

EFFECT OF GUIDED INQUIRY METHOD (GIM) ON ACADEMIC ACHIEVEMENT IN CHEMICAL THERMODYNAMICS AMONG STUDENTS WITH DIFFERENT COGNITIVE STYLES IN PUBLIC SECONDARY SCHOOLS IN AKWA IBOM STATE

Balama Josph Obomanu, A.A.O Mumuni & Ibanga, Aniefiok Adolphus

Curriculum Studies and Educational Technology

University of Port Harcourt, Choba, Port Harcourt, Rivers State.

Email: kanabadafe@rocketmail.com

Abstract: The study investigated the effects of Guided Inquiry Method (GIM) on academic achievement of students with different cognitive styles using a pre-test, post-test control group design. The instruments for the study were the Cognitive Style Test (CST) used for classifying the sample of 320 students into three cognitive style groups and Achievement Test in Chemical Thermodynamics (ATCT). The reliability coefficients of the instrument are 0.84 and 0.74 respectively, using the Pearson Product Moment Correlation formula (PPMC). Data generated in the study were collated and analyzed using mean and standard deviation for answering the research questions while the two-way Analysis of Covariance (ANCOVA) and student t-test were used for test of hypotheses. Results showed that there was no significant difference in students' academic achievement in chemical thermodynamics when taught with Guided Inquiry Method, based on their cognitive styles. However, there existed a significant effect of location of schools and teaching methods on the academic achievement of students in chemical thermodynamics. Based on these findings, it was recommended that chemistry teachers should adopt Guided Inquiry Method as a pedagogical intervention in teaching chemical thermodynamics in order to enhance improvement of students' academic achievement in the concept.

Introduction

Guided Inquiry Method (GIM) is an innovative teaching method focused on students' skill and intellectual development, potent in facilitating concept cognition and high achievement. It has also created a fundamental change in

science education since it allows for collaboration between the teachers and learners, where teachers become facilitators of students' inquiry. Kirchner, Sweller and Clark (2006) posited that some of the characteristics of the inquiry learning process include, emphasis on the constructivist ideology, in which teacher is passive, posing students with problems which allows the students to be engaged in seeking and sorting appropriate analytical solutions to the problem. The advantage of the guided inquiry strategy is that learners' become proficient in use of inquiry skills, such as observation, hypothesizing, collecting and recording of data and data analyses. These processes are part of the procedural approach to effective understanding of the concept of chemical thermodynamics. At the secondary school level, the concepts of chemical thermodynamics are newly introduced into the national chemistry curriculum. This has created some difficulties among learners such as abstractness of the concepts, inadequate laboratory apparatuses and mathematics knowledge demand, irrespective of their cognitive learning styles. Moreover, students approach scientific tasks in different manners authenticating the need for a teacher, guiding the learning process. Guided Inquiry Method (GIM) provides the sequence for the selection of content and students' change in behavior in the basic knowledge of chemical thermodynamics in agreement with the objectives of teaching chemistry in secondary schools (Baja, Teibo, Onwu and Obikwere, 1990).

In the learning process, students' cognition differs mainly due to their differences in cognitive styles. Asuzu and Onwu (2009) identified analytical, rational and inferential cognitive styles and opined that the differential cognitive styles of learners should be considered in the development and implementation of both the curricula and instructional performances. This study considered the effects of the guided inquiry method (GIM) on students' academic achievement in chemical thermodynamics given their differences in cognitive styles, classified using a teacher-made test.

Statement of the Problem

Research evidences abound on students' poor attitude towards the study of science and their individual differences as predictors of students' performances

in the sciences, particularly in chemistry (Morina, 2006; Emina, 2008; Akinmade, 2009; Thornel, 2010). Studies have also identified other factors, including few on students' cognitive styles, as determinants of students' performance in the sciences like chemistry (Asuzu & Onwu, 2009; Babalola, 2008). However, since little or less work is being done in the area of students' cognitive styles and academic achievement, there is need to carry out an investigation on the effects of cognitive styles on students' academic achievement. Hence, the major problem of this study, therefore, is to investigate the effects of Guided Inquiry Method (GIM) of teaching on academic achievement in chemical thermodynamics among students with different cognitive styles.

