NIGERIAN STUDENTS' SELF-CONFIDENCE IN RESPONDING TO STATEMENTS OF CHEMICAL EQUILIBRIUM CONCEPTS AND PRINCIPLES

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ABSTRACT

The goal of the study was to find out the self-confidence and confidence level of senior secondary schools in responding to statements associated with the concepts and principles of chemical equilibrium. Four hundred and fifty year 3 chemistry Senior Secondary Students indicated interest to participate in the study. The main data collecting instrument was the Chemical Equilibrium Test (CET). This test contained statements that required students to indicate how sure or not they were about the correctness of the statements. Overall results of the study revealed that except for students' ability to determine reaction rate from equilibrium systems, about three students in every one hundred students (3:100) had self-confidence in responding to correct statements of the equilibrium system. Students' level of confidence interval ranged from 0.26 to 0.30. This narrow gap translates to doubt that students have self-confidence in responding to statements of equilibrium system. *[African Journal of Chemical Education—AJCE 6(2), July 2016]*

INTRODUCTION

How sure are you that your answer is correct? This is one of the questions good teachers ask students when answers are given to tasks presented to them (students). All that the teacher wants to find out is the confidence and the level of confidence a student has in giving his/her nod to an answer to the problem. Specifically, chemistry teachers ask students this question when an answer is provided to a chemistry problem.

According to Oxford Advanced Learner's dictionary (6th edition), confidence is the feeling that you can trust, believe in and be sure about the abilities or good qualities of somebody or something.

From Wikipedia's free encyclopedia, confidence is generally described as a state of being certain either that a hypothesis or prediction is correct or that a chosen course of action is the best most effective. We are particularly interested in the individual's confidence-having confidence in oneself. Self-confidence relates to self-assurance in one's personal judgment, abilities and power. To be self-confident is to be secure in yourself and your abilities [1].

Student's self –confidence in responding to educational tasks in a way affects the teacher's lesson delivery in the classroom. In the cause of teaching, teachers ask students questions. As the students answer these questions correctly, teacher's self-confidence is boosted. The implication is that the students are following the teacher and learning becomes meaningful to the students.

Having taught chemistry for over ten years at the secondary school level, I have noted difficulties students encounter in learning some topics and concepts. I also observed that some chemistry students lack confidence in responding to tasks arising from such topics and concepts. One of such topics and related concepts is chemical equilibrium.

The author is not alone. Researchers have indicated why chemical equilibrium poses some difficulty to the students. Glickstein [2] revealed that lack of a human touch is what often keeps high school students from connecting with scientific principles in the way they might connect with literary or historical works. For most teenagers, human relationships are intensely important so lack of this sort of connection in what they are studying can be a determining factor in whether they put their full effort into understanding a concept. Glickstein [2] observed further that standard chemistry textbooks can inadvertently place a barrier between students and the understanding of complex concepts. Chemistry, an inherently abstract discipline, often provides little tangible evidence from every day experience from which a beginner can verify, by direct observation, the phenomena being witnessed. Equilibrium chemistry is one such concept that a teacher can hardly make a presentation that touches the students as a personal way.

Cheung [3] has observed that chemistry curriculum content and chemistry teacher education are two factors that need to be addressed. Secondary students find chemical equilibrium very difficult not only because the concept is abstract but also because there are problems in the selection of curriculum content. Misleading information presented by textbook writers can cause school teachers to hold misconceptions about chemical equilibrium. Teachers cannot help their students understand what they themselves do not understand.

For example, there is a misrepresentation of the equilibrium constants in general chemistry textbooks. Quilez-Diaz and Quilez-Pardo [4] reported that there is a terminology problem as many authors state that practical equilibrium constants, viz kp and kc are unitless quantities. In many chemistry textbooks kp plays the role of the thermodynamic equilibrium constant ko. The correct terminology should be presented to the students [4, 5]. In all, Ozmen [6], [7], [8], Voska and

Heikkinen [9], Quilez-Pardo Solaz-Portoter [10] while studying students from Turkey and other European countries noted that students generally have misconception about chemical equilibrium.

In Nigeria, Chief Examiners' reports in chemistry have shown that students performed poorly in the concept of chemical equilibrium at Senior Secondary School Certificate Examination [11][12]. In spite of all these problems students have with learning the concept of chemical equilibrium, teachers are still teaching the concept and testing/examining the students. Some students succeed while some of them fail. Given the students that succeed do we teachers try to find out whether they (students) are sure that they have successfully learnt the topic as this problem is recurring at the higher level of learning [5]? The goal of this research was to investigate the self-confidence of chemistry students in responding to statements related to chemical equilibrium.

