change.
6. phase change is taking place in decomposition of water in Volta meter, so it is also a chemical change.

Students were also given chance to reflect, predict and infer during knowledge construction stage. They were also encouraged to explain their views and to promote logical thinking.

Learning of Different Type of Chemical Reactions

Using the same type of approach, teaching-learning process was carried out in the teaching of the types of reactions.

Decomposition Reactions

Students were facilitated to perform the Following activities and to record their observations:

a) $(NH_4)_2\ Cr_2O_7$ was taken on a white tile and was burned by the help of match sticks.

b) $CuCO_3$ was taken in a nickel crucible and it was gently heated.

c) $Pb(NO_3)_2$ was taken in a boiling tube and it was gently heated.

d) heating of $CaCO_3$ was done in a boiling tube and the gas evolved was passed in the $Ca(OH)_2$ solution.

e) decomposition of H_2O was again carried out in Volta meter and the gases evolved on electrodes were collected in test tubes.

Now theoretical aspects of decomposition reactions were discussed by defining these reactions as "the reaction in which a single compound splits/breaks into two or more simple substance(s) under suitable conditions is decomposition reaction".

Now the observations of the students were interpreted as follows:

(a) in burning of $(NH_4)_2\ Cr_2O_7$ following reaction takes place

$$(NH_4)_2Cr_2O_7(s) \longrightarrow Cr_2O_3(s) + N_2(g) + 4H_2O(g),$$

since $(NH_4)_2Cr_2O_7(s)$ is breaking in to $Cr_2O_3(s)$, $N_2(g)$ and $H_2O(g)$ so this reaction is an example of decomposition reaction. Students themselves stated it as a chemical reaction, as evolution of some gases occurred.

(b) heating of $CuCO_3$ results breaking it into its constituents. Colour of compound also changes from green to black upon heating.

It is an example of decomposition reaction.

$$CuCO_3(s) \longrightarrow CuO(s) + CO_2(g),$$

(c) on heating $Pb(NO_3)_2$, its decomposition takes place as follows

$$2Pb(NO_3)_2(s) \longrightarrow 2PbO + 4NO_2(g) + O2(g),$$

the brown gas evolved is NO_2 .

(d) heating of $CaCO_3$ gives CaO and CO_2 as shown below:

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g),$$

when the CO_2 gas was passed through the $Ca(OH)_2$ solution initially calcium bicarbonate is formed which changes to $CaCO_3$ on further passing of CO_2 and turns the solution milky.

(e) following decomposition reaction takes place in Volta meter

$$2H_2O \longrightarrow 2H_2 + O_2,$$

which gases are evolving, was confirmed by noting the volume of water in test tubes. Test tube having less volume of water means more volume of gas. This indicates that it is hydrogen. The other test tube has oxygen. This was further confirmed by burning the gases. The gas in first test tube burns with sound so it is definitely hydrogen gas. In other test tube intensity of flame increases so it is oxygen gas.

Fig. 3: Students performing activities and being observed by teachers

Project Activities for Effective Learning

For proper learning of decomposition reactions students were facilitated to prepare some projects as given below.

(i) Construction of a Volta meter by low cost materials: Each group constructed a Volta meter by arranging a plastic bottle and graphite electrodes from discharged Leclanché cell. Test tubes were made available from the laboratory. Now students were asked to demonstrate the decomposition reaction of water using it.

Fig. 4: Students performing project work

(ii) Preparation of charts on the different type of reactions: Each group prepared charts on chemical reactions through group work. They prepared very nice charts on these reactions.

Organisation of Quiz Competition

Just to revise the concept, quiz competition was also conducted. Students actively participated in the competition and their responses were clearly indicating how much they have learned. Other students of the school were also invited to attend the science quiz.

Fig. 5: students participating in quiz competition related with chemical reactions

Displacement reactions

Students were facilitated to perform the following activities and to record their observations.

(a) Add Zinc strips in aqueous blue solution of $CuSO_4$.

(b) Add aqueous solution of $BaCl_2$ into aqueous solution of Na_2SO_4.

(c) Add KI in the aqueous solution of $Pb(CH_3COO)_2$.

(d) Mix aqueous solution of $(NH_4)_2CO_3$ into aqueous solution of $CaCl_2$.

Now displacement reactions were discussed in term of the reactions in which there is displacement of an element/ion of one compound by element/ion of another compound. There are two types of displacement reactions:

(i) single displacement reactions: These are the reactions in which an element/ion of one compound is displaced by the element/ ion of another compound.