Aim and Objectives of the Study

The aim of this study was to investigate the effects of Guided Inquiry Method (GIM) of teaching on academic achievement in chemical thermodynamics among students with different cognitive styles.

Specifically, the study sought to determine the extent to which:

- 1) students' academic achievement in chemical thermodynamics when taught with Guided Inquiry Method (GIM) differ based on their cognitive styles.
- 2) location of school affect the academic achievement of students in chemical thermodynamics when taught with Guided Inquiry Method (GIM).
- 3) Guided Inquiry Method (GIM) facilitates academic achievement of students in chemical thermodynamics than the Conventional Lecture Method (CLM)

Research Questions

The study sought answers to the following research questions:

- 1) Does students' academic achievement in chemical thermodynamics when taught with Guided Inquiry Method (GIM) differ based on their cognitive styles?

- 2) Does location of school affect the academic achievement of students in chemical thermodynamics when taught with Guided Inquiry Method (GIM)?
- 3) Does Guided Inquiry Method (GIM) facilitate students' academic achievement in chemical thermodynamics than conventional Lecture Method (CLM)?

Hypotheses

The following null hypotheses (Ho) were tested in the study at 0.05 level of significance:

- 1) There is no significant difference in students' academic achievement in chemical thermodynamics when taught with Guided Inquiry Method (GIM) based on their cognitive styles.
- 2) Location of school does not significantly affect the academic achievement of students in chemical thermodynamics when taught with Guided Inquiry Method (GIM).
- 3) There is no significant difference in the facilitative effect of Guided Inquiry Method (GIM) and Conventional Lecture Method (CLM) on students' academic achievement in chemical thermodynamics.

Significance of the Study

The result of this study is of immense benefit to chemistry teachers and students in our senior secondary schools, the State Ministry of Education, the education stake holders in Akwa Ibom state and the general public. More specifically, Chemistry teachers in our senior secondary schools would be aware of the individual differences among students, based on their differences in approaching scientific tasks; hence adopting practical oriented teaching method such as the Guided Inquiry Method (GIM) in concept delivery in order to attain higher achievement especially in chemical thermodynamics. The department of secondary and higher education of Akwa-Ibom State Ministry of Education would effectively equip the chemistry laboratories in our senior secondary schools to enhance effective teaching/learning of chemistry concepts with varieties of instructional materials. In this way, the individual learners can handle

and manipulate varieties of materials and learn the chemistry concepts in their own different perspectives.

Delimitation of the Study

The main focus of this study was the effects of Guided Inquiry Method (GIM) of teaching on academic achievement in chemical thermodynamics among students with different cognitive styles.

The study was delimited to Etim Ekpo Local Government Area of Akwa Ibom State, Nigeria, and eight (8) public senior secondary schools from the area were used. 320 SS II chemistry students were used in the study, while three cognitive styles; analytics, relational and inferential were investigated, using three chemical thermodynamics concepts.

Research Design

The research design adopted for this study is a quasi-experimental design of pre-test, post-test control group.

Two (2) groups of experimental and control, consisting of three (3) cognitive style groups each were used in the study. The three cognitive style groups for each of the experimental and control groups are:

Group I: Analytic Cognitive Style (ACS) group

Group II: Relational Cognitive Style (RCS) group

Group III: Inferential Cognitive Style (ICS) group

This design was chosen because the use of intact class is ensured throughout the research in order to control the reaction of experimentation and eliminate Multiple Treatment Interference (MTI).

Table 1 shows the non-randomized groups in the Pre-test, Post-test control group design.

Table 1: Non-randomized groups pre-test post-test design

Experimental Groups	Pre-test	Treatment	Post-test
Analytic Cognitive Style (ACS)	X_1	O_1	X_2
Relational Cognitive Style (RCS)	X_3	O_2	X_4
Inferential Cognitive Style (ICS)	X_5	O_3	X_6
Control groups			
Analytic Cognitive Style (ACS)	X_7	O_4	X_8
Relational Cognitive Style (RCS)	X_9	O_5	X_{10}
Inferential Cognitive Style (ICS)	X_{11}	O_6	X_{12}

Where X_1 = Pre-test on Group 1

O_1 = Treatment on Group 1 using Guided Inquiry Method (GIM)

X_2 = Post-test on Group 1

X_3 = Pre-test on Group 2

O_2 = Treatment on Group 2 using Guided Inquiry Method (GIM)

