

Effect of Problem Solving Method on Learning of Periodic Table by Using Game Instruction

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Abstract

The purpose of study was to investigate the effect of problem solving method on learning of periodic table by using game instruction. Study objectives were (i) to determine the effect of game instructions on student's problem solving skills; (ii) to investigate the effect of game instructional approach on student's academic achievements: (iii) to compare the mean score of high achiever students and low achiever students taught by game instruction approach. Design of the study was pretest posttest equivalent group design and study was experimental in nature. Population of the study was comprised of the entire Government Girls' High Schools grade-IX chemistry students of District Nowshera. Sample of the study was 40 students of a Government Girls' High School, District Nowshera. Twenty students were assigned to each control group and experimental group on the basis of pre-test through paired random sampling technique. Duration of treatment was 2 weeks. Data were collected personally by the researcher. Analysis of data was done through mean, SD and t-test. The following suggestions and recommendations were made on the basis of findings. The results clearly show that the verities of teaching approach such as use of educational games in teaching and learning process can help to improve student achievement in learning of periodic table, moreover, use of educational games in chemistry classroom during teaching learning process enhance student interest toward chemistry. This study was significant for teachers, students and curriculum development.

Keywords: Problem Solving Method, Game Instruction, Academic Achievement, Secondary Level.

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Introduction

Chemistry is one of all the compulsory subjects in science not solely as results of its various elementary connections with alternative branches of science, however conjointly as results of its wide move influence on the method we tend to measure. Chemistry particularly incorporates four components approaches; want to get (discover or create) chemical data; the ultimate thoughts and specific standards for that reason produced; the functions of that knowledge in perception and ever-changing the world; and also, the implications of that perception and alter for human beings (Cheng & Gilbert, 2009). They conjointly argued that understanding is required to grasp the concepts in chemistry: the persona of chemistry, its norms and methods; the key theories, model and ideas of chemistry; alternatively, chemistry and chemistry-based applied sciences relate to each other; and appreciating the effect of chemistry and chemistry-related applied sciences on society.

Likewise, Nweze, Okafor and Njoku (2004) reported that the teachers have to be expert in the way to use activities that may require creativity and has to be trained with the knowledge of science rather than simply reading the text while teaching science. According to modern learning philosophy, if learners are to gain a practical knowledge of chemistry, they must be forced to be frequently engaged in learning activities. Chemistry should be taught in a way that incorporates innovative ideas, particularly in this innovative era where children learn a lot from mobile phones and computers. Since simply teaching the chemical ideas within the category would not suffice to achieve the requisite mastery of such ideas, chemistry lessons must be activity-based. To overcome these difficulties, innovation such as games could boost mastering and retaining of certain chemical concepts. Drawback resolution technique and game tutorial approach may also be used in educational institutions to spark learners' attention and encourage active participation in chemistry learning.

Mintzes, Wandersee and Novak (2006) have called the periodic table to be "premier graphic tool in chemistry." This claim has been accepted by many historians. Strathern (2000) stated, "Chemistry came of age with the periodic table.... chemistry now has a fundamental concept from which a whole large collection of knowledge might be built".

Since the classical Greek philosophers and their ideas about the nature of matter, the concept of the 'elements' that make up the periodic table has been a source of debate. Is a factor an abstract being, a physically realised substance, or a combination of the two? Mendeleev, who discovered the system of periodic for the arrangement of the elements, had a lot to say

about it, and the periodic table, he believed, was principally a categorization of the elements in their abstract sense. Since then, there has been a long-running debate about how elements survive in compounds, if they do at all. Contemporary debates in chemistry theory are primarily based on a widely quoted paper by radio chemist Paneth, who also proposed the current concept of an element (Paneth, 2003).

Related Research

Adesoji (2008) examined the outcome of a problem solving teaching approach on the success of learners of various skill levels in Chemistry. Poor teaching method was found to be the cause of the difference between high and low performance students' ability to solve science problems. Teachers of science were encouraged to use effective teaching strategies such as problem-solving techniques.

Poripo (2008) investigated in Bayelsa State, Nigeria, the impact of a simulation games on male and female learners' chemistry achievement. The results of the hypotheses that were tested revealed that using the simulation process improved students' chemistry achievement. Students of both the genders all do well, with no statistically meaningful differences in their mean responses.

