

Innovative Way of Learning Basic Language of Chemistry

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Abstract

The symbols of elements, valency and chemical formulae are usually placed in the syllabus of science at the secondary stage in India. It has been observed that students find learning of symbols of elements, their valency and chemical formulae not only difficult but dry and abstract. As a result, students try to memorise them without any interest. Therefore, it becomes a challenge for the teachers to transact these abstract concepts in an interesting way. This research paper focuses on innovative way of making basic language of chemistry interesting and retaining joy of learning among students by allowing them to experience the minds-on, hands-on learning that nurtures their creativity and imagination.

Key Words: Symbols of Elements, Valency, Chemical Formulae, Toy Pedagogy, Visually Impaired, Secondary Stage

Introduction

The subject chemistry has its own language such as symbols of elements, ions, valency, equations of chemical reactions and so on. A chemical symbol denotes in short, a particular element. Chemical reactions are easy to write with chemical symbols than having to write the lengthy chemical names. Numerous studies have revealed that most of the students lack confidence and find difficult in writing chemical symbols and chemical formulae (Marais & Jordaan 2000; Bradley & Steenberg 2006; Taskin & Bernholt 2014).

The experience of Researchers, being in the field of science education, show that students face difficulty in learning symbols of elements, their valencies and chemical formulae. During interaction with teachers, the Researchers observed that teachers also show discomfort in keeping the motivation among students in learning chemistry, as most of the students are unable to balance the chemical equations correctly as they cannot write correct chemical formulae. For writing correct chemical formulae, students have to write correct symbols and their valencies. Also, while interacting with various science educators at different platforms, Researchers realized that learning about symbols; valencies and chemical formulae seem to be universal problem with students across the globe. Symbols of elements, their valencies and writing of chemical formulae are dealt with at secondary level in India. Students try to memorize them without any interest.

There are various card games which can be followed to teach symbols, valency, and chemical formulae etc., in joyful way during teaching-learning process. The studies have shown that card games can be used to learn the

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names and symbols of the elements and also to recognize typical compounds formed by them. This approach was well received by the students and it also engaged them more intensely for longer period (Franco-Mariscal et al., 2012). Card games have also been used by students to practice in identifying an element or ion from chemical symbol, categorizing elements as either metals or nonmetals, determine whether elements will combine to form ionic or covalent compounds etc., (Morris 2011).

In order to make learning of elements and their symbols, valency, chemical formulae etc., interesting among learners, Researchers focused on the following questions:

- Did the innovative way of teaching symbols of elements, their valencies and writing chemical formulae generate interest among learners of secondary stage?
- Was innovative way of teaching symbols, their valencies and chemical formulae more effective and stress free?

Why Toy/Game based Pedagogy?

Teaching basics of chemistry by using toys and involving students in games makes them interested in understanding the basic concepts of chemistry. These allow students to experience the minds-on, hands-on learning that improve their problem-solving skills and also improve their science content knowledge. Toys/games may help in the development of various domains such as, cognitive, psychomotor, socio-emotional, communicative, etc. among learners. The literature has shown that toys and games have existed in India since ancient times. Traditional Indian toys and games were simple and could connect to the real-life knowledge. The literature also shows that how the traditional games are part of one's heritage and cultural tradition, but with the passage of time, they are forgotten and are not passed on to younger generations, due to modern lifestyle (Pramanik & Bhattacharya 2018). According to Amir and Subramaniam 2005, toys can be used by children of all ages to see and recognize science embedded in their daily lives. Teachers who use toys in their lesson plans consider that the creativity, problem solving skills and mental skills of their students improve.

Toys can be used as learning tool for holistic development and experiential learning. As a part of the implementation plan of National Education Policy 2020 in India, it has been voiced that, toys aligned with Indian culture and ethos can be used as pedagogical tools in schools. As a part of the Aatma Nirbhar Bharat mission, the Ministry of Education also recommends to introduce toys and puppet making skills among students.

Methodology - Toy/Game based Pedagogy

Knowing the importance of toy/game-based pedagogy the Researchers used this pedagogy as a strategy for teaching-learning of names of elements and their symbols. They used locally available materials while developing a toy/game. One such example is explained in this paper.

How to create a toy?

Materials Required

Cardboard, coloured chart paper, a pair of scissors, glue, marker, iron nail, one wooden strip.

Stickers having names of following symbols: H, He, Li, Be, B, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, Ar.

Design of the toy

Following steps were followed:

- Took a cardboard and cut it into a shape of a circular disc.
- Pasted a coloured paper on this circular disc.
- Divided this circular disc into twenty equal parts using sketch pen. This has been made tactile by dividing the disc into twenty equal parts using wax or thread or wire etc., (Figure 1).
- Wrote names of the elements/ pasted stickers of elements, such as, Hydrogen, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon, Sodium, Magnesium, Aluminium, Silicon, Phosphorous, Sulphur, Chlorine, Argon etc., one in each part (Figure 2). One can write names of elements alternatively in Braille too.
- Took a wooden strip and pasted a coloured paper on it. Divided this wooden strip into eighteen equal parts using sketch pen. Pasted stickers or wrote symbols of elements one in each part (Figure 3). One may write the symbols of elements alternatively in Braille too.

