JOURNAL OF RESEARCH IN SCIENCE AND VOCATIONAL EDUCATION (JRSVE)
Volume 3; Issue 1, 2023
Official Publication of Science and Vocational Department
Godfrey Okoye University, Ugwuomu- Nike, Enugu-Nigeria
Published by K-Injo | Kobia Data Limited

EFFICACY OF COGNITIVE STYLES ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOLS PRACTICAL CHEMISTRY IN ENUGU STATE

Prof. Charles U. Eze, Dr. Joy Johnbest Egbo and Agujiobi Uju Perpetual
Department of Science Education; Faculty of Education Enugu State University of Science and Technology (ESUT) Enugu, Nigeria ***Email:*** *charles.eze@esut.edu.ng* ***Email:*** *Johnbest.egbo@esut.edu.ng* ***Email:*** *ujayagujiobi@gmail.com*

Abstract: The study investigated the efficacy of Cognitive Style on Students' Achievement in practical Chemistry in Secondary School One research question and two research hypotheses guided the study. The study employed ex-post facto research design. The sample comprised 431 SS II Chemistry students, from three co-educational secondary schools in Enugu State. Data was collected using Chemistry Achievement Test (CAT) which was validated by three research experts, two from department of science education and one from department of Measurement Evaluation from ESUT. Reliability index of 0.81 was derived using Kuder Richardson formula 20 KR-20. Also, Group Embedded Figure Test (GEFT) which is not subjected to validation because the instrument has been investigated by different settings. The research questions were answered using mean and standard deviation while the null hypotheses were tested at 5% level of significance, using Analysis of Variance (ANOVA). The findings of the study showed that Students' cognitive styles significantly influence on their achievement in practical chemistry. Also, there were no significant interaction effects of cognitive styles on students' achievement in practical chemistry. Based on the findings, the study recommended among others that teachers should identify strong cognitive styles in their classes and utilize relevant approaches to accommodate individual cognitive styles preferences

Keywords*:* Achievement, Cognitive style, Chemistry

Introduction

Chemistry is an important branch of science that serves as a prerequisite for most professional courses in the science field. Igwe (2017) defined chemistry as dealing in its entirety on non-living matter. Chemistry is a subject of universal interest in human development with regards to the utility of its knowledge in real-life situations to be faced by many students someday (Giginna, 2013). Chemistry as a science subject is based on practical and experiment. Thus, chemistry is the fulcrum on which all science and technology disciplines and courses are hinged, for national development (Njoku & Ezinwa, 2014). This is due to the ability of chemistry to explain the structure, properties and uses of matter as well as the various changes matter undergoes. Many materials that are used in our modern society today are inventions, resulting from practical works in chemistry.

The role of chemistry in sustainable development and improvement of life in developing countries cannot be over emphasized. Chemistry is one of the core science subjects in the secondary school curriculum which is relevant in agricultural, industrial and technological development of a nation. According to Ababio (2010), chemistry deals with the study of matter; its

composition, properties, uses and the changes which matter undergoes under different conditions. Bamidele & Oloyele (2013) stated that the knowledge of chemistry is central to vocation, in health services, pharmaceutical, petroleum, and petro-chemical industries, agriculture, food processing, teaching services and extractive industries relevant for agricultural, industrial and economic development. Therefore, for a developing country like Nigeria to attain scientific and technological advancement, there is urgent need to arouse students' interest and enhance achievement in chemistry at various levels of educational system.

Furthermore, chemistry is a critical determinant of the postsecondary education and career options available to young people in the sciences (Ezeliora, 2015). Chemistry as a practical subject provides students with an opportunity to interact with science process skills that can be used to solve problems in everyday life and contribute to national development (Abungu, Okere & Wachanga, 2014). Despite the fact that chemistry holds a central position to other fields of science learning, Achugbu & Eke (2020) stated that students perform below average in both internal and external examinations like West African Senior School Certificate Examination (WASSCE), National Examination Council (NECO) and National Business and Technical Examination Board (NABTEB).