X_4 = Post-test on Group 2

X_5 = Pre-test on Group 3

O_3 = Treatment on Group 3 using Guided Inquiry Method (GIM)

X_6 = Post-test on Group 3

X_7 = Pre-test on Group 4 (control group)

O_4 = Treatment on Group 4 using Conventional Lecture Method (CLM)

X_8 = Post-test on Group 4 (Control group)

X_9 = Pre-test on group 5 (control group)

O_5 = Treatment on group 5 using Conventional Lecture Method (CLM)

X_{10} = Post-test on group 5 (control group)

X_{11} = Pre-test on group 6 (control group)

O_6 = Treatment on group 6 using Conventional Lecture
Method (CLM)

X_{12} = Post-test on group 6 (control group)

Population of the Study

The population of this study was 600 senior secondary two (SS 2) chemistry students in the twelve (12) public secondary schools in Etim Ekpo Local Government Area of Akwa Ibom State (State Ministry of Education, LEC Etim Ekpo, 2015). These students, according to the provision of the National Curriculum for Chemistry, are required to learn the concept of chemical thermodynamics.

Sample and Sampling Technique

A sample of 40 SS 2 chemistry students was randomly selected from eight (8) public senior secondary schools in the area of study, using stratified proportionate sampling, giving three hundred and twenty (320) chemistry students as sample size for this study. The eight (8) public secondary schools in the area were inspected by the researcher to ensure that they met the criteria for the study. The eight (8) schools reflected the urban setting (4 schools) and the rural setting (4 schools).

The criteria were based on:

- the type of school which must be co-educational
- the availability of spacious classrooms with adequate learning facilities (furniture, chalkboard)
- the existence of a sufficiently equipped laboratory which is adequate for the teaching of the concept of chemical thermodynamics.
- the existence of qualified and experienced chemistry teachers.

All the Chemistry students in the eight schools constituted the study sample.

A 10-item multiple choice Cognitive Style Test-CST was administered on the 320 students as the sample to identify and classify them into three cognitive style groups, for each of experimental and control groups. There were 3 options of choice for each item of the CST. The 3 options signified the three cognitive styles for this study:

Option A signified Analytic Cognitive Style

Option B signified Relational Cognitive Style

Option C signified Inferential Cognitive Style

The items were scored in percentages and each item had a score of 10%.

Students who scored 60% and above of options A, B and C were grouped under analytic, relational and inferential cognitive styles respectively as shown in table 2.

Table 2: Distribution of students from urban and rural schools into cognitive style groups.

Experimental Group					
Cognitive Style	Urban schools		Rural schools		Total
	Male	Female	Male	Female	
Analytic	14	15	14	13	56
Relational	14	13	14	12	53
Inferential	13	12	13	13	51
Total	41	40	41	38	160
Control Group					
Analytic	14	14	14	13	55
Relational	14	12	14	13	53
Inferential	12	14	13	13	52
Total	40	40	41	39	160
Grand total	81	80	82	77	320

Instrumentation

The research instruments for collecting data for this study were the Cognitive Style Test (CST) and an Achievement Test in Chemical Thermodynamics (ATCT) which were designed by the researcher. The CST which intended to identify the students cognitive styles consisted of 10 multiple choice items while the ATCT consisted of forty (40) multiple choice items and intended to measure students' academic achievement in the concept of chemical thermodynamics. The CST was used to identify and classify the sample of 320 students into 3 cognitive style groups for each of the experimental and control groups for the study. The ATCT was used as pre-test and reshuffled (rearranged)

and used as post-test on all study groups. The items on the ATCT were based on the three concepts of chemical thermodynamics for this study viz:

- exothermic and endothermic reactions,
- enthalpy change (ΔH), and
- Entropy change (ΔS).

Validity of Instruments

The Cognitive Style Test (CST) and Achievement Test in Chemical Thermodynamics (ATCT), used as instruments for this study, were presented to the researcher's supervisors and five (5) practicing chemistry teachers in secondary schools for validation. Areas of consideration in the validation included content validity, test of relevance, ambiguity and vagueness of statements. The instruments were re-assessed to measure academic achievements in the concepts under study and was adjudged adequate for the purpose of this study.