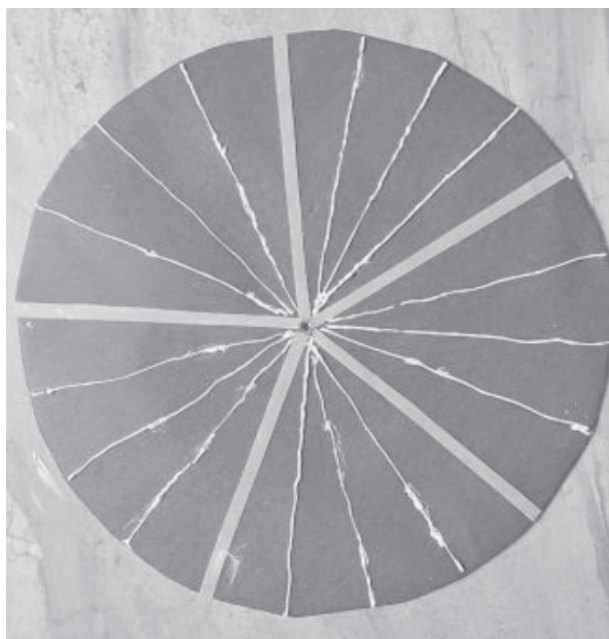


Figure 1: Circular Disc

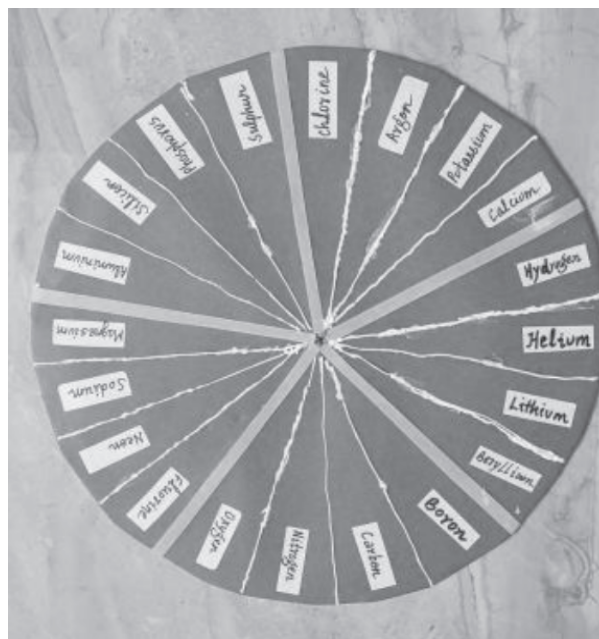


Figure 2: Names of Elements Written on the Disc

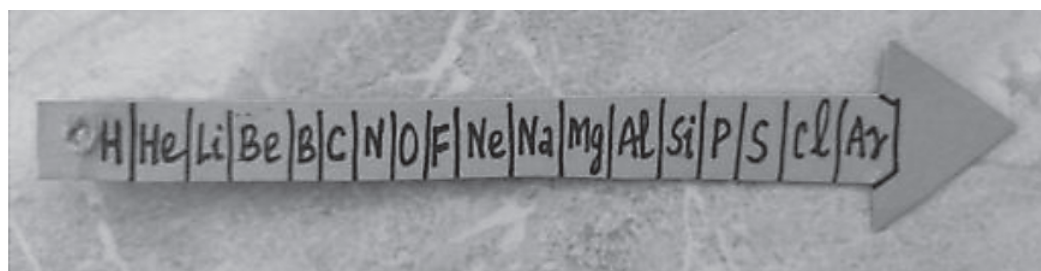


Figure 3: Wooden Strip

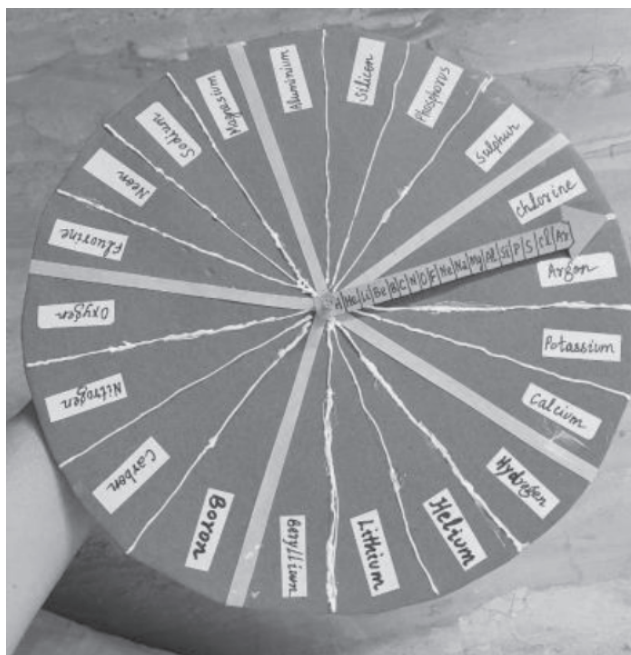


Figure 4: Tick-Tock, Symbol - Element Clock

- Attached this wooden strip to the circular disc using iron nail in such a way that the wooden strip could move freely around the circular disc (as the hand of the clock moves).
- And the toy was ready. The toy was named as “**Tick-Tock, Symbol - Element Clock**” (Figure 4).