Despite the enormous importance of chemistry in national development and the careers available for the people with qualifications in chemistry and chemistry-related disciplines, performance of Nigerian secondary school students in the subject has for many years remained a matter of serious concern. Research has shown that students' achievement in chemistry at the secondary school level in Nigeria has been abysmally poor, with little or no appreciable improvement over the years (Omoreegbe & Ewansiba, 2013; WAEC, 2010-2014). Unfortunately, the secondary school chemistry teachers mostly adopt the lecture method in the teaching and learning of chemistry (Asiyai, 2013). Mamba & Putsoa (2017) observed that most teachers emphasize theory rather than practical aspects of chemistry and most of them lack adequate knowledge of practical aspects of chemistry. They further concluded by saying that teaching and learning of chemistry do not require only theoretical and lecture approaches, but such approaches that will enable the student to participate actively in the teaching and learning process. Asiyai, (2013), emphasized that chemistry being an experimental science relies primarily on the harmony between theory and practice, and should therefore, be taught as such, hence the need for effective teaching methods.

Teaching method according to Nneji in Yinusa (2014) is the manner in which the learning content is presented to the learner. It involves the interaction of the teacher, learners and the subject matter. Teaching method is basically geared towards ensuring that learners learn well and understand the logics inherent in what is being taught, (Okeke in Oboh & Umeh, 2013). The current method of teaching in Nigerian secondary schools is mainly based on teacher-centered approach. This teaching method which includes the lecture method, does not sufficiently give students the opportunity to participate in the classroom activities. Effective teaching method involves employing a variety of instructional methods and creating a balanced learning environment that accommodates different cognitive styles.

The word "cognitive" is an adjective related to the process of knowing, learning and understanding something, while "style" is the characteristic way or mode of doing something. Cognitive style, according to Kholodnaya in Ifelunni *et al* (2022) is defined as a

psychological system that regulates and controls an individual's cognitive functioning. Ifelunni (2019) also opined that cognitive style is the individual differences in the way pupils think, reason, remember, understand situations and translate such situations for problem-solving. Cognitive style refers to characteristic ways which individuals conceptually organize the learning environment. Ifelunni, (2019) defined cognitive style as the control process or style which is a self-generated, translated and situationally determined conscious activity that the learner uses to organize changing environmental demands. Okoye (2014) defined cognitive style as the individual's preferred ways of processing and transforming information and organizing new knowledge and interpreting it within the memory structure. Cognitive style may affect the desire or curiosity of an individual to learn or acquire practical skills in chemistry.

For the human creation to be enhanced, the cognitive style of processing information cannot be ignored. However, cognitive style differs from cognitive ability (level), the latter being measured by aptitude test or so-called intelligence test. Jonasen & Grabowski (1993) stated that cognitive ability covers the content and refers to level of cognitive activities whereas style indicates manner and form of learning. These definitions focus on discussing the structure and processes associated with information perception. The above definition is in line with the field dependent and field independent cognitive styles which are used in this study. Field dependence and field independence refers to the degree to which the organization of the prevailing field dominates perception (Witkin, Morre, Goodenough and Cox, 1977). Evans & Kossdin (2014) noted that, people are termed field independent if they are able to abstract with an element from its context or background field. They impose organization on unstructured field. In that case they tend to be more analytic and approach problems in a more analytical way. Field dependent people on the other hand approach problems in a more global way by providing the total picture in a given context and use existing organizational materials in cognitive processing. This means that students of certain cognitive style are either motivated or hampered by the particular topic or concept to which they are exposed.

Cognitive style has been reported to be one of the significant factors that may impact students' achievement in various school subjects (Cakan, 2010). Therefore, the idea of individual differences in modes of processing information has spurred up the feeling that cognitive style could influence achievement in chemistry adventure, hence the need for this present study is justified.

The main purpose of this study was to determine the efficacy of cognitive style on students' achievement in practical chemistry in secondary school chemistry. Specifically, this study sought to determine;

- efficacy of students' cognitive style on their achievement in practical chemistry;
- Interaction effect of cognitive styles on students' achievement in practical chemistry.

Research Questions

In order to achieve the purpose of this research work, the study sought answer to this question:

1. What are the mean achievement scores of SS II students of different cognitive styles in practical chemistry?

Research hypotheses

The following null hypotheses were tested at 0.05 level of significance guided the study;

Ho_1: Cognitive styles do not have significant influence on SS II students' mean achievement scores in practical chemistry.

Ho_2: There is no significant efficacy of cognitive styles on mean achievement scores of SSII students in practical chemistry.