According to Linda (2020), both chemistry students and chemists can benefit from the periodic table of elements. It depicts all naturally occurring elements and all artificial elements produced in laboratories. Each part, as well as many numbers, is put in its own box. The interpretation of the numbers can tell us a lot about the elements. For chemistry students, the periodic table can be challenging; however, games and puzzles can be very helpful in making the learners to grasp the table. These games can be a lot of fun as well.

There are several advantages of using a student-made board game regarding the periodic table and elements. When learners build the game and solve someone else's, they learn about chemistry. When the learners make the game with someone else, they can even have some experience interacting together (Oakley, 2004).

Statement of the Problem

Problem solving is an essential part of the information, as it should be. It allows learners to use their already gained skills in practical, real-world experiences while also encouraging and assisting the learners in reasoning at higher levels. It assumes that learners should accept certain

responsibilities for their own learning and that they can take personal steps to address challenges, settle issues, explore solutions, and emphasize thought as an important part of the curriculum. Use of instructional games is one of the many problem solving approaches that may be suitable to enhance students understanding regarding chemistry especially in learning of periodic table. The aim of this study is to exercise this method for secondary level students in learning of chemistry especially in periodic table. Problem under investigation is to investigate the effect of problem solving method on learning of periodic table by using game instruction.

Objectives

Objectives of the study were:

- To determine the effect of game instructional approach on students' problem- solving skills.
- To investigate the effect of game instructional approach on students' academic achievements.
- To compare the mean score of high achiever students and low achiever students taught by game instructions.

Hypotheses

The hypotheses were:

- H₀₁ There is no significant effect of educational games on student's learning of Periodic table.
- H₀₂ There is no significant effect of educational games on student's academic achievement in Periodic table.
- H₀₃ There is no significant difference between the mean score of high achievers and low achievers.
- H₀₄ There is no significant difference between the mean score of pre-test and post-test.

Method and Procedure

Population

All Government Girls High School students of Grade-IX studying Chemistry were the population of the study.

Sample

For the conduction of experiment, a sample of 40 students were taken from Grade-IX of a Government Girls' High School, Nowshera. These forty students were separated in two groups by paired random sampling technique.

Research Design

The research study was experimental, where two groups of the participants were formed i.e., experimental and control. To determine the impact of method that involved two equivalent groups and design was pretest posttest equivalent group design (Farooq & Tabassum, 2017).

$$\begin{array}{l} R_E = O_1 \quad T \quad O_2 \\ R_C = O_3 \quad \quad \quad O_4 \end{array}$$

$$\begin{array}{l} dR_E = O_2 - O_1 \\ dR_C = O_4 - O_3 \end{array}$$

$$D = dR_E - dR_C$$

Where:

RC = Randomly Control Group

RE = Randomly Experimental Group

O₁ & O₃ = observation of pre test

O₂ & O₄ = observation of Post-tests

d = Difference between mean scores

T = Treatment (teaching by experiential learning model)

Research Instrument

For collecting data following tool were used.

Pretest and Posttest

Teacher's constructed pre-test and post-test were used for this study. Pre-test was taken to check the student's learning abilities before starting of the treatment on the sample students whereas the post-test was taken after the treatment. Both these tests consisted of 40 items related to periodic table.

Treatment

Experimental group was taught with problem solving method. The students were introduced with game instructional technique (StopGoPs) to solve their problem which they face in learning of periodic table. The students were asked to form simple daily use sentences from the symbols of the elements, then write the atomic and mass number of every element use in the sentence and then memorize with practice. The students were guided to form sentences from the pictures consisting of first alphabet of the element symbol. And fill periodic table worksheet after activates performed in classroom. After treatment researchers were collect data from the result of post-test. While control group was treated with lecture method by delivering lesson on every group of periodic tables daily with additional explanation of necessary topics.

Procedure

Steps followed before treatment

- i) A pretest was taken from the students to check their previous knowledge in the related topic.
- ii) Some questions were asked from the sampled students by the researcher to check their interest towards learning of periodic table and their difficulties in the subject of chemistry and periodic table.
 1. Why do you feel chemistry is difficult?
 2. Do you know the use of periodic table?
 3. Can you people give me an example of a daily use element?
 4. What is the atomic number of that element?
 5. What is the atomic mass of that element?
 6. What is the difference between the atomic number and atomic mass?
 7. Is this element metal or non-metal?
 8. What is the difference between metal and not metal?
 9. From which group these elements belong?
 10. Is there is any relation between the valence and group number?

