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Effect of Dialectical Constructivism on Second-Year Home Science Students' Performance and Attitude towards Biochemistry at Mukuba University

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Abstract*— The purpose of the study was to determine the effect of Dialectical Constructivist learning approach on the attitude and performance of second-year Nutritional Sciences students in Introduction to Biochemistry course. The sample size of the study was 75 students, 38 were in the control group, and 37 were in the experimental group. The research subjects were purposively sampled but randomly assigned to control and experimental groups. Two research instruments were used for data collection. The first was Attitude towards Biochemistry Questionnaire and the second was a Biochemistry Performance Test. The design of the study was pre-test post-test control group quasi experimental design. The students in the experimental group were taught Biochemistry course using Dialectical constructivist learning approach, whereas students in the control group were taught using the conventional approach. To assess attitude of the students towards Biochemistry, a Biochemistry Attitude Questionnaire was used. There was enhancement of attitude towards Biochemistry in the experimental group than in the control group owing to a significant change of attitude Mean. Therefore, using Dialectical constructivism in teaching Biochemistry was found to have a positive effect on enhancing Nutritional Science students' attitude towards Biochemistry. Further, to assess the achievement of students towards Biochemistry, a Biochemistry achievement test was used. An independent samples t-test at an alpha (α) = .05 was conducted to analyze the results of the pre-test and post-test scores. There was a significant difference in the scores for experimental (M=58.9189, SD=15.01551) and control (M=43.4474, SD=13.92392) groups; t (73) =4.629, p = 0.000 The magnitude of the differences in the means was large (eta squared =.227). Therefore, using Dialectical Constructivism in teaching Introduction to Biochemistry course was found to have a positive effect on enhancing students' performance in the course.

***Index Terms*— Attitude, Dialectical constructivism, Performance.**

I. INTRODUCTION

Introduction to Biochemistry (CHE 200) is a course among courses taught to students in the Bachelor of Education in Nutritional Sciences Programme in the School of Applied Sciences and Technology of the Mukuba University in Zambia. However, the author, when he first taught the course to the class, interesting aspects' of students towards the course were observed. For instance, in the main, students were failing to draw correct structural formulae for biomolecules during classroom transactions. Additionally, students were generally not enthusiastic to learn the course and they expressed negative sentiments towards Biochemistry during classroom transactions such as it was a difficult course to learn and felt that they would fail the course during the sessional examinations. It was thereafter learnt that in the previous years, the performance of students in Biochemistry was not impressive. Some students were made to pass the examination when examination results were moderated.

Further, it was discovered that students in this Programme were made to study Introduction to Biochemistry in second – year without doing any foundation course in Chemistry in the first year. This was due to a high number of courses that they learnt in the first year. However, curriculum design presumes that students' good performance in a higher course depends on students getting enough grounding and successful completion of a lower course whose content forms the fundamentals and prerequisite knowledge of the higher course [1]. Therefore, Learning Biochemistry without any background in Chemistry, specifically, Bonding and Organic Chemistry makes students struggle to comprehend structure and reactions of Biomolecules. This results from the fundamental superposition that students should be taught knowledge and skills in a prerequisite lower course upon which the successive higher courses will build [2]. We must hasten to state that Biochemistry is a challenging course to students owing to the fact that students' meaningful learning is dependent on the application of prerequisite knowledge gained from general chemistry, organic chemistry and biology to the fundamental Biomolecules and their chemistry [3].

To learn meaningfully in Biochemistry as it is in all other courses, students should be able to associate the new knowledge with what they already know. But without prior knowledge in general and organic chemistry, students obviously experience rote learning in Introduction to Biochemistry. Information acquired through rote learning is stored in the short-term memory unlike for meaningful learning in which it is stored in the long-term memory [4]. It must be mentioned that information acquired through rote-learning is easily forgotten. Learning Introduction to Biochemistry by second-year students in the Bachelor of Education in Nutritional Sciences by memorization of facts does not motivate students to like the course, therefore it

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leads to negative attitude towards Biochemistry [4]. Indeed, there seems to be a strong association between attitude and performance. That, generally, negative attitude towards a course leads to undesirable performance [5].