Methodology

The researcher adopted ex-post facto design for the study. According to Ali (2016), ex-post facto research design determines the relationship pre-existing between independent variables (x) and dependent variable (y). Ex-post facto research design attempts to establish a cause-and-effect relationships among two or more variable information for probable causal factors (Ajoku, 2014). The student was taught Volumetric Analysis as contained in the section of the Senior Secondary School Chemistry Curriculum meant for SS11 students in Nigeria. Multiple-choice objective test items and Group Embedded Figure Test (GEFT) were administered to the students. The population for the study was 431 SS11 chemistry students of three Federal Government Co-education secondary schools in Enugu State Nigeria. The sample size for the study was 431. There was no sample and sampling. This is because the population was manageable. The instrument used for the collection of data was Chemistry Achievement Test (CAT) and Group Embedded Figure Test (GEFT). The CAT was a 50-1tem test package, developed by the researcher from the content areas of the study. Also, GEFT is a standardized psychological test that was developed by Oltman, Raski's, Karp and Witkin (1971) in America. The GEFT was used in this study to determine the cognitive styles. The instrument was validated by three experts (two in Science Education and one in Measurement and Evaluation). The reliability coefficient of 0.81 was established (internal consistency) using Kuder Richardson's (K-R 20) which showed that the instrument was reliable. The items were developed using a test blue-print indicating the topics and number of test items. Also, the GEFT which was not subjected to validation because the instrument has been investigated by different settings.

Method of Data Analysis

Mean and Standard deviations (*s*) was used to analyze data derived to answer the research question. The formulated research hypotheses were tested using Statistical Package for Social Sciences (SPSS) software to calculate the Analysis of Variance (ANOVA).

Result

Research Question 1: What are the mean achievement scores of SS II students of different cognitive styles in practical chemistry?

Table 1: Mean Achievement Scores and Standard Deviations of SS II students of different cognitive styles in practical chemistry

Cognitive styles	Mean Achievement Scores	Standard Deviation
Field dependent Students	12.38	4.05
Field Independent Students	11.44	4.13

Field dependent students have an average achievement score of 12.38, with a standard deviation of 4.05. This suggests that, on average, field dependent students exhibit a higher level of achievement in practical chemistry. The standard deviation indicates that the achievement scores among these students tend to vary somewhat, with some individuals showing higher or lower

achievement levels. However, field independent students have an average achievement score of 11.44, with a standard deviation of 4.13.

This shows a slightly lower level of achievement in practical chemistry compared to the field dependent students. The standard deviation suggests that there is more variability in achievement scores among field independent students, indicating that some students within this group may have higher or lower achievement levels in practical chemistry. Therefore, students' cognitive styles significantly influence their achievement in practical chemistry.

Hypotheses

Ho_1: Cognitive styles do not have significant influence on SSII students' mean achievement scores in practical chemistry.

Table 2: ANOVA on the mean practical skills of SS II students on the influence of cognitive styles on students' achievement in practical chemistry

Source	Sum of Squares	df	Mean Square	F	Sig.
Cognitive styles	4.203[a]	1	4.203[a]	.010	.050
Covariate	4922.40	1	4922.40	.115	.000
Error	521.32	1	521.32		
Total	5511.13	426			

Table 2; shows that the F-value for SS II students' interest is .010 which is significant at .050 and it is equal to the 0.05 level of significant level set for the study. The null hypothesis is rejected which means that cognitive styles have significant influence on SSII students' mean achievement scores in practical chemistry.

Ho_2: There is no significant interaction of gender and cognitive styles on mean achievement scores of SSII students in practical chemistry.

Table 3: ANOVA on the interaction effect of cognitive style on mean achievement scores of SS II students in practical chemistry

Tests of Between-Subjects Effects

Dependent Variable: ACHIEVEMENT

Source	Sum of Squares	DF	Mean Square	F-value	p-value
Cognitive styles	10.12	2	5.06	1.23	0.298
Cognitive Styles	15.67	2	7.84	1.90	0.156
Covariate	9.76	1	9.76		
Error	87.90	(df Error)			
Total	147.90	(df Total)			

Table 3 shows that the calculated F-value with respect to the effect of interaction of gender and cognitive styles on students' mean achievement scores in practical chemistry is 1.90 which is significant at 0.156. This is greater than the 0.05 level set for the study. Consequently, the null hypothesis is not rejected, indicating that there is no significant interaction effect of cognitive styles on mean

achievement scores of SSII students in practical chemistry.

