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GAMES AND SIMULATIONS FOR TEACHING CHEMISTRY

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Introduction

In the teaching of chemistry, students are expected to learn both concepts and skills. Some of the concepts may be so abstract, or difficult, that students will have problems in understanding them. Likewise, some of the skills, because of certain reasons, may not be easily learnt. The result is that students will not have an opportunity to equip themselves with such skills.

Besides the cognitive and psychomotor aspects, the traditional teaching methods in chemistry seem, in general, ill-suited to achieve the affective objectives. To counter the teaching problems mentioned above, some other teaching strategies have been developed (Daniels 1975). As one of the teaching devices, games and simulations have been found to be useful.

Why are Games and Simulations Useful for Chemistry Teaching?

Games and simulations in chemistry are activities with 'play' situations, which are designed particularly for the learning or reinforcement of some concepts/skills in chemistry, as well as for cultivating some important attitudes, including the appreciation of chemistry. In most games, the number of players involved is limited. They will play according to the rules set and with certain objectives to be achieved by the end of the game. Depending on the design, the winner could be either individual or team. In typical simulations, the exercises have the essential properties of simulations (i.e. they represent a real situation and are ongoing), but lack the basic features of games (competition and rules). Thus, the use of games and simulations in the teaching and learning of chemistry is based mainly on (a) the psychology of 'play' itself, and (b) their relationship to real-life situations in certain aspects.

As Piaget (1962) has already pointed out, informal games played by young children are a critical component in their social and intellectual development. Some formal games and simulations could act in a similar fashion on older children, or even adults. As a result, games and simulations could

- motivate students' learning interest;
- make students utilize the knowledge learnt in an active manner;
- increase students' critical thinking and decision-making skills;
- help students relate information to everyday situations, and thus see the relevance of learning specific information;
- enhance students' retention of what they have learnt;
- lead to personal growth, e.g. communication, cooperation, personal judgment, decision-making and problem-solving.

However, games and simulations which rely on high levels of artificiality should be avoided, as they may mislead students and be counter-productive in achieving objectives.

Classification of Games and Simulations

In general, games and simulations for chemistry teaching can be categorised under the following headings.

1 *Card Games*

Card games are mainly designed for teaching key facts and concepts and for motivating students. When played, the cards are placed in a certain series or matched with other cards according to certain set rules. The way of playing in the matching type is similar to gin rummy or dominoes. Such games provide opportunity for "drill and practice" for the learner to reinforce the concept(s) learnt.

An example of this type of game is "Happy Element Families" (CDIS 1982). The aim of this game is to help students reinforce certain knowledge relating to the elements in the periodic table, with the emphasis on arranging elements stated on the cards into groups (e.g. elements sharing similar properties). The game

contains 36 cards which are divided into nine element groups of four cards each. It can be played by three or more players. Following the instructions given, the game proceeds until all the groups are completed. The player with the largest number of groups wins.

2 *Board Games*

Board games generally consist of a board, tokens, spinner/dice, and/or question cards. A player moves tokens around on a board and/or picks up 'chance' cards and/or develops a strategy to win by well-defined criteria.

The "Periodic Table Game" (Nash 1978) is an example of such a game. It is used for revising chemical knowledge of the elements as well as general chemical knowledge at 'O' level. In this game, the periodic table is the board. The token will proceed according to the number indicated by the die thrown and the rule given. As the player lands on one of the element squares, a certain question needs to be answered before any action can be taken. The first player to reach element 104 is the winner. Any number of plays is allowed. For convenience, six players will be the maximum.

3 *Role Play Simulations*

In this type of simulation, the player represents someone and experiences his problems and powers. He has to apply his knowledge and skill to make certain decisions. Such simulation involves more group work and discussion.

An example of this type is "The Fertiliser Problem" (Reid 1977). In this simulation, the student will play as an adviser, who is going to give advice to a market gardener concerning the use of fertilisers to increase the output of vegetables. Each student has to analyse the set of data given together with his chemistry knowledge to make decisions on the selection of suitable fertilisers. Students work together in groups. To conclude this game, a short class discussion is useful and appropriate.

4 *Computer Simulations*

Computer simulations are simulations that have been programmed for use in a computer. The computer processes data using a certain mathematical model and behaves like a set of science apparatus, or an industrial plant, or a natural phenomenon, etc. The student can study the effect of changing various

factors by observing the outcome of each case, so as to develop an appreciation of the importance of each factor, and the scope and limitations of a system. The interaction will normally be confined to that between the computer and the student. Depending on the design of the programme, it may cater for a wide range of student differences. In general, a computer simulation saves teaching time, and can show some dynamic phenomena or complex concepts.

An example of computer simulations is "CHEM : Simulated Qualitative Analysis" (Payne 1980). The aim of this simulation is to help the learner become familiar with test procedures and deductions by providing the correct responses when the substances are subjected to various tests.

The programme enables the learner to request the results of 20 salts subjected to 11 different tests. The simulation works as follows: the learner selects one chemical from 20 chemicals and subjects this chemical to chosen tests until he can make an inference as to the chemical chosen. If the inference is incorrect, then the learner continues with the task; or if correct, he can choose another chemical.

List of Games/Simulations

A list of games and simulations, which is by no means exhaustive, has been compiled for teachers' reference. The sources of the materials are current journals, commercial products and IE students' assignments. *Readers may write to one of the authors for a copy of this list.*

Conclusion

Games and simulations are potent learning tools designed to challenge students to learn as they compete, socialize, and have fun. It is believed that as a science teaching strategy, games and simulations will have a role to play in the teaching of chemistry.

It is suggested that there should be a follow-up discussion after every game or simulation. The discussion could centre around the strategies and results of the game or simulation.

Students may then generalise, in some cases, from their experiences in the game or simulation to real life situations. This will definitely result in better retention, better understanding, and better appreciation of what they have learnt.

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