In order to enhance attitude of Home Science students towards Biochemistry and consequently improve their performance, dialectical constructivism was employed during classroom transactions. The basis for selecting this teaching approach was because dialectical constructivism supposes that knowledge is constructed during social interaction, classroom transactions and interactions that is characterized by sharing, comparing and debating among students and teachers [6]. Dialectical constructivism is a highly interactive learning process in which a students' social environment of learning is given first priority and students are enabled to challenge their understanding, refine their own meaning and assist their colleagues to discover meaning thereby constructing or building knowledge mutually. The basic nature of dialectical constructivism is collaborative-elaboration of knowledge through social interaction as opposed to individual inquiry of cognitive constructivism. It is through a highly interactive social milieu of learning that a student constructs own knowledge.

II. PURPOSE OF THE STUDY

The purpose of the study was to find out the effect of dialectical constructivism on Second-year Home Science students' attitude and performance in Biochemistry.

III. RESEARCH QUESTIONS

1) What is the effect of Dialectical Constructivism on second-year Home Science students' attitude towards Biochemistry?

2) What is the effect of Dialectical Constructivism on second-year Home Science students' performance in Biochemistry?

IV. HYPOTHESES

The Research Hypothesis was:

H_A: There is a statistically significant difference in performance between Home Science Students in the Bachelor of Education in Nutritional Sciences who are taught Introduction to Biochemistry using Dialectical Constructivism and those taught using the Conventional Lecture Method.

The Null Hypothesis

H_O: There is no statistically significant difference in performance between Home Science Students in the Bachelor of Education in Nutritional Sciences who are taught Introduction to Biochemistry using Dialectical Constructivism and those taught using the Conventional Lecture Method.

V. METHODOLOGY

A. RESEARCH DESIGN

The study was not a true experimental design, because participants were purposively selected but randomly assigned to experimental and control groups. Therefore, the design was pre-test post-test control group quasi experimental design. The pre-test enabled for the assessment of whether the control and experimental groups were equivalent on attitude towards Biochemistry and performance in Biochemistry before the treatment was given to the experimental group. Additionally, it was possible to carry out an assessment of any changes that may have ensued in either control or experimental groups during post-treatment by comparing the observations made during pre-test and those made during post-test. If Dialectical constructivist learning had any effect on either attitude or performance of students in Introduction to Biochemistry, then there was a significant change of attitude or performance for the experimental than for the control group.

B. The structure of quasi-experimental design that was used during the study

The experimental group studied carbohydrates, lipids, and proteins in the Introduction to Biochemistry (CHE 200) course of the Bachelor of Education in Nutritional Sciences of the Mukuba University through the use of Dialectical Constructivist learning approach. The control group was taught the same content using the conventional lecture method.

The following was the structure of the pre-test post-test quasi experimental design that was used in this study.

O_1	X	O_2
O_1	–	O_2

Where:

O_1 were the observations made during the pre-test measures. Both the experimental and control groups were given a test on chemical bonds of biological molecules, identification of functional groups in biological molecules, and water and its importance in biological systems. Students had already covered this content and hence it was pertinent to test them in order to ascertain their equivalency on performance in Biochemistry. Thereafter a Biochemistry Questionnaire was administered

X was the treatment that was employed in order to assess its effect on students' performance and attitude towards carbohydrates, lipids, and proteins in the Introduction to Biochemistry (CHE 200) course of the Bachelor of Education

in Nutritional Sciences of the Mukuba University. The experimental group was taught using Dialectical constructivist learning, but the control group was denied the treatment, they were taught using the conventional lecture method during Biochemistry lessons. The treatment (X) involved students in the experimental group working together at tasks as learning teams. Each team typically consisted of five (5) students. During classroom team work transactions all the students in a team were to participate, agree on responses as a team but each member to write agreed on responses on their own. During classroom presentation of work, only one student chosen by the teacher at random would do the presentation to the whole class and the students' score would be the score for the whole team of students. Further, only one student from the team would have their work assessed, but the score would be for the whole group. Therefore, students were encouraged to practice collaborative elaboration and teach their peers as the randomly chosen students' work would be representative of the rest of the members and would be used for evaluating the whole team.

O_2 were the observations made during the post-test. Both the experimental and control groups were given carbohydrates, lipids, and proteins test (CLP), and then the Biochemistry Attitude Questionnaire as post-test measures. Then comparisons were made between pre-test and post-test attitude and performance within groups and between groups. If there was a significant difference in both or either attitude towards biochemistry and CLP test between the two groups, then it was deduced that the dialectical constructivism learning was the cause of such change.