METHODOLOGY

A total of 2303 year three Senior Secondary chemistry students constituted the target population of the study. These students were from five randomly selected schools in Port Harcourt metropolis of Nigeria. These schools are relatively close to each other with a distance of approximately 200metres. These students were requested to indicate their interest to participate in a study involving their knowledge of chemical equilibrium. Four hundred and fifty students indicated their interest. This constituted the sample of study. Age range of the students was from 15 years with mean age of 16.3 years. The students also indicated that they were conversant with,

1. mathematical expressions for the determination of equilibrium constants, k,
2. K is constant for a system at constant temperature,
3. the relationship between kp and kc,
4. the calculation of kp and kc from given set of data, and
5. the difference between homogenous and heterogeneous equilibrium systems.

A Chemical Equilibrium Test (CET) constituted the main data collecting instrument.

Table 1: Specification table for chemical equilibrium test (CET)

S/n	Content	Item numbers	Total
1	Ability to recall definition of Equilibrium terms (concepts)	3, 5,9,12,23,25,26, 27,30,31,32,36,39	13
2	Ability to determine equilibrium constant from an equation of chemical reaction	7,8,11,13,19,20, 28, 29	8
3	Ability to identify factors that affect equilibrium reactions	2,6,14,15,16,17,18,21, 33,34,35,37,38,40.	14
4	Ability to determine reaction rate from equilibrium systems	1,4,10,22,24	5
	Total	40	40

A specification table showed the content and the distribution of the items (Table 1). Altogether the test is made up of 40 items covering students' ability to recall definition of chemical equilibrium terms (concepts), ability to determine equilibrium constant from an equation of chemical reaction, ability to identify factors that affect equilibrium reactions and ability to determine reaction rate from equilibrium systems.

CET contained chemical equilibrium concepts and principles that may be adjudged to be correct or incorrect. There was also an opportunity for the students to remain neutral or undecided if they were not sure of the correctness or incorrectness of the statements. A copy of CET was given to each of three chemistry teachers who had been teaching chemistry for the past ten years at the senior secondary school level. The teachers agreed on the clarity and correctness of 35 items (87.5% of the time). With the suggestions given by the teachers, the remaining items of disagreement were reconsidered and changes effected.

Reliability co-efficient of 0.89 for correctness 0.59 for undecided 0.41 for incorrectness were achieved by comparing two sets of scores of the CET of 25 students from a school not used for the study, after administering the test on two different occasions spanned by two weeks.

CET was administered to the subjects (students) in their various schools. Permission was sought from the schools' authorities and provision was made for the administration of the instrument. The investigator with assistance from the subject's teachers in the schools administered the instrument. Copies of CET were numbered 001 to 450 for the purpose of identification. It took five days to administer the instrument in the chosen five schools. The students were simply requested to tick (√) against each statement, the correctness (sure the answer is correct); If they were not sure, they should indicate "undecided" or ''incorrect'' if they felt that such statement was not correct. The students were allowed 50minutes to provide their responses to the statements.

ANALYSES OF DATA AND RESULTS

Students' responses to correctness of statements, incorrectness and not being sure (undecided) were converted to percentages. The range of percentages for correctness of statements spanned from 12.1% to 48.6% with mean of 34.4% (see Table 2). The range was taken as the confidence interval within which student have confidence in their choice of the correctness of the statements in chemical equilibrium.

Confidence level of each item response to the correctness of the equilibrium statements was estimated by dividing frequency of response by the total sample used for the study namely, (f/N). The confidence level range from 0.08 to 0.42 with mean of 0.28. The overall confidence level of the students in responding to the correctness of concepts and principles in equilibrium systems was taken as 0.28.

Table 2: Item analyses of students' response to the statements of equilibrium systems