Reliability of Instruments

The research instruments for this study were the Cognitive Style Test (CST) and Achievement Test in Chemical Thermodynamics (ATCT). The CST was used to identify and classify the 320 students for this study into three cognitive style groups for each of the experimental and control groups. Both the CST and the ATCT were trial tested on thirty (30) students randomly selected from the research population, who were not part of the sample for the study. The scores obtained from these trials tests were collated and used in the estimation of their reliability coefficients using Pearson-Product Moment Correlation (PPMC) index. The reliability coefficients were calculated as 0.84 for the CST and 0.74 for the ATCT. These reliability indices indicated that the instruments used for this study were sufficiently reliable.

Scoring of Instruments

In the Cognitive Style Test (CST) used in grouping the students into different Cognitive Style groups, a concept option to each item scored 10% (10 marks). The total score for the 10-item instrument was 100marks. In the Achievement Test in Chemical Thermodynamics (ATCT) used as pre-test and post test on all

the study groups, a correct answer to each question scored $2\frac{1}{2}$ (2.5) marks. The overall score for the 40 item multiple choice instrument was 100 marks.

Procedure for Data collection

The Cognitive Style Test (CST) was administered on 320 students in order to identify and classify them into 3-cognitive style groups for each of the experimental and control groups for the study. The Achievement Test in Chemical Thermodynamics (ATCT) used as major instrument for this study, was administered by the researcher as pre-test to the different groups. The SS 2 Chemistry teachers in each of the eight (8) schools for this study assisted the researcher in the administration of the pre-test by arranging the classes and in supervision to avoid collusion among the students. There was no prior information for students to prepare for such test. Sufficient time (1 hour) was given for the students to finish solving all the test items. Students were free to ask questions to help them understand the questions better and to eliminate any language difficulty.

After the administration of the ATCT as pre-test to all groups, their performances were scored in percentages, using the marking guide for the study, the scores were collated and analysed to ensure the comparability of the groups. The three concepts of chemical thermodynamics for this study: exothermic and Endothermic reactions, Enthalpy change (ΔH) and Entropy change (ΔS) were then taught to the experimental cognitive style groups by the researcher for three(3) weeks using the Guided Inquiry Method (GIM) Lessons Plan as instrument. The instrument consisted of eleven (11) experiments/activities for students in the different cognitive style groups to be involved in open-ended laboratory activities. Students in the cognitive style control group were also taught the same chemical thermodynamics concepts by the researcher using the Conventional Lecture Method (CLM) Lessons plan. This consisted of the researcher's description of the experimental activities and expected results, without involving the students in any laboratory activity. After the three weeks concurrent teaching to all the groups, the ATCT items were re-shuffled/rearranged and re-administered on the students in all the groups as post-test. This was to establish the effect of the treatments on the academic

achievement of students in chemical thermodynamics based on their performances in the ATCT. The performances of students in the post-test from all the groups were also scored in percentages, collated and analyzed

Method of Data Analysis

The performances of students in the pre-test gave an insight into students' conceptual knowledge of chemical thermodynamics. The students' performances in the pre-and post-tests were scored in percentages using a marking scheme developed by the researcher (Appendix D). The students' performance scores in the ATCT were collated and analysed using mean and standard deviation for answering all the research questions, the Two-Way Analysis of Covariance (2-way ANCOVA) was used to test hypotheses one to three while the student t-test analysis was used for test of hypotheses four and five for this study.

Research question 1

Does the students' academic achievement in chemical thermodynamics when taught with guided inquiry method differ based on their cognitive styles?

Research question 2

Does gender affect the students' academic achievement in chemical thermodynamics when taught with guided inquiry method?

To answer these research questions 1 – 2, mean and standard deviation were employed. The results obtained are as presented together in table 3.

Table 3: Mean and standard deviation of the students' score in ATCT based on their cognitive styles and gender.

Cognitive Style	Gender	N	Mean	SD
Analytic Style	Male	28	52.04	8.08
	Female	28	49.62	6.34
	Total	56	51.00	7.44
Relational Style	Male	28	49.61	7.49
	Female	25	48.94	8.12
	Total	53	49.31	7.73
Inferential Style	Male	26	50.15	8.22
	Female	25	47.13	8.68
	Total	51	48.66	8.33
	Total	160	49.70	7.94

Results in table 3 revealed that the mean scores of the students in ATCT are 51.00, 49.31 and 48.66 respectively for those that have analytic, relational and inferential cognitive styles. And the standard deviation of their scores are 7.44, 7.73 and 8.33 respectively for analytic, relational and inferential cognitive styles. Based on their mean scores one could deduce that the analytic group has the highest mean score followed by relational and then inferential cognitive styles. It could then be deduced that students' academic achievement do differ based on their cognitive styles, even when taught with same teaching method.