C. TARGET POPULATION

The population of this study included all the second-year students registered in the Introduction to Biochemistry (CHE 200) course of the Bachelor of Education in Nutritional Sciences at the Mukuba University.

D. SAMPLE AND SAMPLING PROCEDURE

Second-year students registered in the Introduction to Biochemistry (CHE 200) course of the Bachelor of Education in Nutritional Sciences of the Mukuba University were purposively selected, but randomly assigned to control and experimental groups. In the control group, there were 38 students, whereas, in the experimental group, they were 37. This gave a total sample of 75.

E. RESEARCH INSTRUMENTS

The two independent variables in this study were: attitude towards Biochemistry, and performance of students in the Introduction to Biochemistry (CHE 200) course of the Bachelor of Education in Nutritional Sciences of the Mukuba University. To assess performance of students in carbohydrates, lipids, and proteins a CLP test whose test items were constructed by the researcher was used. Further a questionnaire was used to assess the attitude of students towards the course.

F. CONSTRUCTION OF THE BIOCHEMISTRY ATTITUDE QUESTIONNAIRE

To measure attitude of Home Science students towards Biochemistry, a Questionnaire was constructed. The questionnaire items were designed after 'brainstorming' a meagre sample of only 20 students. Students were required to list down to the extent possible, the various facets of their attitude towards Biochemistry. The criterion used for selection of the aforementioned 20 students was their expression of either low or high liking of the Introduction to Biochemistry course. This was premised on the assumption that the responses of such students would facilitate the design of questionnaire items that span the whole spectrum of attitude towards Biochemistry that the researcher desired to measure [7].

In order to avoid the tendency by respondents to give the same response to every questionnaire item (response bias), the items were reverse-phrased, that is, positively worded items were also negatively worded and vice versa [7]. In addition, the items were scored in reverse when data was being entered into the SPSS. Upon completion of the designing of the questionnaire, the order of the items was randomised. The questionnaire with 50 items was initially constructed, and 100 copies were piloted to a hundred students who were studying Introduction to Biochemistry in second-year but were not part of the sample. This was done with a goal of refining the questionnaire.

After the pilot study, questionnaire responses were entered into SPSS with each item having its own column. The response scale was a 5 point Likert, and for negatively worded items the scoring was 5 = Strongly disagree, 4 = Disagree, 3 = Neither Disagree nor Agree, 2 = Agree, 1 = Strongly agree). Positively worded items were scored in reversed form.

Prior to conducting factor analysis, it was vital to get rid of questionnaire items that were not useful and therefore further reduce the number of items. Descriptive statistics helped achieve the elimination of inutile items. The ideal situation was that each questionnaire item should bring about normal distribution of a set of responses across subjects [7]. In different words, the Mean of each item should be at the middle of the scale without any skew. Thus, to detect the questionnaire items that brought out skewed data, the researcher sought out the skewness and standard error skew (SE skew) in the descriptive statistics output of the SPSS. Then, the skewness was divided by its SE skew to come up with a z-score. If the z-score (absolute value) was more than 1.96, then it was concluded that the skew was significant [7],

and the item was eliminated from the questionnaire. Twenty two (22) items were detected to have significant skew and were therefore removed from the analysis. Thereafter, Varimax rotation was carried out and twenty four (24) items were deemed appropriate to form the Biochemistry Attitude Questionnaire (BAQ). The Biochemistry Attitude Questionnaire was used both in the pre-test and post-test without changes.

VI. FINDINGS OF THE STUDY

There were three main constructs in the study. The independent variable was the dialectical constructivism, and the dependent variables were attitude and performance of students in Introduction to Biochemistry.

A. EFFECT OF DIALECTICAL CONSTRUCTIVISM ON STUDENTS' ATTITUDE TOWARDS BIOCHEMISTRY

(i) Pre-test Attitude for Control and Experimental Groups

The Biochemistry attitude questionnaire was administered during the pre-test and post-test in order to measure the attitude of students towards Biochemistry. The following tables presents the attitude Means and standard deviation on how students responded to the questionnaire items. The first part presents attitude for both control and experimental groups.

