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COMPARING STUDENTS PERFORMANCE IN CHEMISTRY THEORY AND PRACTICAL PAPERS: IMPLICATION FOR TECHNOLOGICAL DEVELOPMENT

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ABSTRACT

This paper investigated the performance of students in practical examination and compared them with performances in theory. Science students from the school of sciences in the College of Education, Agbor make up the sample population. From these, three departments of Biology/Chemistry, Physics/Chemistry, and Integrated Science double major were selected. The research subjects were pooled from these subject combinations according to class size. Academic Board verified results for three successive academic sessions of 2004/2005, 2005/2006 and 2006/2007 constitute the study data. Two hypotheses were postulated. The students't-test was the statistical method of analysis. Findings from the analysis were displayed in tables and figures in the form of bar charts. Results obtained indicate a higher performance in practical papers especially in years 1 and 2. This seeming pattern changed abruptly in year 3 (final year) with students scoring higher in theory than in practical papers. Values of t-observed were 99 per cent of the times lower than the t-critical.

Keywords: **performance, practical, theory, science, chemistry, subject-combination.**

INTRODUCTION

Science education has been defined as the activities in the teaching-learning process aimed at inculcating the knowledge and tenets of science and technology (Oyem, et el, 2007).

Science itself is a body of knowledge derived from systematic observation and experimentation (Oriaifo, 1990). It is classified in to basic and social sciences (Obiwulu, 2006). One of the components of basic science is Chemistry. Okecha (1993) defined Chemistry as the study of the properties and composition of substances and of the changes they undergo. An aspect of the teaching of chemistry is the practical class. Chemistry is distinctively an experimental science; every student of chemistry therefore is expected to develop skills of experimental analysis and procedures using methods of investigation employed by scientists generally (Shokare, 2006). This scientific method involves a feed back loop of induction and deduction (Konyeme, 2002; and Obiwulu, 2006).

Chemistry practical entail laboratory activities crucial for the acquisition of analytical skills. Chemical analysis in the words of Murray (2007) is the body of procedures and techniques used to identify and quantify the chemical composition of a sample of a substance. Analysis in chemistry is divided in to qualitative and quantitative analyses. Quantitative analysis attempts to determine the quantity (amount) or concentration of a specific substance in a given sample (Oyem, 2005). While qualitative analysis is the process of determining what a sample actually contains, whether a salt sample contains the element iodine for example. That is, it determines the composition of an unknown substance (Mordi, 2006).

Writing on "Methodology of Science Teaching", Urevbu (1990) noted that laboratory work is not only one kind of activity, but also a range of activities from true experimental investigations to confirmatory exercises and skill learning. This goes a long way in underscoring the crucial role of practical classes in the training of science students as future scientists who are expected to play a role in the modernization process and contribute in the economic progress of the nation and the world at large (Adamu, et al, 2006). This human capital/resource is indeed Nigeria's most reliable asset and need therefore to be properly and correctly mobilized without which development will not be achieved (Adamu, et al, 2006; Oyem et al, 2007).

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Comparing Students Performance in Chemistry Theory and Practical Papers: Implication for Technological Development

It is common place that countries that are scientifically and technologically developed and wealthy transformed and modified their economic systems in to sustainable economic standards to obtain the highest level of economic growth (William, 1967; and Conn, 1975). Therefore, both attention and emphasis too need to be placed and sustained on the teaching of practical chemistry at all levels of our educational system and not merely on theory. It is in the light of the above that this paper seeks to compare the performance of students in theory and practical chemistry papers and therefore determine the level of practical skills acquisition in chemistry at the College of Education, Agbor.

Research Hypotheses

- There is no significant difference in the academic performance of students in theory and practical papers.
- No significant difference exist between core chemistry and integrated science double major students in practical chemistry exams.

METHODOLOGY

Study population and study sample: the population of the study consists of all the science students in the School of Sciences at the College of Education, Agbor, Delta State. The study sample is comprised of students of Chemistry and Integrated science departments. The research subjects are years 2 and 3 students who are perceived to be better acclimatized to the school environment, and more exposed to intensive study in the chemistry curricula at both departments. All the students in Physics/Chemistry and Integrated science double major were pooled because of their small class size. However, one-third of the Biology/Chemistry students' population was sampled using simple sampling technique.