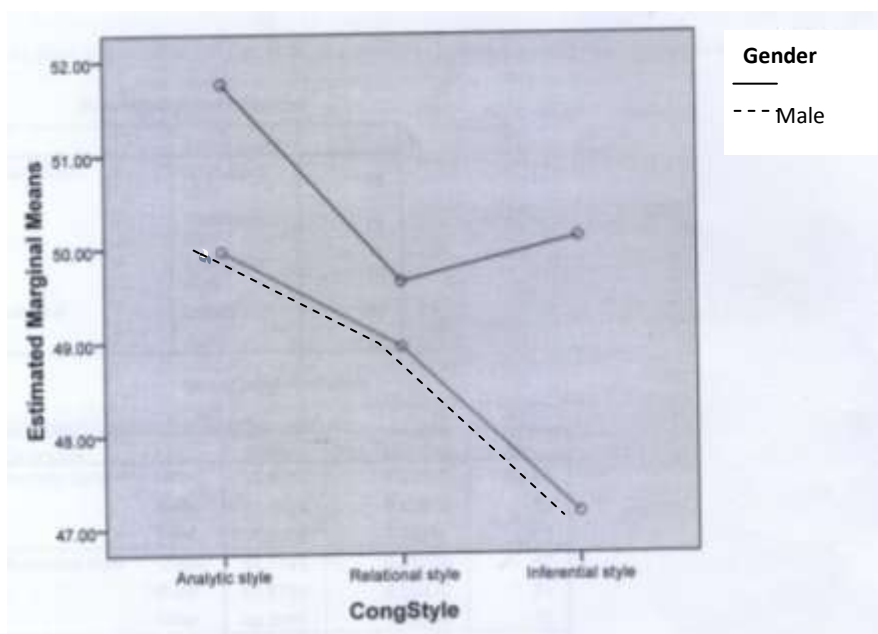


Fig 4.1: Estimated Marginal Means of Post Academic Achievement

Hypothesis 1: There is no significant difference in students' academic achievement in chemical thermodynamics, when taught with guided inquiry method based on their cognitive styles. To test these null hypotheses 1, two way analysis of covariate (2-way ANCOVA) was employed. The results obtained are as presented in table 4.2.

Table 4: Summary of two-way Analysis of Covariate (2-way ANCOVA) on the influence of cognitive styles on academic achievement in chemical thermodynamics among students based on gender

Source of Variance	Sum squares	of Df	Mean square	F	Sign
Pre achievement	133.65	1	133.65	2.17	0.142
Group	213.36	2	106.68	1.73	0.179
Gender	189.75	1	189.75	3.08	0.081
Group X Gender	48.91	2	24.45	0.397	0.673
Error	14362.07	233	61.64		
Total	15050.40	239			

Table 4 revealed that the F-calculated value for cognitive style groups 1.73 was significant at 0.179 level ($P > 0.05$) which is greater than 0.05, the chosen level

of probability. Hence cognitive styles of students do not significantly influence their academic achievement in chemical thermodynamics. The null hypothesis one is therefore upheld.

Research question 4: Does location of school affect the academic achievement of students in chemical thermodynamics when taught with guided inquiry method?

Hypothesis 4: Location of school does not significantly affect the students' academic achievement in chemical thermodynamics when taught with guided inquiry method.

To answer this research question 4, mean and standard deviation were employed while to test the corresponding null hypothesis, independent t-test statistics was employed.

The results obtained are presented together as in table 5.

Table 5: Mean, standard deviation and independent t-test, analysis of the influence of school location on students academic achievement in chemical thermodynamics.