Table 3.1 Pre-test control group Biochemistry attitude questionnaire responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn Biochemistry can behave normally	21.1	42.1	21.1	13.2	2.6	2.34	1.05
2	Biochemistry has done more harm than good to humans	2.6	7.9	18.4	50	21.1	3.74	0.95
3	I would like to become a Biochemist	3.4	17.2	12.1	58.6	8.6	2.38	1.00
4	Biochemists do not have leisure time to spend with their families	1.7	12.1	24.1	46.6	15.5	2.38	0.95
5	It is wise to spend money buying Biochemistry materials and resources	15.5	50	20.7	10.3	3.4	3.64	0.99
6	It would be boring to work as a Biochemist	5.2	15.5	13.8	56.9	8.6	2.52	1.03
7	People who study Biochemistry look like any other people	5.2	6.9	17.2	44.8	25.9	2.21	1.07
8	Biochemists make harmful discoveries	22.4	50	19	5.2	3.4	3.33	0.96
9	Working in a Biochemistry laboratory would be interesting	5.2	15.5	13.8	55.2	10.3	2.5	1.05
10	Studying Biochemistry makes you unfriendly to other people	1.7	13.8	24.1	46.6	13.8	2.43	0.96
11	Biochemistry knowledge makes life better	20.7	44.8	20.7	13.8	0	3.72	0.95
12	A career prospect in Biochemistry would be boring	3.4	19	13.8	53.4	10.3	2.52	1.03
13	People who study Biochemistry can be athletic like other people	3.4	6.9	13.8	43.1	32.8	2.05	1.03
14	There are other B.Ed Nutritional Sciences courses which are more important than Biochemistry	24.1	44.8	15.5	12.1	3.4	3.24	1.07
15	I would like to become a teacher of Biochemistry	1.7	15.5	13.8	53.4	15.5	2.34	0.98
16	People who study Biochemistry do so only to earn a living	0	15.5	24.1	48.3	12.1	2.43	0.90
17	Biochemistry helps in making our planet a better place to live in	17.2	44.8	17.2	19	1.7	4.02	1.05
18	I wouldn't become a Biochemist because it is a difficult field	1.7	19	15.5	51.2	12.5	2.48	0.98
19	People who study Biochemistry are as fit and healthy as others	3.4	8.6	13.8	50	24.1	2.17	1.01
20	Money spent on Biochemistry materials and chemicals is just wasted	19	44.8	20.7	12.1	3.4	3.64	1.04
21	It would be interesting to work as a Biochemist	2	15.5	12.1	51.4	19	2.24	0.94
22	Biochemists are untidy	1.7	17.2	24.1	42.8	14.1	2.52	0.98
23	Biochemistry is one of the most interesting subjects in school	16	51.2	19	10.3	3.4	3.42	1.00
24	I wouldn't like to work in a Biochemistry laboratory after completing school	3.4	15.5	12.1	63.8	5.2	2.48	0.94
	Average	8.4	24.8	17.5	38.0	11.3	2.8	1.00