Data Collection and Analysis

Data used in this study were results of theory and practical papers of students in Chemistry and Integrated Science departments in the past four (4) years as approved by the institution's "Academic Board". The results were duly verified by the results Verification Committee of the College. The mean values of the students' scores in three Chemistry papers [two theory (organic and inorganic), and one practical paper per semester as sampled], were determined. The student T-test was used to test the stated null hypotheses. Bar charts were also constructed for better pictorial elucidation and comparison.

RESULTS AND DISCUSSION

The results of first and second semesters for the three academic sessions are analyzed and presented in tables 1.1a,b,c and 1.2a,b,c representing first and second semester scores respectively for the 2004/2005 academic session; while those of the 2005/2006 and 2006/2007 sessions are presented in tables 2.1a,b,c and 2.2a,b,c; and 3.1a,b,c and 3.2a,b,c respectively.

Table 1.1a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	53.1	5.51	12	2.18	0.92	Reject null Hypothesis
Practical paper	50.3	8.99	12			

P < .05

Table 1.1b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	53.6	8.5	12	2.18	-0.88	Reject null Hypothesis
Practical paper	56.8	9.1	12			

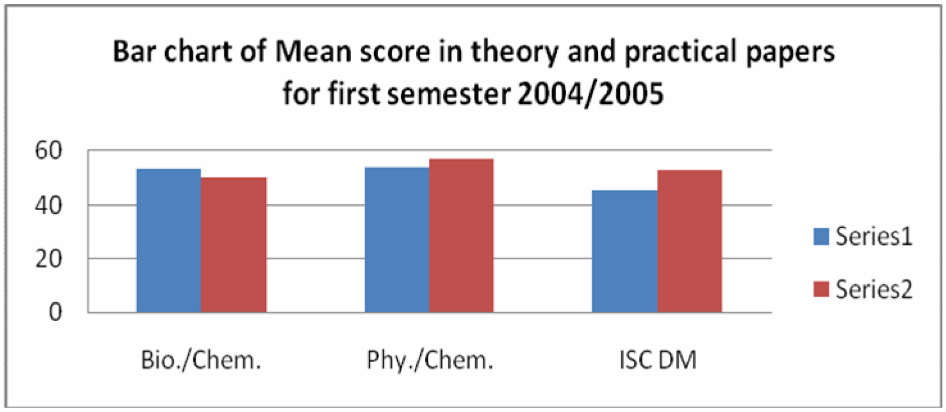
P < .05

Table 1.1c: T-test of scores in theory and practical papers for Integrated science double major.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	45.5	12.3	12	2.18	-1.56	Reject null Hypothesis
Practical paper	52.7	10.2	12			

P < .05

Fig. 1.1



Tables 1.1a,b, and c above show the analyses of results obtained from the scores of students sampled from biology – and physics/chemistry combinations and integrated science double major in 2004/2005 academic sessions.

From these tables, the mean values of students' scores obtained show higher values of 56.8 and 52.7 in practical papers were obtained in physics/chemistry and int. sc. double major subject combinations; whereas in biology/chemistry subject combination, the theory papers had a higher mean value.

Also from tables 1.1a, b, and c, the t-observed values obtained is much lower than the t-critical value of 2.18, clearly indicating that the null hypothesis is rejected. Therefore indicating that a significant difference does exist in students' performance in theory and practical courses in the first semester of the 2004/2005 academic session.

On the other hand, tables 1.2a, b, and c represent second semester scores for theory and practical papers in 2004/2005 academic session for the same subject combinations as in the first semester.

Table 1.2a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	52.9	10.2	15	2.13	-0.57	Reject null Hypothesis
Practical paper	55.3	12.6	15			

P < .05

Table 1.2b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	45.2	6.6	11	2.20	0.6	Reject null Hypothesis
Practical paper	42.2	16.1	11			

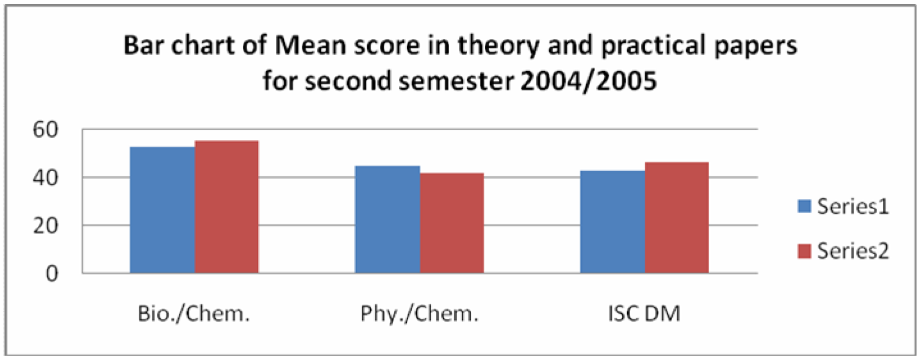
P < .05

Table 1.2c: T-test of scores in theory and practical papers for Integrated science double major.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	43.0	11.5	10	2.23	-0.75	Reject null Hypothesis
Practical paper	46.7	12.9	10			