S/n	Statement	Correct	Undecided	Incorrect	Confidence level
		%	%	%	%
1	When the rate of backward reaction equals the rate of forward reaction, the system is said to be in a state of dynamic equilibrium	39.8	28.2	32.0	0.40
2	The concentration of A in aA + bB $\rightleftharpoons$ zZ + yZ is doubled, it is expected that the number of collisions between A and B will increase.	43.9	30.0	26.1	0.42
3	The equilibrium constant which expressed the chemical reaction CH_3 COOH $\rightleftharpoons$ CH_3 COO– +H^+ can be written as $K_a = [CH_3\ COOH]\ [H+]$.	40.0	37.3	22.7	0.33
4	The rate of the reaction A+ B $\rightleftharpoons$ C+D can be expressed as rate = k [A] [B] .	35.1	32.1	32.8	0.28
5	If a system contains SO_2, O_2 and SO_3 gases at equilibrium, this will lead to a reaction in which more SO_3 is forned.	48.6	35.7	15.7	0.38
6	In the reaction CH_3 COOH $\rightleftharpoons$ CH_3 COO- + H^+ the introduction of a catalyst will favour the forward reaction.	28.2	40.6	31.2	0.28
7	The expression for equilibrium constant kc always shows all gaseous species.	42.6	43.7	13.7	0.33
8	The expression for kc for the equilibrium C(s) + CO_2 (g) 2 $\rightleftharpoons$ CO (g) is CO_2.	39.4	35.8	24.8	0.33
9	In a system of one mole of H_2 and two roles of NH_3 at 500°C at equilibrium, the ratio of the component will be 1:3:2.	43.1	32.9	24.0	0.37
10	In the equation $N_{2(g)}$ + $3H_2$ (g) $\rightleftharpoons$ $2NH_3$ (g) the rate of forward reaction can be expressed as Rate (f) = kf $[A]^a$ $[B]^b$.	40.0	29.7	30.3	0.26
11	The expression of kc for the equation N_2 (g) + $2O_2$ (g) $\rightleftharpoons$ 2 NO_2(g) is 2[NO_2] [N_2] $[O^2]^2$.	41.8	34.8	23.4	0.33
12	The position of equilibrium would not be appreciably affected by change in container volume for N_2 (g) + O_2(g) $\rightleftharpoons$ 2NO (g).	19.2	36.6	44.2	0.31
13	The expression for kc for the equilibrium N_2 (g)+ $3H_2$ (g) $\rightleftharpoons$ $2NH_3$ (g) is [NH_3] [N_2]$[H_2]^3$.	28.1	32.1	39.8	0.30
14	Increasing original reaction concentration will invariably increase the yield of products at equilibrium	19.5	44.5	36.0	0.34

15	Addition of more H_2 to the system $N_2(g)$ +$3H_2$(g) ⇌ $2NH_3$(g) will favour forward reaction.	38.5	25.4	35.7	0.31
16	Addition of more H_2 to the system N_2 (g) +3 H_2 (g) ⇌ $2NH_3$ (g) will favour the production of Hydrogen only.	40.0	45.0	15.0	0.26
17	Increasing the total pressure for N_2(g) +$3H_2$ (g) ⇌ $2NH_{3g}$ will lower the reaction rate.	37.8	32.7	29.5	0.31
18	Increasing the temperature for N_2 (g) + $3H_2$ (g) ⇌ $2NH_3$ (g) will reverse the reaction.	29.5	38.5	32.0	0.25
19	The expression of kc for $2S0_2$(g) + $O_{2(g)}$ ⇌$2SO_3$(g) is $[S0_3]^2$ $[S0_2]^2$ $[O_2]^2$ $[O_2]$.	28.6	49.7	21.7	0.23
20	The value of equilibrium constant kc for a given reaction depends only on the temperature.	33.4	27.3	39.3	0.27
21	In the equation PCl_5 + heat ⇌ PCl_3 + Cl_2 (g), higher temperature will favour the production of more products in the system.	38.5	30.5	31.0	0.33
22	The rate of the reaction A+B ⟶ C + D may be expressed as Rate = k [A] [B].	13.9	44.6	41.5	0.08
23	Considering the reaction $C_{(s)}$ +CO_2 (g) ⟶ 2CO (g) the amount of gaseous reaction is one mole.	29.8	31.6	38.6	0.26
24	The rate of the forward reaction for Aa + Bb⇌Cc + Dd can be expressed as rate f = kf $[A]^a$	33.9	40.7	25.4	0.28
25	Consider $C_{(s)}$ + Co_2(g) ⟶2CO(g), if one mole of carbon reacts with one mole of carbon dioxide to produce two moles of carbon monoxide, the ratio of carbon (c) to carbon-dioxide is 1.1 .	37.0	42.7	20.3	0.24
26	Dynamic equilibrium involving chemical change is Chemical equilibrium.	45.5	28.3	26.2	0.25
27	Reactions that can proceed in either direction under suitable conditions are reversible reactions.	24.1	27.3	48.6	0.19