Table 3.2 Pre-test Experimental Group Biochemistry attitude questionnaire responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn Biochemistry can behave normally	3.4	10.9	14.7	41.8	29.1	2.18	0.89
2	Biochemistry has done more harm than good to humans	13.4	50.7	25	7.3	3.6	3.51	0.91
3	I would like to become a Biochemist	3.6	18.2	12.7	56.4	9.1	2.51	1.01
4	Biochemists do not have leisure time to spend with their families	1.8	12.7	25.5	45.5	14.5	2.419	0.96
5	It is wise to spend money buying Biochemistry materials and resources	16.4	50.9	20	9.1	3.6	3.473	0.92
6	It would be boring to work as a Biochemist	3.6	16.4	12.7	58.2	9.1	2.473	1.00
7	People who study Biochemistry look like any other people	5.5	7.3	14.5	45.5	27.3	2.182	1.09
8	Biochemists make harmful discoveries	21.8	50.9	18.2	5.5	3.6	3.418	0.96
9	Working in a Biochemistry laboratory would be interesting	5.5	18.4	14.7	50.4	11.1	2.527	1.05
10	Studying Biochemistry makes you unfriendly to other people	1.8	14.5	23.6	45.5	14.5	2.436	0.98
11	Biochemistry knowledge makes life better	20	45.5	21.8	12.7	0	3.527	0.93
12	A career prospect in Biochemistry would be boring	3.6	20	12.7	52.7	10.9	2.527	1.05
13	People who study Biochemistry can be athletic like other people	3.6	7.3	14.5	43.6	30.9	2.091	0.94
14	There are other B.Ed Nutritional Sciences courses which are more important than Biochemistry	25.5	45.5	16.4	9.1	3.6	3.8	1.04
15	I would like to become a teacher of Biochemistry	1.8	16.4	12.7	52.7	16.4	2.346	1.00
16	People who study Biochemistry do so only to earn a living	0	16.4	23.6	47.3	12.7	2.436	0.92
17	Biochemistry helps in making our planet a better place to live in	16.4	45.5	18.2	18.2	1.8	3.264	1.03
18	I wouldn't become a Biochemist because it is a difficult field	1.8	24	12.7	50.5	10.9	2.473	0.95
19	People who study Biochemistry are as fit and healthy as others	3.6	9.1	14.5	49.1	23.6	2.2	1.02
20	Money spent on Biochemistry materials and chemicals is just wasted	18.2	45.5	21.8	10.9	3.6	3.636	1.03
21	It would be interesting to work as a Biochemist	0	16.4	10.9	56.4	16.4	2.273	0.93
22	Biochemists are untidy	1.8	18.2	23.6	43.6	12.7	2.527	1.00
23	Biochemistry is one of the most interesting subjects in school	16.4	50.9	20	9.1	3.6	3.173	0.98
24	I wouldn't like to work in a Biochemistry laboratory after completing school	3.6	16.4	14.9	59.6	5.5	2.491	0.96
		8.0	26.2	17.5	36.7	11.6	2.7	0.98

From table 3.1 and 3.2 the data shows that the respondents in both control and experimental groups expressed varied opinions of their attitude towards questionnaire items. Further, the findings reveal that the group average Mean attitude of 2.7 for control and 2.8 for experimental were 0.1 points apart on a 1.0 to 5.0 scale. The implicature of such a minute difference in attitude suggests that the control and experimental groups had equivalent attitude towards Biochemistry before the treatment was administered to the experimental group. Further, the group average Means of 2.7 and 2.8 for control and experimental groups respectively is closer to 3, implying that overall the students neither agreed nor disagreed to the questionnaire items. This further suggests that prior to treatment, the students in both groups generally neither possessed negative nor positive attitude towards Biochemistry.

(ii) Posttest Attitude for Control and Experimental Groups

The same Biochemistry Attitude Questionnaire administered during pretest was again administered during posttest. The following tables presents the attitude Means and standard deviation on how students responded to the questionnaire items during posttest.

Table 3.3 Post-test Control Group Biochemistry attitude questionnaire responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn Biochemistry can behave normally	6.9	48.3	10.3	20.7	13.8	3.14	1.24
2	Biochemistry has done more harm than good to humans	17.2	53.4	19	6.9	3.4	3.74	0.95
3	I would like to become a Biochemist	5.4	12.2	14.1	50.6	10.6	2.48	1.00
4	Biochemists do not have leisure time to spend with their families	6.9	48.3	10.3	20.7	13.8	3.14	1.26
5	It is wise to spend money buying Biochemistry materials and resources	17.2	51.7	19	8.6	3.4	3.71	0.97
6	It would be boring to work as a Biochemist	3.4	15.5	12.1	60.3	8.6	2.45	1.08
7	People who study Biochemistry look like any other people	10.3	44.8	10.3	22.4	12.1	3.19	1.25
8	Biochemists make harmful discoveries	22.4	50	19	5.2	3.4	3.83	0.96
9	Working in a Biochemistry laboratory would be interesting	5.2	15.5	12.1	58.6	8.6	2.5	1.03
10	Studying Biochemistry makes you unfriendly to other people	6.9	44.8	13.8	13.8	20.7	3.03	1.31
11	Biochemistry knowledge makes life better	20.7	46.6	20.7	12.1	0	3.76	1.22
12	A career prospect in Biochemistry would be boring	3.4	20.7	12.1	53.4	10.3	2.53	1.05
13	People who study Biochemistry can be athletic like other people	19	37.9	17.2	12.1	13.8	3.36	1.31
14	There are other B.Ed Nutritional Sciences courses which are more important than Biochemistry	25.9	46.6	15.5	8.6	3.4	3.83	1.028
15	I would like to become a teacher of Biochemistry	1.7	15.5	12.1	53.4	17.2	2.31	1.00
16	People who study Biochemistry do so only to earn a living	6.9	46.6	12.1	19	15.5	3.1	1.25
17	Biochemistry helps in making our planet a better place to live in	19	44.8	17.2	17.2	1.7	3.12	1.04
18	I wouldn't become a Biochemist because it is a difficult field	1.7	19	12.1	56.9	10.3	2.45	0.98
19	People who study Biochemistry are as fit and healthy as others	17.2	41.4	12.1	15.5	13.8	3.33	1.32
20	Money spent on Biochemistry materials and chemicals is just wasted	19	46.6	20.7	10.3	3.4	3.67	1.02
21	It would be interesting to work as a Biochemist	0	15.5	10.3	58.6	15.5	2.26	0.91
22	Biochemists are untidy	6.9	48.3	10.3	17.2	17.2	3.1	1.28
23	Biochemistry is one of the most interesting subjects in school	17.2	51.7	19	8.6	3.4	3.71	0.97
24	I wouldn't like to work in a Biochemistry laboratory after completing school	3.4	15.5	10.3	61.5	9.2	2.47	0.94
	Average	11	36.7	14.2	28	9.7	3.1	1.1