P < .05

Fig. 1.2



Results from tables 1.2a, b, and c show slightly higher average scores of 55.3 and 46.7 in practical papers recorded for students in biology/chemistry and integrated science double major combinations respectively in second semester of 2004/2005 session. However, marginally higher average score of 45.2 for theory papers in the physics/chemistry subject combination was observed in the second semester of 2004/2005.

Meanwhile, T-test analyses of the scores in these three subject combinations, unanimously recorded significantly lower t-observed values of (-0.57, 0.6 and -0.75) respectively. It follows therefore, that contrary to the stated hypothesis, a significant difference clearly exist between academic performances in theory and practical papers in the three subject combinations in the 2004/2005 academic session.

Finally, from closer observation of the mean scores for first and second semesters of this session under consideration, no significant difference also existed in the performances of integrated science double major students in practical papers when compared with the core chemistry combinations of the sampled subject areas of biology/chemistry and physics/chemistry. This is clearly depicted in figs. 1.1 and 1.2 respectively, showing once again that comparison of performances in these areas is within proximate range in both semesters.

The results of the findings of the 2005/2006 academic session are displayed in tables 2.1a, b, c and 2.2a, b, c for first semester's scores respectively; and figs. 2.1 and 2.2 in similar order.

Table 2.1a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	44.5	7.6	20	2.09	-1.3	Reject null Hypothesis
Practical paper	49.1	14.4	20			

$P < .05$

Table 2.1b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	49.9	6.00	7	2.36	-1.4	Reject null Hypothesis
Practical paper	59.4	15.38	7			

$P < .05$

Table 2.1c: T-test of scores in theory and practical papers for Integrated science double major.

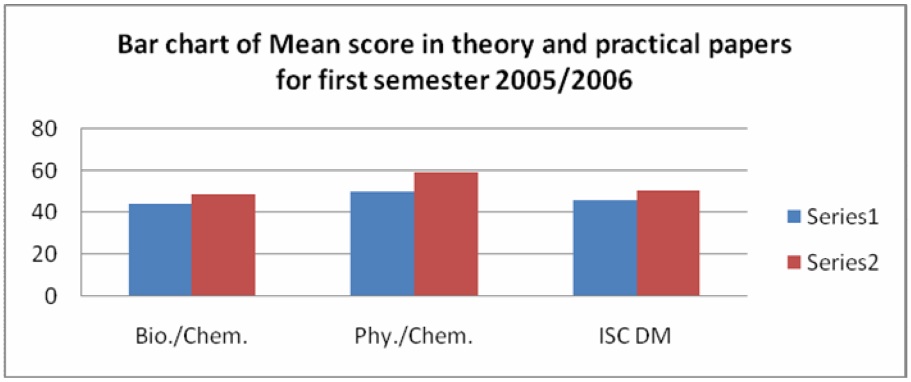
Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	45.8	4.99	12	2.18	-1.25	Reject null Hypothesis
Practical paper	50.8	12.9	12			

$P < .05$

Observations from tables 2.1a, b, and c reveal a striking pattern of higher mean scores in practical papers over performances in theory papers for these subject combinations.

T-observed values of (-1.3, -1.4 and -1.25 respectively) were also reported for this period; ostensibly indicating a marked variation from the t-critical values of the respective subject combinations; by implication therefore, the null hypothesis which states that no significant difference exist in performance in theory and practical papers is jettisoned. A clear difference in performance is thus indicated from the results of the analysis of scores in these papers.

Fig. 2.1



Results obtained for the second semester of 2005/2006 session is presented in tables 2.2a, b, and c below.

Table 2.2a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	44.5	7.40	20	2.09	-1.30	Reject null Hypothesis
Practical paper	49.1	14.06	20			

P < .05

Table 2.2b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	50.2	7.98	7	2.36	0.25	Reject null Hypothesis
Practical paper	48.7	12.43	7			

P < .05

Table 2.2c: T-test of scores in theory and practical papers for Integrated science double major.

