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Remedial Science Students' Understanding of Selected Chemistry Concepts During Their Post-Primary School Science Programme

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The present study was undertaken with a view to evaluate the understanding of the basic concepts in chemistry needed by remedial entrants for pure and applied science-based degree courses.

Introduction

The notion that tertiary institutions bear some responsibility for helping students overcome weaknesses in academic backgrounds and skills has been expressed in literature. Morse and Clapp (1980) in their concern for the student who comes to the college chemistry ill-prepared had proposed various solutions to students' weaknesses in the introductory chemistry courses. Their alternatives approach to teaching freshman chemistry through problem-solving led to improved performance by students. Niedzielski and Walmsley (1982) had recognized the general deficiency in students' chemistry background as they opt for remedial freshman chemistry courses for the various science based programmes in tertiary institutions. Their research provided an insight into the specific chemistry concepts that should be mastered by a freshman after completing the freshman chemistry programme. Rouse (1981) had observed that most students backgrounds in remedial freshman chemistry classes range from no previous chemistry to two years of high school chemistry. Remediation, therefore, would imply helping a student overcome academic deficiencies in order that the student may enter a university remedial science programme for degree courses in the natural and applied sciences. Such work mainly consists of non-credit courses in biology, chemistry, English, mathematics, and physics taken as prerequisites to degree courses.

Most universities in Nigeria require credit at General Certificate of Education Ordinary Level (GCE O/L) in some of the natural sciences for degree courses in the faculties of agriculture, engineering, medicine, and the sciences (JAMB Brochure, 1988/89 session). Academic performance clearly becomes the *sine qua non* for the validation of most universities remedial courses. The validating criteria consist of grades and test scores. But recent statistics in sessional results in

chemistry for remedial entrants in the University of Cross River State (UNICROSS) indicate a poor trend of performance. The trend is illustrated in Table I.

TABLE I

1984-88 Remedial Chemistry Results

Year	Number of Students	Percentage Scoring Grade C and Below*
1984/85	139	96%
1985/86	125	74%
1986/87	125	93%
1987/88	150	69%

*UNICROSS assigns a letter grade of C to scores of 50%–59%

In an attempt to get to the solution to the problem of what to do for the student who comes to remedial chemistry ill-prepared, it was thought of interest to undertake this study with a view to:

1. Evaluating the understanding of the basic concepts in chemistry needed by the UNICROSS remedial entrants for degree courses in the Faculty of Pure and Applied Sciences.
2. Identifying the concepts which are not very well understood by students.
3. Teaching the identified concepts with appropriate treatment and emphasis; and
4. Comparing the entry performance of students with their terminal course examination in chemistry.

Methodology

Sample: The sample for the present study comprised of two sets of randomly selected UNICROSS remedial science students; viz, 100 remedial science students for the 1986/87 school year; and 150 remedial science students for the 1987/88 school year. Table II presents the demographic information of the sample.

A break down by sex indicated that for the 1986/87 school year 60 males and 40 females took part in the study; while the sample consisted of 81 males and 69 females in the 1987/88 school year. Most of the remedial entrants had attended urban secondary schools. Only 70 of the 150 entrants in the 1987/88 school year had the pre-entry academic qualification of the General Certificate of Education Ordinary Level (GCE O/L) in chemistry. Similar qualification had been indicated by 55 out of 100 respondents during the 1986/87 school year. Other relevant academic experiences of the respondents were as spelled out in Table II.

Instrument: A 40-item multiple choice pre-test of internal consistency 0.58 was developed by the researchers and administered to similar subjects prior to the experiment. The pre-test concepts were derived from the work of Zimelis (1981); and the recent syllabus contents of the Comparative Education and Adaptation Centre (CESAC 1985) Chemistry Curriculum. About twenty school certificate level concepts based on the syllabi were selected. Two multiple choice questions, each having five options, were asked of each concept.

Four experienced chemistry lecturers were asked to validate the instrument. Their comments and suggestions were incorporated in the final draft of the instrument which tested the concepts listed in Table III.