Table 3.4 Post-test Experimental Group Biochemistry attitude questionnaire responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn Biochemistry can behave normally	7.3	45.5	9.1	25.5	12.7	4.49	1.236
2	Biochemistry has done more harm than good to humans	16.4	52.7	20	7.3	3.6	3.71	0.956
3	I would like to become a Biochemist	14.5	47.3	12.7	20.5	5	4.51	1.034
4	Biochemists do not have leisure time to spend with their families	9.1	45.5	9.1	23.6	12.7	3.15	1.253
5	It is wise to spend money buying Biochemistry materials and resources	16.4	50.9	20	9.1	3.6	4.27	0.982
6	It would be boring to work as a Biochemist	14.5	40	12.7	25.5	7.3	3.51	1.034
7	People who study Biochemistry look like any other people	9.1	45.5	10.9	23.6	10.9	3.18	1.219
8	Biochemists make harmful discoveries	21.8	50.9	18.2	5.5	3.6	3.82	0.964
9	Working in a Biochemistry laboratory would be interesting	16.4	50.9	14.5	16	2.2	4.35	0.866
10	Studying Biochemistry makes you unfriendly to other people	12.7	40	9.1	25.5	12.7	3.15	1.297
11	Biochemistry knowledge makes life better	25	40.5	18.5	12.7	3.3	3.73	0.932
12	A career prospect in Biochemistry would be boring	14.5	47.3	12.7	20	5.5	3.51	1.034
13	People who study Biochemistry can be athletic like other people	9.1	49.1	9.1	25.5	7.3	4.27	0.862

14	There are other B.Ed Nutritional Sciences courses which are more important than Biochemistry	25.5	45.5	16.4	9.1	3.6	3.8	1.043
15	I would like to become a teacher of Biochemistry	14.5	40.1	14.5	21.8	9	3.56	0.996
16	People who study Biochemistry do so only to earn a living	9.1	45.5	9.1	23.6	12.7	3.15	1.253
17	Biochemistry helps in making our planet a better place to live in	16.4	45.5	18.2	18.2	1.8	4.56	1.032
18	I wouldn't become a Biochemist because it is a difficult field	14.5	47.3	12.7	25.5	5	3.51	1.034
19	People who study Biochemistry are as fit and healthy as others	10.9	43.6	5.5	27.3	12.7	4.13	1.292
20	Money spent on Biochemistry materials and chemicals is just wasted	18.2	45.5	21.8	10.9	3.6	3.64	1.025
21	It would be interesting to work as a Biochemist	16.4	49.1	12.7	21.8	0	3.6	1.011
22	Biochemists are untidy	10.9	47.3	5.5	27.3	9.1	3.24	1.232
23	Biochemistry is one of the most interesting subjects in school	16.4	50.9	20	9.1	3.6	4.67	0.982
24	I wouldn't like to work in a Biochemistry laboratory after completing school	20	43.6	9.1	20.3	7	3.56	1.102
	Average	15	46.3	13.2	19	6.6	3.8	1.1