Group	**Mean**	**SD**	**N**	**t-crit. value**	**t-cal. value**	**Remark**
Theory paper	44.9	13.4	12	2.18	-0.93	Reject null Hypothesis
Practical paper	49.8	12.4	12			

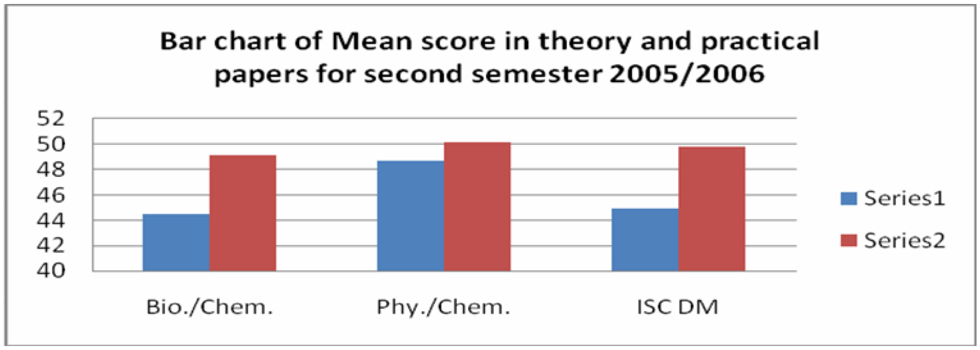
P < .05

From these tables, values of mean scores in practical papers are higher than those of the theory papers for these subject combinations in the second semester of 2005/2006 session.

Once again, very low t-observed values of (-1.3, 0.25 and -0.93 respectively) were obtained for these sampled subject areas. By implication therefore, the null hypothesis is again rejected. Going by these values, it is further asserted that a significant difference is indicated in the performances of students in theory and practical papers. With students doing much better in practical courses, indicating improved performance that could be attributed perhaps to students' being greater commitment to studies, better acclimatized to the school environment and practical classes, and increasing interest in learning which according to Okoye (1998) is highly related to ability (performance).

From figs. 2.2, no clear cut distinction exists between the performance in core chemistry combinations and integrated science double major students; indicating that the latter did as well as the former in chemistry courses.

Fig. 2.2



In the 2006/2007 session, the exercise was again repeated. Tables 3.1a, b, c and 3.2a, b, c represent analyses of scores obtained in first and second semesters respectively.

Table 3.1a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	46.8	9.2	20	2.09	2.04	Reject null Hypothesis
Practical paper	40.1	11.4	20			

$P < .05$

Table 3.1b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	55.7	7.1	8	2.31	2.50	Accept null Hypothesis
Practical paper	41.3	14.7	8			

$P < .05$

Table 3.1c: T-test of scores in theory and practical papers for Integrated science double major.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	48.4	6.5	8	2.31	0.57	Reject null Hypothesis
Practical paper	44.8	16.7	8			

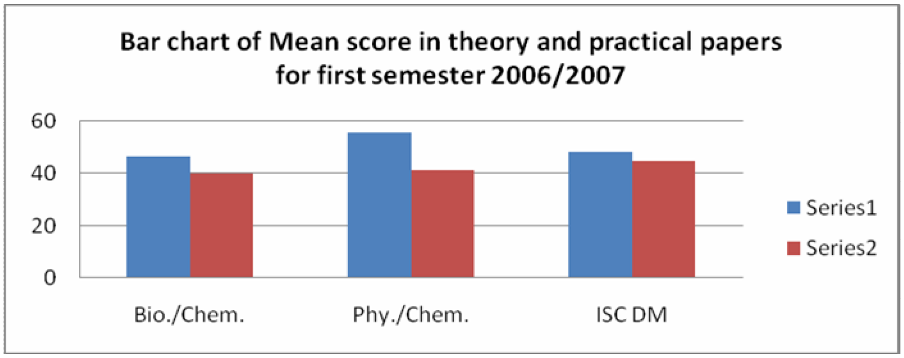
$P < .05$

From tables 3.1a, b, c, one distinct observation is that higher mean values were recorded for theory papers than in practical papers; indicating higher performances in theory papers in first semester of 2006/2007 academic session.