Administration: The final draft of the instrument was administered to randomly selected remedial science students during the 1986/87 and 1987/88 academic sessions respectively. By each session, the test was promptly administered during the first week of reopening. This was to ensure that the subjects' responses were not affected by University instruction. The results of the pre-test and post-test for the 1986/87 remedial

TABLE II

Respondents' Demographic Information

Variable		Distribution	Number			
1.	Sex	Male	81		60*	
		Female	69		40*	
2.	School Location	Urban	80		55*	
		Rural	70		45	
			O/Level GCE	Form 5	Form 4	Form 3
3.	Respondents' Pre-Entry	Biology	84	106	108	111
	Academic Experience with		71*	90	100*	100*
	Science (GCE/	Chemistry	70	100	101	104
	O Level score		55*	80*	95*	98*
	at Credit Level)	Physics	30	71	76	80
			20*	31*	40*	60*
		Mathematics	50	116	119	150
			21*	95*	98*	100*

*Asterisked numbers denote 1986/87 demographic information of 100 respondents; non-asterisked numbers denote 1987/88 information of 150 respondents.

entrants provided the basis for identifying and reteaching the concepts which seemed difficult to the 1987/88 students. The identified difficult concepts were given appropriate treatment and emphasis during the 1987/88 school year. By the end of the 1987/88 session, therefore, students had a post-test of the designed instrument and their regular end of course examination in chemistry.

Data Analysis

The data was analysed by grading the answer sheets of the respondents. The index of difficulty for each item of the test was computed as specified by Lindeman and Merenda (1979) by "dividing the number of pupils passing the item by the total number of pupils in the combined high and low groups." The average difficulty index for every two multiple choice questions asked of each concept was calculated. The cut-off values for high, middle, and low range of difficulty was empirically determined as 0.66 to 0.99; 0.46 to 0.65; and 0.10 to 0.45 respectively. The results are presented in Table III.

The mean score and standard deviation were calculated for the two sessions' test scores. The levels of performance between the pre-test and the post- test of each session were then compared and their significance levels estimated by

TABLE III

Test Concepts and Response Patterns Among Students

	Test Concepts	1986/87* Test Scores				1987/88** Test Scores			
		No Right		Difficulty Index		No Right		Difficulty Index	
		Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1.	Separation and Purification of Substances	85	92	0.80	0.95	116	140	0.77	0.93
2.	Chemical Combinations	54	60	0.52	0.63	60	79	0.40	0.53
3.	Kinetic Theory of Matter	36	39	0.25	0.35	35	28	0.23	0.19
4.	Gas Laws	64	60	0.63	0.61	58	63	0.39	0.42
5.	Periodic Table and Bonding	75	92	0.72	0.90	89	97	0.59	0.65
6.	Chemical Measurements	50	57	0.48	0.52	58	54	0.39	0.36
7.	Water	37	45	0.35	0.41	38	43	0.25	0.29
8.	Solubility	44	47	0.43	0.44	43	54	0.29	0.36
9.	Acids,Bases and Salts	60	65	0.62	0.68	72	43	0.48	0.29
10.	Oxidation and Reduction	49	54	0.46	0.52	58	55	0.39	0.37
11.	Electrolysis	34	31	0.30	0.28	24	41	0.16	0.27
12.	Energy Changes	75	80	0.72	0.76	84	80	0.56	0.53
13.	Rates of Reactions	35	32	0.32	0.29	31	29	0.21	0.19
14.	Chemical Equilibrium	46	49	0.42	0.46	48	59	0.32	0.39
15.	Metals and their Compounds	78	76	0.77	0.74	76	66	0.51	0.44
16.	Non-metallic Chemistry	47	50	0.43	0.49	54	60	0.36	0.40
17.	Organic Structure	77	83	0.74	0.81	93	129	0.62	0.86
18.	Particulate Nature of Matter	80	89	0.78	0.88	95	94	0.63	0.63
19.	Nuclear Chemistry	70	81	0.71	0.78	90	121	0.60	0.81
20.	Laboratory Techniques	49	53	0.46	0.50	50	51	0.33	0.34

* 1986/87 Test Scores for 100 students

** 1987/88 Test Scores for 150 students

TABLE IV

t-Test Results on Test Scores

Session	N	Mean Score	SD	Df	t	Table t
1987/88	150	Pre-test=63.6 Post-test=69.3	24.2 31.3	149	3.34*	At 5%=1.96 At 10%=1.65
1986/87	100	Pre-test=57.3 Post-test=61.8	12.8 19.0	99	3.48*	At 5%=1.96 At 10%=1.65

*The t value for each session shows that some significant differences exist between the mean of pre-test and post-test.

employing t-test statistics at both 0.05 and 0.1 within the relevant degrees of freedom. The results are presented in Table IV.

Results and Discussion

The present study was undertaken with a view to identify chemistry concepts which were not well understood by remedial entrants during their post-primary chemistry programme; and also to provide the remedial chemistry instructors with areas that needed in-depth treatment and appropriate emphasis during the teaching-learning process. After incorporating any identified difficult concepts into a modified teaching- learning scheme, it was expected that there would be a general improved performance in the terminal course examination in chemistry.