Tables 3.3 and 3.4 above shows that during posttest, students in the control and experimental groups had varied attitude towards Biochemistry. However, the group average Attitude Mean of 3.1 for the control group, and that of 3.8 for the experimental group, is indicative of the fact that there was significant difference between the control and experimental groups in terms of attitude towards Biochemistry after the administration of the treatment. It should be observed that there was 0.7 points difference in attitude towards Biochemistry during post-test compared to a paltry 0.1 points difference on a 1.0 to 5.0 scale noticed during the pre-test. Further, for control group Mean, there was a paltry 0.4 points increase in attitude from 2.7 to 3.1 during pretest and posttest respectively. However, for experimental group Mean, there was a significant increase of 10 points from 2.8 to 3.8. This suggests that there was a significant positive enhancement of attitude of Nutritional Science students towards Introduction to Biochemistry after administration of treatment than for the control group. This implies that using dialectical constructivism to teach Introduction to Biochemistry enhances attitude of students in Nutritional Science Programme towards Biochemistry.

VII. EFFECT OF DIALECTICAL CONSTRUCTIVISM ON STUDENTS' PERFORMANCE IN BIOCHEMISTRY

A. .Equivalence in Performance between groups prior to Treatment

Before treatment was administered to the experimental group, the two groups were given a pre-test. The pretest to measure performance of the experimental and control group was intended to ascertain whether the two groups were equivalent in terms of performance in Biochemistry [8]. The pretest was constructed using the content that the students in both groups had covered prior to the research. They were pretested on chemical bonds of biological molecules, identification of functional groups in biological molecules, and water and its importance in biological systems. The reason for testing students on content other than what was to be learnt during treatment was in order to avoid the effects of history, and maturation on the performance of students during posttest. These factors are inimical to the intents of the pretest-posttest quasi-experimental design. In order to ascertain whether the control and experimental groups were indeed equivalent on performance, performance scores were input into SPSS version 20, and an independent samples t-test was conducted. The following was the group statistics and independent samples t-test tables generated.

Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Performance	Control Group Pre-test	38	34.0526	16.54143	2.68337
	Experimental Group Post-test	37	32.2703	13.18385	2.16741

In the Group Statistics, the pretest performance Mean for the control group was 34.05 (SD = 2.68) whereas that for the experimental group was 32.27 (SD=2.17). The number of research subjects was 38 and 37 in the control and experimental groups respectively. The control group performance Mean (34.05) indicates that students in this group performed slightly better than their counterparts in the experimental group (Mean = 32.27).

Independent Samples t-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Performance	Equal variances assumed	2.398	.126	.515	73	.608	1.78236	3.45979	-5.11298	8.67771
	Equal variances not assumed			.517	70.281	.607	1.78236	3.44937	-5.09671	8.66143

An independent-samples t-test was conducted to compare pretest performance in Biochemistry for control and experimental groups to determine whether the two groups were equivalent before the treatment was administered to the experimental group. There was no significant difference in the pretest scores for control (M=34.0526, SD=16.54143) and experimental (M=32.2703, SD=13.18385) groups; t (73) =0.515, p = 0.608. These results suggest that the control and experimental groups were equivalent on the pretest performance in Biochemistry.

B. Posttest Performance Test results

After the administration of the treatment to the experimental group, students in both control and experimental groups were given a Carbohydrate, Lipid, and Protein (CLP) test in order to ascertain if there was any difference in terms of performance in Biochemistry after treatment. Carbohydrates, Lipids, and Proteins were the topics that were covered during treatment. Students in the experimental group were taught these topics using Dialectical Constructivism learning approach. On the other hand, students in the control group were taught the same content using the conventional lecture method.

C. HYPOTHESIS TESTING

The Research Hypothesis was:

H_A: There is a statistically significant difference between Home Science Students in the Bachelor of Education in Nutritional Sciences who are taught Introduction to Biochemistry using Dialectical Constructivism and those taught using the Conventional Lecture Method.

The results on posttest performance of the two groups showed that their Mean performance scores were different, indicating that the control and experimental groups were different on performance in Biochemistry. In order to find out if the difference between experimental and control group Means was due to dialectical constructivism and not due to random errors, and therefore test the research hypothesis, an independent samples t-test was conducted. The following were the group statistics and independent t-test tables generated from SPSS.

Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Performance	Control Group Post-test	38	43.4474	13.92392	2.25876
	Experimental Group Post-test	37	58.9189	15.01551	2.46853

In the Group Statistics box, the control group Mean posttest performance was 43.45, whereas that for the experimental group it was 58.92. The standard deviation for the control group was 13.92 whereas that for the experimental group was 15.02. The number of research subjects in the control group was 38 whereas in the experimental group, they were 37. The experimental group performance Mean (58.92) indicates that students in this group performed better than the control group (Mean = 43.45).

Independent Samples t-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Performance	Equal variances assumed	.168	.683	-4.629	73	.000	-15.47155	3.34258	-22.13331	-8.80979

	Equal variances not assumed			-4.624	72.244	.000	-15.47155	3.34599	-22.14127	-8.80183

D. EFFECT SIZE

Effect size statistics provide an indication of the magnitude of the differences between the control and experimental groups, and not just whether the difference could have occurred by chance [9]. Effect size was obtained by manually calculating Eta Squared due to the fact that SPSS does not give eta squared values for t-tests. Eta squared represents the proportion of variance in the dependent variable that is explained by the independent variable.

$$\text{Eta squared} = \frac{4.629^2}{4.629^2 + (N1 + N2 - 2)}$$

Replacing the appropriate values from our post-test independent t-test output:

$$\text{Eta squared} = \frac{4.629^2}{4.629^2 + (38 + 37 - 2)}$$

$$= 0.227$$

The guidelines [10] for interpreting Eta squared values are: .01=small effect, .06=moderate effect, .14=large effect. For our posttest results we can see that the effect size was large.

In this quasi-experiment, an independent-samples t-test was conducted to compare performance between the experimental group in which dialectical constructivism was used in teaching Introduction to Biochemistry course, and the control group in which the conventional lecture method was used. There was a significant difference in the scores for experimental (M=58.9189, SD=15.01551) and control (M=43.4474, SD=13.92392) groups; t (73) =4.629, p = 0.000. The magnitude of the differences in the Means was large (eta squared =.227).

The implicature of these findings are that dialectical constructivism significantly enhances students' performance in Biochemistry. Specifically, these findings show that when dialectical constructivism is used to teach Introduction to Biochemistry course, students' in the Bachelor of Education in Nutritional Sciences understanding of Biochemistry concepts being leant is enhanced leading to impressive performance.

VIII. DISCUSSIONS AND CONCLUSIONS

A. DISCUSSION OF FINDINGS

It has been established in this study that learning Introduction to Biochemistry course without pre-requisite knowledge leads to undesirable attitude and performance of learners in the course. Therefore, attitude and performance can be enhanced when students are given enough grounding in a prerequisite lower course to prepare them for the academic terrain they are expected to traverse in the higher courses requiring the prerequisite knowledge. However, our assumption on the importance of prior knowledge to learning higher courses that require that prerequisite knowledge is at variance with other studies [11, 12]. Further, lack of prior knowledge would lead to learners developing negative attitude towards a subject since the subject matter becomes challenging to comprehend, it is learnt through rote [5]. However, when it is not feasible to teach foundational information of a course that is taught in a programme of study in another school in a university, Dialectical Constructivism is the method of choice. During classroom transactions, the social milieu of learning enables learners to acquire the needed specialized language of the subject and communication tools to enable them comprehend the subject matter they do not possess prior knowledge in.

There seems to be a direct association between attitude and performance in a course. Generally, positive attitude enhances performance. Therefore, using dialectical constructivism makes learners to be in charge of the learning process as they collaborate and help one another to construct own meaning from a learning process. This high level interaction, enhances students' attitude towards a course which in turn has a positive effect on learning and consequently on performance as well. Indeed, Dialectical Constructivism approach enhances students' attitude in a subject matter, due to the fact that, when students collaborate on a learning task, the subject matter knowledge is elaborated [13].

Further, Dialectical Constructivism enhances students' performance in a given course, due to the fact that, the elaborated subject matter knowledge is stored in the long term memory and is easily retrieved from memory even after a long period of time. It should be emphasised that, Dialectical Constructivism is commensurate with meaningful learning. Students, even when they do not have prior knowledge on a subject matter, are prepared for the new knowledge during the learning of the subject specialized language and communication tools segment of a Dialectical Constructivist lesson.

B. CONCLUSIONS

It has been established in this study that Dialectical Constructivism:

(1) enhances students' attitude towards Biochemistry.

(2) enhances students' performance in Biochemistry.

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