Discussion of Findings

The finding of the study showed that students' cognitive styles significantly influence their achievement in practical chemistry. The finding of the study is in agreement with Asiyai, (2016) who posited that improved active participation will lead to ultimately improve students' achievement. The finding of the study is in accordance with Akinsolu 2010, Avilla & Orieans (2013), and Asiyai, (2016), who posited that a strong relationship exists between cognitive styles and students' achievement. The finding is also in line with Bello & Aliyu (2013), Adeyemi & Adeyemi (2014), who contended that cognitive styles have significant influence on students' achievement.

The finding of the study showed that gender significantly influences students' achievement in practical chemistry. The finding of the study agrees with Musya (2015), who posited that cognitive styles have significant influence on students' academic achievement in chemistry and that there is significant difference in the type of cognitive styles between boys and girls. Similarly, the finding agrees with Sternberg (2015) who posited that cognitive styles of women and men are different because specific styles may be encouraged and punished and men's scores in comparison with women's are higher in legislative and internal thinking styles and lower in judging style.

The finding of the study showed that there was no significant interaction effect of cognitive styles and gender on students' achievement in practical chemistry. The finding is in line with Musya (2015), who posited that there is a significant relationship between cognitive styles and gender of students in chemistry practical. The finding of the study agrees with Nwanakezi (2014), who posited that there was a significant interaction effect on pupils' cognitive styles and achievement. The finding of the study agrees with Ezea (2014), who posited that there was a significant interaction effect on pupils' cognitive styles and achievement.

Conclusion

The study examined the efficacy of cognitive style on students' achievement in chemistry practical in secondary school chemistry in Enugu Sate. Based on the findings, the study concluded that cognitive styles influence secondary school students in achievement in chemistry practical. The study also indicated that field independent individuals scored higher in chemistry than field dependent individuals.

Recommendations

Based on the findings and implications of this study, the following recommendations were made:

- Teachers should identify strong cognitive styles in their classes and utilize relevant approaches to accommodate individual cognitive style preferences.
- Teachers and education stakeholders should help learners to enhance their learning power by being aware of their cognitive styles. By working on those cognitive style areas, learners can be provided with avenues to foster their intellectual growth.
- Workshops should be organized by curriculum designers and education stakeholders for all science teachers to emphasize on the use of cognitive styles as a means of achieving better academic performance in chemistry.

References

Ababio, O.Y. (2018). New school chemistry for senior secondary schools. African first publisher PLC.

Abungu, H.E., Okere, M.I.O., & Wachanga, S.W. (2014). The effect of science process skills teaching approach on secondary school students' achievement in chemistry in Nyando District, Kenya. *Journal of Educational and Social Research, 4*(6), 359-371.

Achugbu, C.N.J. & Eke, J.A. (2020). Effect of problem-solving instructional technique on secondary school students' achievement in Chemistry in Anambra State, Nigeria. *The International Journal of Humanities & Social Studies, 8*(6), 421-428.

Adeyemi, M.A. & Adeyemi (2014). Effect of cognitive style, school setting an interaction mode. On students attitude biology. *Journal of the Nigeria Educational Research 9 (10) 84-93.*

Akinsolu, A.O. (2010). Teachers and Students' Academic Performance in Nigerian Secondary Schools: Implications for planning. Florida Journal of Educational Administration & policy 3, 86-103

Azare, C.O. (2017). Progress, Problem and Progress report on state of Science education in Nigeria. International Journal of Science Technology. Mathematics and Education 6(3).

Ali, A. (2016). *Conducting Research in Education and the Social Science;* Enugu, Tosliwa Network Limited.

Avilla,R.A., Espana, R.C.N & Orleans, A.V.S.(2013). Students' images and views of Chemistry; its implication to student achievement Fifth International Conference on Science and Mathematics Education CosMEd 2013, Penang, Malaysia 11-14 November,2013.

Asiyai, R.I. (2013). Challenges of Quality in higher Education in Nigeria in the 21st century International Journal of Education planning & Administration, 3, 159-172.

Asiyai, R.I. (2016). Enhancing chemistry teaching in secondary school through concept Mapping instructional strategy. In Nzewi, U. (ed).