(ii) double displacement reactions: In these reactions, there is exchange of ions between the reactants.

Now students' observations were interpreted to construct the knowledge about displacement reactions as given below:

- in first activity students observed that on adding zinc strips in the solution of $CuSO_4$ its blue colour starts to disappear. This was explained by indicating the following reaction:

  $Zn + CuSO_4 \longrightarrow Cu + ZnSO_4$.

- zinc being more reactive than copper, displaces copper from the solution of copper sulphate and thus zinc sulphate is formed which is colourless. Since zinc is displacing copper, so it is an example of single displacement reaction.

- mixing of aqueous solution of $BaCl_2$ with aqueous solution of Na_2SO_4 gives white precipitate so the observation can be interpreted in terms of the following reaction:

  $BaCl_2 + Na_2SO_4 \longrightarrow NaCl + BaSO_4$,

  $BaSO_4$ is formed by exchange of ions between $BaCl_2$ and Na_2SO_4 so this reaction is an example of double displacement reaction. $BaSO_4$ being insoluble in water appears as white precipitate.

- appearance of yellow colour on mixing of aqueous solutions of $Pb(CH_3COO)_2$ and KI is due to ion exchange between $Pb(CH_3COO)_2$ and KI. Formation of PbI is as per the reaction given below:

  $Pb(CH_3COO)_2 + 2KI \longrightarrow PbI_2 + 2K(CH_3COO)$,

  so the above reaction is also an example of double displacement reaction.

- when aqueous solution of $(NH_4)_2CO_3$ is mixed with aqueous solution of $CaCl_2$ white precipitate of $CaCO_3$ is obtained due exchange of ions between $(NH_4)_2CO_3$ and $CaCl_2$ as given below:

  $(NH_4)_2CO_3 + CaCl_2 \longrightarrow CaCO_3 + 2NH_4Cl$.

Organisation of Seminars

To ensure proper learning of the concept, each student was facilitated to prepare a topic for seminar on chemical reactions and they were made free to present their topic thoroughly. Students were also encouraged to actively

participate in the open session. Initially some hesitation was observed in the students as they felt difficulty in expressing themselves but through motivational sessions they did very well later on. Feedback/views of the students were taken, which are as follows:

- they were highly afraid and hesitant before seminar but during seminar they felt confident because of friendly environment of the classroom. Their hesitation gets removed due to this activity.
- due to this activity they were well-versed in the topic taught.
- during open sessions some students asked questions and presenter replied, it was very much enjoyable and helped them in building up the confidence.
- this was the first step towards eradication of phobia in expressing themselves.
- they felt appreciated when students of their own class clapped on their performance.
- they felt as if they are on moon. They really enjoyed it.

Feedback of the Students about Learning Outcomes

Feedback of the individual student was also taken about their learning out comes. Feedbacks of some students are given below:

- when our teacher taught us, we were used to think, how reaction takes place, what are chemical reactions but now I came to know what a chemical reaction is and how it occurs.
- by doing activities, we have learned the topic by heart. We have learned a lot about chemical reactions.
- we used to simply read the topic but we could not understand about chemical reactions but when we did the activities we got the command on the topic.
- whatever is taught in this way is very well remembered and we will never forget this topic. We also enjoyed a lot in the classroom.
- we want that we should be taught in this way.
- when we used to see the figures in books nothing came to our mind but you showed us everything in reality. Sir, smile has come on our face.
- we are enjoying the teaching learning process. We think that other topics of science should also be taught in this way.
- by seeing these activities it appears that science is not a difficult subject if we are taught in this way.
- we should be taught in this way (activity based) so that we can learn the topic properly.
- learning in this way has motivated us to go ahead in life.
- when our teachers used to teach us in traditional way we were not able to concentrate on studies as we used to be bored, but when you taught us using activity based way, we never felt bored. We should be given such type of environment in the classroom.
- teaching in this way encourages us to learn effectively.

Conclusion

From the findings of the study, it may be concluded that if students are properly motivated and activity-based learning method is used in teaching-learning process, even the students considered as not to have attitude for active learning can also do wonder. In the present case simultaneous assessment has indicated that students were learning well and enjoying the teaching learning process. Performance in state board examination was also improved. This may be attributed due to the motivation and activity-based learning of students towards their studies.

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