After discussion with student and pretest result it was cleared that students have difficulties in the following area of the periodic table.

- i) Difference between atomic number and atomic mass
- ii) Difference between group and period
- iii) Difference between metal and non-metal
- iv) Position of the element within group and periods
- v) Number and names of the elements in same group and period.

As this research study is only related to number and names of the elements in the same group and periods, but it is impossible to know the concept of arrangement of elements in groups and period without knowing the concept of atomic mass, atomic number, group and period. To overcome these problems, the researcher guided the experimental group students to find solution of their problems by playing different educational games and activities, before learning the sequence of elements within the group and periods in the periodic table, while control group was thought by lecture method. Including group discussion and answer questions practices.

Day 1 Activities

The teacher provided instruction to students to prepare a model from the China clay or small ball. (consisting of a big ball in the center occupying large area and having compact mass, representing nucleus and small balls revolving around the nucleus representing electrons) to understand the concept of number of proton, electron and neutron and structure of an atom.

From this activity the students learned that

- i) Atom is mainly composed of three particles known as electron proton and neutron.
- ii) Proton and neutron are located in the center forming nucleus of the atom.
- iii) Electrons are revolving around the nucleus in specific shell and sub shell.
- iv) The number of electron or proton present in an atom called its atomic number.
- v) The number of proton or neutron present in an atom called its atomic mass.

Day 2 Activities

Three groups A B and C were formed group one was called to collect pencils, group two was called to collect books and group C was called to collect erasers from their class fellow, after collection they were directed to arrange all these collected material on the basis of similarities i.e., size and color in the horizontal and vertical rows.

From this activity student learned that as they arranged pencils of different size in one group, chemistry books in other group, English books in other group and erasers in other group, all the things were kept in their respective category as student found it, in this why scientist kept elements

in the similar group after their discovery one by one on the basis of similarities in their characteristic.

Day 3 Activities

Two groups A and B were formed. Group A was assigned a task to arrange the students in 10 mins without giving them any criteria. While group B Students were directed to arrange students of their class in ascending order of their roll number.

From this activity the students learned that it is easy to arrange the students on the basis of their roll number. In the same way scientist first try to arrange elements on the bases of similar property and atomic mass later Moseley arranged the elements in the periodic table on the bases of atomic number.

Day 4 Activities

Three groups A, B and C were formed consisting of 2 and 8,8 students respectively standing on a horizontal line. These students were called to collect balls from the basket according to their row number. These three groups represent first three periods of the periodic table, while balls in their hand representing their valence electron.

From this activity student learned about first three periods of the periodic table, number of elements in these periods and the number of valence electron of these elements.

Day 5 Activities

Students were introduced with game instruction and problem solving method to solve their problems which they face in learning of periodic table. The students were asked to form simple sentences of their daily use from the symbols used in periodic table for example Science is Fun. As every alphabet of this sentence represent atomic symbol of different elements.

After activities class work was discussed with the students and they were asked to do their assigned task in groups by shearing different ideas and homework was given on daily basis. Moreover, Students were also encouraged to search on internet also.

Periodic Table and positions of different element were taught by using different educational games. Control group was taught with the traditional teaching method, which includes book, chalk/marker, blackboard/ whiteboard and oral tables and experimental group was taught with problem solving method. The students were introduced to game instructional technique to solve their problem which they face in learning of periodic table.

After finding pretest result it was interpreted that students face two types of problem in periodic table i.e., Name and symbol of the elements as well as their position in group or period.

To overcome these problems, the students were guided to find solution of these problems by playing different games i.e., they were asked to form simple sentences of their daily use from the symbols used in periodic table for example (I) Be Nice then find out their atomic number and atomic mass by using periodic table.

${}^5\text{B}_{10}$ Boron	${}^{28}\text{Ni}_{58}$ Nickel	${}^{38}\text{Ce}_{140}$ Cerium
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Data Collection

Data collection was an important part of the study. For data collection, the researcher developed pre-test and post-test with valuable feedback of the subject experts. Pre-test was used before the start of the experiment while post-test was administered to check sampled students' achievements after treatment.