Group	N	Mean	SD	Df	t-cal	t-crit	Decision at P < 0.05
Urban	161	48.25	7.68	238	2.72	1.96	* significant
Rural	159	51.20	7.95				

Table 5 revealed that the mean scores of the urban and rural students in ATCT are 48.25 and 51.20 respectively. The standard deviations of their scores are 7.68 and 7.95 respectively for urban and rural students. Based on their mean score, it is deduced that the rural students had a higher mean score than their urban counterparts by a difference of 2.95. When this mean difference was subjected to independent t-test it was found that calculated t-value of 2.72 was obtained and this calculated t-value was significant at 0.001 level ($P < 0.05$) which is less than 0.05; the chosen level of probability. Therefore, location of schools greater than the table t-value of 1.96 at 0.05 alpha levels. Hence, the null hypothesis was rejected at 0.05 alpha level. Location of schools significantly

affects the achievement of students in chemical thermodynamics when taught using Guided Inquiry Method (GIM).

Research Question 5: Does Guided Inquiry Method (GIM) facilitate students' academic achievement in chemical thermodynamics than Conventional Lecture Method (CLM)?

To answer research question 5, mean and standard deviation were employed. The result obtained is as presented in table 4.4.

Table 6: Mean and standard deviation of students' scores in ATCT based on treatment method and cognitive style group

S/No	Experimental Group				Control Group				Mean score difference
	Cognitive Style	N	Mean score	S.D	Cognitive Style	N	Mean score	S.D	
1	Analytic	56	49.89	7.34	Analytic	55	40.35	9.68	9.54
2	Relational	53	50.49	7.14	Relational	53	34.75	11.54	15.74
3	Inferential	51	49.60	7.40	Inferential	52	40.23	9.95	9.37

From the result in table 6, students from the analytic cognitive style group who were taught chemical thermodynamics with guided inquiry method (experimental group) performed better than students from the same analytic cognitive style group who were taught chemical thermodynamics with conventional lecture method (control group) by a mean score difference of 9.54. It was also observed from table 6 that students from the relational cognitive style group who were taught chemical thermodynamics with guided inquiry method (experimental group) performed better than students from the relational cognitive style group who were taught chemical thermodynamics with conventional lecture method (control group) by a mean score difference of 15.74. Furthermore, students from inferential cognitive style group who were taught chemical thermodynamics with guided inquiry method (experimental group) were observed to outperform their counterparts in the control group who were taught chemical thermodynamics with conventional lecture method

by a mean score difference of 9.37. Based on these findings, it was deduced that guided inquiry method of teaching is more facilitative in enhancing students' academic achievement in chemical thermodynamics than the conventional lecture method.

Hypothesis 5: There is no significant difference in the facilitative effect of Guided Inquiry Method (GIM) and Conventional Lecture Method (CLM) on students' academic achievement in chemical thermodynamics. For test of this hypothesis, independent t-test statistics, involving treatment method and students' cognitive style was employed.

Table 7: Independent t-test analysis of facilitative effect of treatment method on students classified by cognitive styles.

S/No	Experimental Group				Control Group				df	tcal	tcrit	Decision at P < 0.05
	Cognitive Style	N	Mean score	S.D	Cognitive Style	N	Mean score	S.D				
1	Analytic	56	49.89	7.34	Analytic	55	40.35	9.68	109	16.92	1.98	*sig
2	Relational	53	50.49	7.14	Relational	53	34.75	11.54	104	26.50	1.98	*sig
3	Inferential	51	49.60	7.40	Inferential	52	40.23	9.95	101	16.13	1.98	*sig

From the result in table 7, the independent t-test analysis of facilitative effect of treatment methods on students classified by cognitive styles showed that the calculated t-value (tcal) for students from the two groups of analytic cognitive style stood at 16.92 which was greater than the table t-value (tcrit) of 1.98 at degree of freedom 109 and 0.05 alpha level. This showed a significant difference in academic achievement of students between the two groups of analytic cognitive style. Moreover, the calculated t-value (tcal) for students from the two groups of relational cognitive style stood at 26.50 which was also greater than the table t-value (tcrit) of 1.98 at 0.05 alpha level. This also showed a significant difference in academic achievement of students between the two groups of relational cognitive style. Furthermore, the calculated t-value (tcal) for students from the two groups of inferential cognitive style stood at 16.13 which was still greater than the table t-value (tcrit) of 1.98 at 0.05 alpha level. This further showed a significant difference in academic achievement of students

between the two groups of inferential cognitive style. This showed a significant difference in the facilitative effect of the two treatment methods for this study as the guided inquiry method showed a higher facilitative effect in enhancing the academic achievement of students in chemical thermodynamics, than the conventional lecture method; hence null hypothesis was rejected at 0.05 alpha level. This means that there is a significant difference in the facilitative effect of Guided Inquiry Method (GIM) and conventional lecture method on students academic achievement in chemical thermodynamics.