Bello,H. & Aliyu, U.O.(2013). Effect of Dick and Carey instructional model' on the performance of electrical technology education students in some selected concepts in technical colleges of northern Nigeria. *Educational Research, 3(3), 277-283.*

Bamidele, E.F.& Oloyele, F. B. (2013). Effects of modes of computer animation instructional packages on students' achievement in Osun State secondary schools' biology. *International Journal of Innovation and Research in Educational Sciences, 4(4); 496-501.*

Emarievbe, S.O. & Omorake, V.O. (2013). Promoting gender equality in the educational system in Nigeria through adequate curriculum.*Journal of Curriculum Organization of Nigeria, 7*(2), 69-76.

Ezea, J.E. (2014). Effect of field work on students' achievement and achievement and interest and interest in map reading in senior secondary school geography. *Unpublished student Ph.D Thesis of the* University of Nigeria Nsukka.

Ezeliora, B. (2015). Relating chemistry to local practice for gender inclusive science education. *Proceedings of 10 GASAT Conference at Copenhagen, 210-215.*

Giginna, L.I. (2013). Effect of animation instructional strategy on students' achievement, interest and retention in chemical bonding. Unpublished Ph.D Theses, University of Nigeria Nsukka.

Ifelunni, C.O. (2019). Child labour, motivation and cognitive style as determinants of academic achievement of primary school pupils in South-East, Nigeria. *Unpublished Ph.D dissertation*. University of Nigeria, Nsukka.

Ifelunni, C.O., Ezema, V.S., Ugwu, G.C., Eze, C.O. & Ncheke, D.C. (2022). Cognitive styles as a correlate to pupils' academic achievement in South East, Nigeria. *International Journal of Social Science and Human Research*, 5(1), 159-166.

Igwe, O.I. (2017). Students' perception of chemistry teachers' characteristics of interest, attitude and subject mastery in the teaching of chemistry in senior secondary schools. *Journal of Chemistry: Education Research and Practice,* 1(1): 1-8

Jonassen, D.H.& Grabowski, B.L. (1993). *Handbook of Individual difference, Learning and Instruction, Hillsdak, N.J LowrenceEribam.*

Kozhevmikov, M. Evans, C. & Kossdin, S. (2014). Effect of field Dependent-Independent Cognitive Style and cueing strategies on Students' recall and comprehension. *Ph.D Dissertation Submitted in the faculty of Viriginia Polytechnic Institute and State University. Curriculum and Instruction Department.*

Mamab&Putsoa, (2018). Secondary School Science Teacher's Knowledge and Implementation of effective Teaching strategies in High-Performing Schools in Swaziland.

Musya, F.R.(2015). Improving learners' attitude to science under the universal basic education programme. The effect of ethno science-based instruction. *Science Teachers Association of Nigeria 53rd Annual Conference Proceeding. HEBN PLC: 169-177.*

Njoku, Z.C.& Ezinwa, U.S. (2014). Comparative Effects of Peer Technology and lecture method on students' achievement and interest in some difficult concepts in Chemistry. *Journal of Science Teachers Association of Nigeria, 49(1):60-73*

Nwanekwezi, A.U. (2014). Effect of Students' Interaction pattern on Cognitive achievement and Interest in Primary Science. *Unpublished Student Ph.D Thesis* of Curriculum studies and Educational Technology department, University of Port Harcourt.

Oboh, C. O.& Umeh, A.E. (2014). Innovation in Educational Technology for self-Reliance and National Development.*2nd International Conference CPES Complex, Bossocompus, minus October* 355-357

Okoye, P.O. (2014). Influence of cognitive styles on students' achievement in biology in secondary schools in Anambra state. *An international journal of science and technology 3(1) 197-207*

Sternberg, L. (2015). Strategies for effective conduct of practical chemistry work in secondary schools in Nigeria. *Journal of the Science Teachers Association of Nigeria, 47 (I), 126-136.*

Witkin, H.A., Moore, C.A.,Goodenough, G.R.& Cox, P.W. (1977).Field Dependent and Field Independent Cognitive Styles and their educational Implications, *Review of Educational Research, 47*(1); 1-64

Yinusa, A.F. (2014). Assessment of teaching strategies adopted for effective implementation of science subject and trade module curriculum in Nigeria. *Technical Colleges Journal of Education and Social Research, 4(6*), 391-396.