28	For a given reversible reaction a high value of k will lead to greater yield of product.	33.4	27.3	39.3	0.26
29	In the expression mA+ nB $\rightleftharpoons$ pC + qD given by k = $[C]^p[D]^q(A)^m[B]^n$ A, B, C, D present the concentration of A,B, C and D.	36.1	35.8	28.1	0.28
30	In k = $[C]^p[D]q\ [A]_m[B]_n$, k means equilibrium constant.	34.8	38.4	26.8	0.26
31	In K = $[C]^p[D]^q[A]^m\ [B]^m$, p and q represent the amount in moles of the products .	34.1	39.7	26.2	0.24
32	The reaction, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is reversible.	32.2	32.7	35.1	0.27
33	In $X_2(g) + Y_2(g) \rightleftharpoons 3Z_2(l)$ $\triangle$ H is negative. A decrease in Pressure and an increase in temperature will shift the equilibrium position to the right.	36.2	33.4	30.4	0.26
34	In a closed vessel of A (g)+B(g) $\rightarrow C_{(s)}$ + D (g)$\triangle$H is negative will increase the yield of C by removing some D.	36.2	33.4	30.4	0.28
35	In A (g) + B(g)$\rightleftharpoons C_{(s)}$ + D(g) increase in pressure will shift the equilibrium position.	34.7	32.8	32.5	0.28
36	In A(g) + B(g) $\rightleftharpoons C_{(s)}$ +D(g), the amount gaseous reactants is 3 moles.	46.4	14.4	39.2	0.40
37	In $C_{(s)}$ +CO_2 (g) $\rightleftharpoons$2CO(g),if some of the carbon did not change, the equilibrium will shift to right.	29.5	45.5	25.0	0.26
38	Considering Ca $CO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ addition of more $CaCO_{3(s)}$ will shift the equilibrium to the right.	12.1	41.9	46.0	0.40
39	Dynamic equilibrium involving a physical change is known as physical equilibrium.	39.3	22.3	38.2	0.18
40	Introduction of a catalyst in a system will enable equilibrium to be reached in a shorter time	43.6	26.3	30.1	0.23

Table 3: Overall means of self-confidence levels of the students' responses to chemical equilibrium statements

S/N	Ability to	Mean ($\bar{x}$)self-confidence levels of students
1	recall definition of chemical equilibrium terms (concepts)	0.28
2	determine equilibrium constant from an equation of chemical reaction	0.29
3	Identify factors that affect equilibrium reactions	0.30
4	determine reaction rate from equilibrium systems	0.26
	overall	0.28

It was observed in table 3 that except for students' ability to determine reaction rate from equilibrium systems (S/No.4), about three students in every one hundred students (3:100) had self confidence in responding to correct statements of the equilibrium system. Table 3 also provides a range of values or interval within which to assess further the confidence of the students. Therefore the interval 0.26 to 0.30 consists of the probability of accepting the self-confidence of the students in correctly responding to the statements of the equilibrium system.

DISCUSSION OF FINDINGS

Teachers use objective and essay tests or both in evaluating what the students have learnt. It is also necessary to find out whether the students are sure of what they have learnt. This is possible by presenting the students with the fact and making them to assert their confidence on the correctness of the facts. This study has shown that the students are confused when they are presented with the facts which they would have learnt. The student used for the study indicated that they were conversant with chemical equilibrium concepts and principles. The study showed over 14% of the students were undecided about the equilibrium statements. And about 13% indicated incorrectness of the chemical equilibrium statements. This was quite surprising because the students that participated in the study had earlier indicated that they were familiar with the concepts and principles of chemical equilibrium.

The equilibrium systems include amongst others those of homeostatic balance as in biology, equilibrium of forces as found in mechanics of physics and chemical equilibrium. When chemical equilibrium is mentioned these equilibrium systems come to memory of the learner. The implication of this is that something is common with the systems which is the concept of balance. A student learning chemical equilibrium is likely to use the knowledge gained with respect to balance to understand equilibrium in biology and physics. There are static and dynamic equilibrium. These are generally applied in the understanding of the equilibrium systems. It becomes necessary for students to understand in totality the concept of equilibrium when learning chemical equilibrium. A measure of the students' confidence in responding to chemical equilibrium reveals their level of seriousness in learning the concepts which is of concern to a chemistry teacher and chemical educator.

RECOMMENDATIONS

The study has shown that secondary students do not have confidence in responding to concepts and principles related to chemical equilibrium system. The narrow gap between the confidence interval of 0.26 and 0.30 reveals, this. This result may be due to some variables identified by some earlier researchers. These include the students' attitude towards learning, teachers' conception and misconception in chemical equilibrium, presentation of information related to statements in chemical equilibrium as revealed in some chemistry textbooks and the curriculum content of chemical equilibrium [4,7]to mention a few.

On this note, it becomes necessary to re-examine the curriculum content of chemical equilibrium with respect to validity, reliability, significance and relevance. Chemical equilibrium systems in the chemistry books commonly used by the secondary students should be reassessed for the right conceptions and misconceptions corrected. It appears that the students are not sure of what they are learning.

Studies [3] have shown that chemistry teachers and chemical educators are part of the misunderstanding the students have in learning chemical equilibrium. Teachers do not seem to have a grasp of the knowledge contents of chemical equilibrium. Teachers cannot teach what they (teachers) do not know. Maybe the government should ensure regular in-service training for the chemistry teachers.

It is also necessary to consider the memory capacity of the students in terms of concretizing related concepts and principles in chemical equilibrium.

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