Discussion of Findings

The research study revealed that there was no significant difference in students' academic achievement in chemical thermodynamics, when taught with guided inquiry method, based on their cognitive styles. This finding disagreed with the views of Babalola (2008) and Asuzu & Onwu, (2009) who posited that individuals approach scientific tasks in differing manner, hence the consideration of cognitive styles are of less importance, based on instructions in chemistry. This finding also disagreed with the theoretical position of Klobb's(1998) experiential learning which predicted that students with different learning styles will respond differently to various teaching methods and that instructional strategies should match the learning styles of students. When Wu, Dale and Bethel (1998), adopted the use of concrete/abstract models and cognitive styles in teaching recursion, the result showed that abstract learning style performed better than the concrete learning style in learning recursion. This showed some agreement with this finding despite the fact that conceptual models (abstract or concrete) were used which is similar to experimentation based on the use of concrete models (3-dimensional models).

The study also revealed that school location do affect the students' academic achievement in chemical thermodynamics. There was also a significant difference in students' academic achievement in chemical thermodynamics based on the teaching methods.

Summary of Findings

The findings of this study are enumerated as:

From the research Questions

- Students in the Analytic cognitive style group had a mean score of 51.00 with standard deviation of 7.44 those in the relational group had a mean score of 49.31 with a standard deviation of 7.73 while those in the inferential group had a mean score of 48.66 with the standard deviation of 8.33. The mean score of the analytic cognitive style group (51.00) is greater than those of relational (49.31) and inferential (48.66). Therefore, students' academic achievement in chemical thermodynamics do differ based on their cognitive styles, even when taught with same teaching method.
- Students from the three cognitive style groups in rural schools had a mean score of 51.20 with corresponding standard deviation of 7.95 and performed better than their urban counterparts who had a mean score of 48.25 with a corresponding standard deviation of 7.68. Therefore, the location of school do affect the academic achievement of students in chemical thermodynamics. Students taught with guided inquiry method performed better than those taught with conventional lecture method. Therefore, the guided inquiry method is more facilitative than the conventional lecture method in the academic achievement of students in chemical thermodynamics.

From the Research Hypotheses:

- There was no significant difference in students' academic achievement in chemical thermodynamics, when taught with guided inquiry method, based on their cognitive styles.
- There was significant effect of location of school on students' academic achievement in chemical thermodynamics when taught using Guided Inquiry method.
- There was a significant difference in the facilitative effect of Guided Inquiry Method (GIM) and Conventional Lecture Method (CLM) as the guided inquiry method showed a higher level of facilitative effect than the conventional lecture method.

Conclusion

Students have difficulties in understanding the concepts of chemical thermodynamics. This difficulty has been linked with the adopted pedagogy in handling concepts in chemistry. The use of guided-inquiry method in modifying students' cognitive learning style in the learning of chemical thermodynamics showed significantly improved achievement. Therefore it is recommended that for students' academic achievement to be improved in the concepts of chemical thermodynamics, the concept of cognitive styles among learners should be ignored when the use of guided-inquiry teaching method is adopted.

Recommendations

Based on the findings of this study, it is recommended that:

- Chemistry students should study co-operatively in order to improve their academic achievement in chemical thermodynamics
- Chemistry teachers should adopt Guided-Inquiry Method (GIM) teaching in order to eliminate intricacies in certain concepts and improve pedagogy of such concepts. This method arouses students' interest and active participation in the learning process.
- The state ministry of education and the state secondary schools' board should adequately supply concept-based science equipment to schools' laboratories to enable the learners and teachers better access and to utilize them for the teaching of chemistry in schools.

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Reference to this paper should be made as follows: A.A.O Mumuni et. al., (2016), Effect of Guided Inquiry Method (GIM) on Academic Achievement in Chemical Thermodynamics among Students with Different Cognitive Styles. *J. of Education and Policy Review*, Vol. 8, No. 2, Pp. 62-82.