The average difficulty index for every two multiple choice items asked of each concept is presented in Table III. The mean scores and standard deviation together with t-values are presented in Table IV.

The test concepts and response patterns as presented in Table III show that the difficulty indices for test concepts on separation and purification of substances, periodic table and bonding, energy changes, metals and their compounds, organic structure, particulate nature of matter, and nuclear chemistry fall between 0.70 and 0.95 for both pre-test and post-test during the 1986/87 session. It may be inferred that some of the test items on these concepts were relatively easy. During the 1987/88 session the remedial entrants again passed well on the concepts of separation and purification of substances, organic structure, and nuclear chemistry with the difficulty indices ranging between 0.60 and 0.93 for the pre-test and post-test scores.

The difficulty indices for concepts like chemical combinations, gas laws, chemical measurement, oxidation and reduction, chemical equilibrium, non- metallic chemistry, and laboratory techniques during the 1986/87 session ranged between 0.46 and 0.65. This signifies that the included concepts were in the middle range of difficulty; and would clearly not discriminate between those who did well and those who did poorly on the particular test item. The performance of the 1987/88 entrants on the listed concepts was generally poor as judged from most of the difficulty indices that ranged between 0.10 and 0.45. While these concepts challenged the abler students, each test item on these concepts may need to be restructured to provide for the reasoning ability of the average student.

Generally it can be inferred that more than 50% of the concepts tested by this instrument were found difficult by the remedial entrants of

the 1986/87 and 1987/88 school years. These included chemical combinations, kinetic theory of matter, gas laws, chemical measurements, water, solubility, acids-bases-salts, oxidation-reduction, electrolysis, rates of reaction, chemical equilibrium, non-metallic chemistry, and laboratory techniques.

TABLE V

Course Performance on Identified Difficult Concepts During 1987/88 Session

	Concepts	%age Passing Each Concept at Credit Level*
1.	Chemical Combination	60
2.	Kinetic Theory of Matter	55
3.	Gas Laws	56
4.	Chemical Measurements	70
5.	Water	68
6.	Solubility	65
7.	Acids-bases-salts	50
8.	Oxidation-Reduction	56
9.	Electrolysis	40
10.	Rates of Reaction	60
11.	Chemical Equilibrium	67
12.	Non-metallic Chemistry	70
13.	Laboratory Techniques	45

*Pass at Credit Level means a score of 50% and above.

The results in Table IV indicate an overall significant difference in the mean scores of the four treatment groups. The t-test statistical analyses signify that the response pattern to the test is peculiar to each set of entrants in a particular year.

It seems that the identification of concepts which were not well understood by students, and teaching the identified concepts with appropriate treatment and emphasis increased students' ability to comprehend and apply any acquired chemical information. The 1987/88 course examination results in Table V indicate a general improved performance on the identified difficult concepts.

Significance of Study

The University of Cross River State admits 80 per cent of her indigenous students mainly from schools around the state for the remedial science programme. Thus, the results of this investigation was taken as a representative of the complete range of schools in the Cross River State and a partial range of schools in Nigeria.

The degree of accuracy of students' pre-test and post-test performance formed the basis of identifying the concepts which were not very well understood by students. The identified difficult concepts provided the remedial chemistry instructors with areas that needed in-depth treatment and appropriate emphasis during the teaching-learning process. It was hoped that the study might foster dialogue between secondary school and university teachers. Such a dialogue may be helpful in the reorganization of the time allotments that one assigns to each topic. Moreover such forum may generate other basic information so that further data could be gathered and other studies conceived to improve instruction in remedial chemistry.

Conclusion and Recommendations

Wiseman (1981) has stressed that "the combination of factual material, mathematical

calculation, and theory that constitute modern chemical knowledge contribute toward making chemistry one of the most intellectually demanding subjects in the university or high school curriculum". This study obviously found that some chemistry concepts in the secondary school curriculum are giving difficult time to students during the teaching- learning process. For the concerned chemistry instructor, areas where more emphasis is needed or a more thorough review of fundamentals is required have been identified. The study should be repeated to include other relevant chemistry concepts. The cumulative result of such study should help to establish a set of objectives that would encompass those ideas or concepts of chemistry which should be required by every student completing a secondary level chemistry course.

There is need to determine the kind and level of academic skills that are essential to the mastery of specific concepts in the various science disciplines. A similar research is needed in the areas of biology and physics as well as mathematics. It is hoped that such work would contribute to the smooth continuation of science work when students transfer from the remedial programme to the regular university courses.

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