How to play the game using the Toy “**Tick-Tock, Symbol - Element Clock**”

Rules of the game

This game can be played inside or outside the classroom.

A healthy inclusive classroom environment provides equal opportunity to all the students; those with and without learning difficulties can learn together.

- The Researchers encouraged visually impaired student to touch and feel the shape of the circular disc before starting the game.
- They divided the class into Two Teams-- A and B.
- The Researcher held the **Symbol - Element Clock** in her hand.
- One member from each team stood next to the Researcher.
- The team who won the toss got the first chance. The member from Team B named any one symbol displayed on the stick of the **Symbol -Element Clock**, say Cl.
- The member of team A moved the disc of the **Symbol-Element Clock** freely and waited till it stopped on its own. The stick stopped pointing towards any one of the Element, say Chlorine.

- Now, the player of Team B has to answer the following questions:
 - Is Cl the symbol of the chlorine?
 - Write any one formula having chlorine non-metal.
- The member of the Team B answered it correctly and got one point. He/she had also written at least one formula correctly, say KCl. The Team B got one more point.
- If Team B was not able to answer the question correctly, then chance would have been given to the member of Team A. If he/she answered it correctly, Team A would have got two points.
- Similarly, the game continued. The team that collected the maximum points won the game.

What More Can We Do?

This toy/game can also be modified and played to encourage multidisciplinary approach during teaching-learning

- Symbols can be written on the circular disc and valency can be written on the stick.
- Chemical name of the substances can be written on the disc and formulae on the stick.
- Specific characteristics of organisms on the circular disc and names of phylum of animalia on the stick.
- Names of rivers/ mountains on the circular disc and names of the states on the stick.

Science Concept behind the Toy/Game

One of the Researchers used this toy/game based pedagogy in the classroom with students of Class IX. While playing this game, it was important for the Researcher that students must know the science behind the toy / game. A chemical symbol is a short-hand method of representing an element. Instead of writing the name of an element, an element name can be represented with one or two letters. The chemical symbol for an element is used while writing the chemical formula for a molecule, or when writing a chemical equation. Valency is the ability of an atom to gain or lose electron, in order to achieve the noble gas configuration. It is obtained by determining the number of electrons in the outermost shell of an atom. The toy/game helped students to understand about the name of elements, their symbols and valency in interesting and joyful way.

Suggested Extension

The Researcher brought fun and enjoyment in the class by using the toy/ game. It motivated students to connect concepts of science with language (poetry/ prose).

One such example is placed below:

Tick Tock, Symbol - Element Clock
 Tick Tock, Symbol - Element Clock
 Hydrogen-H, Boron-B, Carbon-C, Oxygen-O
 Have first letter capitalized,
 What else you want to know?

Fluorine, Phosphorus and Sulphur
 It's the same case So?
 It's F, P and S
 Is there something else?
 He, Li, Be, Ne, Al, Si, Cl, Ar,
 All have first two alphabets from their name
 But there is one...which is not the same
 Sodium is not S or So....
 Symbol of Sodium is Na...
 It comes from Natrium, its latin name.
 H, Li, F, Na, Cl all have Valency one
 Be, O, Mg, S all have Valency of two
 What about elements with Valency three
 B, N, Al, P all these have Valency three...
 Let's play Symbol-Valency clock...
 This goes Tick-Tock, Tick

After playing the game using toy, the Researchers observed that the learning outcomes which students had achieved during teaching-learning process were:

They could--

Use scientific conventions to represent symbols of elements, valency, and formulae.

Exhibit creativity in designing toy/game using eco-friendly materials.

Apply learning of scientific concepts such as importance of symbols of elements in everyday life.

Exhibit values of honesty, objectivity, rational thinking while making the toy and playing the game.

Communicate the findings and conclusions effectively.

Make efforts to conserve and keep environment clean by making judicious use of materials and so on ...

Conclusion

One of the Researchers used this toy/ game pedagogy in the class and observed that students when divided into groups took it as a challenge to win the game. This not only strengthened the concepts but also made it joyful. The challenge for the Researcher was to engage the learners in joyful manner without losing the actual learning of the science concepts.

Researcher kept students engrossed in toy making and playing the game. The curiosity among students leads to acquisition of knowledge. It was observed that their positive emotions played an important role in

learning. Researchers also used this toy/game as an assessment tool, where students were assessed in a stress-free atmosphere. It changed students' state of mind from anxiety to fun and transformed over all environment of the class.

It is recommended that teaching science by using toys and involving students in games makes students interested in understanding the basic concepts of science. Toy/game- based learning allows students to experience the minds-on, hands-on learning that improves their problem-solving skills and nurtures their creativity and imagination (Jarrett et al., 2020).

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