However, the t-observed values of 2.04, 2.50 and 0.57 were recorded for biology/physics chemistry combinations and in integrated science double major respectively. In all three cases, it was only the physics/chemistry case that posted a t-cal. value quite higher than the t-cri. Therefore, the null hypothesis is upheld. The converse was the case with the other two combinations, where it is indicated that t-cal. is less than the t-cri. value. The null hypothesis is in this case is rejected.

The extent of closeness/disparity between performances in theory and practical examination in this semester is revealed in a bar chart in fig. 3.1 below.

Fig. 3.1



Meanwhile in the second semester of the same year, the following tables 3.2a, b, c presents the results of the analyses of performance scores in theory and practical papers.

Table 3.2a: T-test of scores in theory and practical papers for Biology/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	48.2	13,24	20	2.09	0.44	Reject null Hypothesis
Practical paper	46.6	7.86	20			

P < .05

Table 3.2b: T-test of scores in theory and practical papers for Physics/Chemistry combination.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	55.0	11.3	9	2.26	1.35	Reject null Hypothesis
Practical paper	48.1	10.4	9			

P < .05

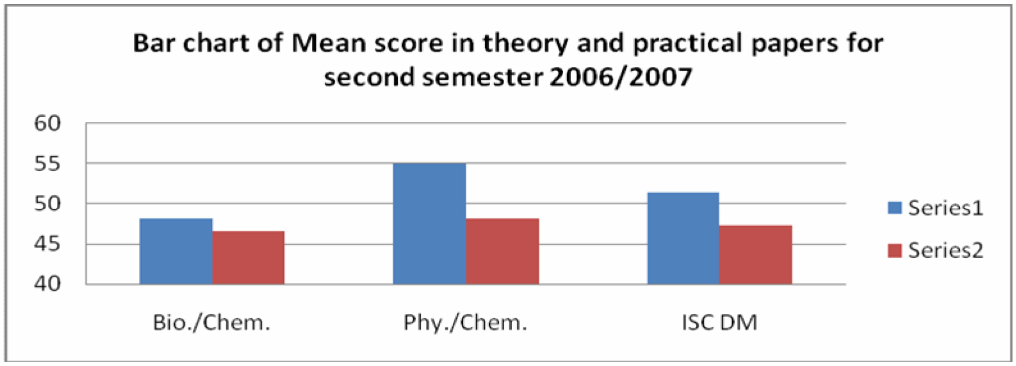
Table 3.2c: T-test of scores in theory and practical papers for Integrated science double major.

Group	Mean	SD	N	t-crit. value	t-cal. value	Remark
Theory paper	51.4	6.3	8	2.31	0.82	Reject null Hypothesis
Practical paper	47.3	12.5	8			

P < .05

Result s obtained from second semester analyses of biology/physics chemistry combinations and integrated science indicate higher mean performance for theory papers than in practicals. Therefore implying, that performance by these students in theory papers at the concluding semester of their final year in school were better than the practical papers. This might also indicate increased study/reading habits, aiming at a culminative optimum performance leading to graduation; thus suggesting a shift in interest. This observation clearly agrees with the findings of Kerr (1963) that interest in practical science work is of less significance in older students.
The disparity in performance in theory and practical papers is obviously depicted in fig. 3.2c below:

Fig. 3.2



Lastly, an observation of the t-observed values for the three subject combinations indicates in all cases that the t-critical values were indeed higher than the t-observed values. Therefore, by interpretation, the stated null hypothesis is rejected.

CONCLUSION

A breakdown of the findings of this study indicates a proximate difference in academic performances in theory and practical chemistry papers. This difference, though marginal is however significant, as buttressed by the results of t-test analyses of semesters' scores in the three academic sessions under review.

In figures 1.1, 1.2 and 2.1, 2.2 representing years 1 and 2, a pattern of increasing performances in practical papers is observed which becomes totally apparent and established in year 2. However by year 3 (2006/2007) a change from this pattern is revealed, indicating higher performance in theory papers in the surge for graduation; thereby suggesting a shift in interest from practical to theory as the students got older.

It is therefore safe to conclude that an obvious and significant difference does exist in the performance of students in theory and practical papers, thereby contradicting and rejecting the first null hypothesis. Furthermore the second hypothesis suggesting that no significant difference existed between the performance of core chemistry students and integrated science double major students in practical chemistry, is up-held.

Finally, from the findings of this research exercise, practical skills are clearly being imbibed by science students of College of Education, Agbor in spite of the paucity of resources, a good indication for technological development.

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