Data Analysis and Findings

Collected data were tabulated, analysed and interpreted. For statistical treatment of the data mean, SD and t-test was applied. Level of significance was 0.05 in order to obtain results from statistical analysis.

H_{01} .

Table 1

Significant effect of games on student's learning of periodic table

Group	N	Mean	SD	V	df	t-value	Effect
Post-Control	20	11.35	2.27	5.186			
Post-Experimental	20	24.85	4.70	22.134	38	11.55	Significant

Significance level = 0.05

Table Value = 2.024

Table No.1 depicts that the calculated t-value 11.55 was greater than table value 2.024 which were significant at significance level (0.05); hence the

null hypothesis is rejected. It means that games have significance effect on students' learning of periodic table.

H₀₂.

Table 2

Significant effect of games on student's academic achievement in periodic table

Group	N	Mean	SD	V	df	t-value	Effect
Pre-Experimental	20	10.45	2.03	4.155			
					19	15.48	Significant
Post-Experimental	20	24.85	4.70	22.134			
Significance level = 0.05					Table Value = 2.093		

Table No.2 indicates that calculated t-value 15.48 was greater than table value 2.093 which were significant at significance level (0.05); hence the null hypothesis is rejected. It means that games have significance effect on students' academic achievement in periodic table.

H₀₃.

Table 3

Significant difference between high achiever and low achiever students

Group	N	Mean	SD	V	df	t-value	Effect
High Achiever	18	25.611	4.313	18.604			
					17	7.486	Significant
Low Achiever	2	18	0	0			
Significance level = 0.05					Table Value = 1.739		

Table No.3 It is apparent from the table that calculated t-value 7.486 was greater than table value 1.739 which was significant at significance level (0.05); hence the null hypothesis is rejected. It means that there is significance difference between high achiever and low achiever students.

The current study was carried to scrutinize the effect of Problem Solving Method on learning of Periodic table by using game instruction. Following were objectives; (i) to determine the effect of game instructional approach on student's problem solving skills; (ii) to investigate the effect of game instructional approach on student's academic achievements; (iii) to compare the mean score of high achiever students and low achiever students by using Game instruction. All students of Grade-IX from Government Girls' High Schools of District Nowshera were the population of this study. This study was delimited to chemistry subject of Grade-IX used by Government Schools in Khyber Pakhtunkhwa to analyze the effect of problem solving method by using game instruction. 40 girl students of Grade-IX from a Government Girls' High School of District Nowshera constituted the sample of the study.

Conclusions

- It was concluded from the results that “game instructions” had significant effect on student's problem solving skills.
- The result of this study discovered that educational games had significant effect on students' educational attainment.
- The results show that after the treatment with games instruction, the mean score between high achievers and low achievers had significant difference, as it was almost same before the treatment.
- It can be concluded that as in learning and teaching games may improve students' achievement, so suitable game should practice in the classroom.
- The better result in academic achievements of the experimental group also shows that students' interest in using games in learning periodic table are positive and students gain better knowledge from the learning process as compared to experimental group.

Recommendations

- It was concluded from the results that “problem solving method by using game instruction” has significance effect on students' academic achievement and the learner took interest in the subject. Hence it is recommended that teachers should teach periodic table by using games in classroom.

- The result of this study discovered that educational games had significant effect on students' educational attainment. Hence it is recommended that curriculum makers should include such topics in textbook of chemistry which can be taught through educational games.
- It was concluded that the students produce better result in learning of periodic table by using games. Hence it is recommended to apply educational games in other chapters and topics too.
- It is also recommended to use problem solving method and educational games in others science subject and other classes too.
- This study was conducted in girls' school in Pakistan. It is recommended that it would be worth presenting if a similar study is conducted in boys' school.
- Academic achievements of the students were only evaluated in this study, further studied may be required in order to find out the usefulness of problem solving for other dependent variables.
- The curriculum planners should design Chemistry Curriculum to accommodate the activities involving inquiry based skills and problem solving to encourage student's interest in chemistry.
- Keeping the benefits of activity based learning it should be made part of the curriculum of teachers training for pre-service courses.

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