

Gender and Teaching Strategies on Chemistry Students' Achievement in Organic Compounds Nomenclature

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ABSTRACT

This study examined the effect of gender and teaching strategies on chemistry students' achievement in organic compounds nomenclature in EMOLGA of Rivers State, Nigeria. Used in the study was pretest, post test nonequivalent control group quasi- experimental design. One hundred and seventy-five (96 males and 79 females) SSS II Chemistry students were drawn from three secondary schools in EMOLGA of Rivers State. Six research questions were answered, while six hypotheses were tested at 0.05 level of significance. The instrument for data collection was a 50-item Organic Chemistry Nomenclature Achievement Test (OCNAT) developed by the researcher. Students were divided into two experimental groups and a control group. The experimental groups were subjected to treatment using thinking-aloud and self assessment metacognitive strategies, while the control group was taught using the discussion strategy. Mean and SD were used to answer the research questions while t-test statistics and ANCOVA were used to analyze the hypotheses. The findings showed that there is significant difference in the achievement of chemistry students in organic compounds nomenclature when taught with metacognitive teaching strategies. However, self assessment was the best strategy for teaching organic compounds nomenclature the study reveals. The findings also revealed that there is no interaction effect between gender and teaching strategies. The study concluded that metacognitive teaching strategies such as thinking-aloud and self assessment have been identified in this study as innovative teaching strategies that could be adopted in effective teaching of organic compounds nomenclature. In addition self assessment model of metacognitive teaching strategy was found to have superior impact on students' achievement in organic compounds nomenclature and thus is advocated for use in our secondary schools.

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Introduction

Organic Chemistry is a branch of Chemistry encompassing the scientific study of the structures, features and reactions of organic compounds. Organic Chemistry is the Chemistry of carbon together with a few others elements like Hydrogen, Nitrogen, Oxygen, Sulphur. Chemistry as a field is also significant to technology; it is the Chemistry of dyes, drugs, paper and ink, paints, plastic, gasoline, rubber and the host of others. It is the Chemistry of the food we eat and the clothing we wear (Carey, 2006).

With over 35 million known organic compounds there is the need to name these compounds to eliminate mistaken identity which may lead to adverse reactions that may properties and peoples' lives. The International Union of Pure and Applied Chemistry (IUPAC), a body saddled with naming of chemical compounds and rules governing chemistry have lay down rules for naming organic compounds. Many Chemistry learners and instructors still do not adopt the IUPAC nomenclature in naming organic compounds and this has led to failure in organic Chemistry. The WAEC Chief Examiner reports of 2011-2014 have continuously indicated that candidates' poor performance in organic Chemistry is in their inability to draw accurate structures of organic compounds and giving them names

using the IUPAC nomenclature. The problem of nomenclature of organic compounds has been attributed to Chemistry textbook and Chemistry teachers (Nwokocha and Ahiakwo, 2013).

The instructional methods utilized by Chemistry teachers have been reported by many researchers as the major cause of poor performance in Chemistry (Chinda 2012, Ogbaba and Adagba, 2013). Many strategies have been used to teach Chemistry such as discussion, laboratory, field trip, problem solving, demonstration lecture etc. Due to the problem of instructional strategies this study seek to use discussion and metacognitive (self-assessment and thinking aloud) strategies to see whether it will enhance student performance in organic compounds nomenclature

Discussion teaching strategy is the method involving groups of students interacting to exchange ideas, facts opinions and verbal expression about a topic of interest or outmost concern under the guidance of a teacher (Ogbaba and Adagba, 2013). Discussion method gives every class member or group freedom to express his or her views. It enables learners to acquire critical and evaluation thinking and listening skills and afford them some confidence through active participation. Aghaebrahimiya and Mirshahjafari (2014) carried out a study comparing discussion strategy and

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lecture method of instruction on the social skill of high school students in Chemistry and found out that, discussion teaching strategy increases students' social skills and achievement. In the same vein Omwirihiem (2015) asserted that discussion, strategy enhances achievement and productivity in organic chemistry. Similarly Uzezi and Deya (2017) found out that there is a noticeable distinction between students that belong to a peer group and those that do not fall under a peer group on the Chemistry learners' academic achievement. Ogbaba and Adagba (2013) studied the effect of laboratory and discussion strategy on students' achievement in Chemistry and the outcome indicated that learners taught using laboratory strategy achieved noticeably higher scores than those students taught using discussion strategy. For appreciable performance, Chemistry teachers should use instructional strategies that will promote problem solving skills and creativity. This could be realised through the utilization of teaching strategies that are metacognitive.

Koch (2001) sees metacognition as a hidden level of behaviour that involves focusing on thinking and its relation to intellectual performance. It is a self-regulatory system that helps a person understand and control his or her own cognitive performance. Metacognitive is a process which the learner uses to achieve a desired goal it involves critical thinking above the ordinary level of teaching. Metacognition gives the students the opportunity to plan their learning through the use of their prior knowledge as they explore, develop and reinforce their understanding of principles. Loveth (2016) found out that students who believed that they could succeed academically had higher motivational persistence in learning tasks. She added that students who are aware and self-regulated can make their brain smarter. Cook, Kennedy and McGuire (2013) studied the effect of metacognitive learning methods teaching on performance in general Chemistry courses and found out that metacognitive strategies improve students' achievement in general Chemistry courses.

Metacognitive techniques are strategies which the learners who want to empower themselves in a notably meaningful manner adopt. For the motive of this study thinking aloud and self-assessment are the two metacognitive techniques employed.

Thinking aloud is a metacognitive approach in which the instructor facilitates the students to prepare and enhance their thought at the same time as they may be solving problem or particularly throughout troubles fixing. While pupils think aloud, they discover ways to become reflective metacognitive independent learners.

Jeon, Huffman and Noh (2005) studied the effect of thinking aloud pair problem solving (Tapps) technique on Chemistry learners' problem solving and verbal interplay. The result found out that students in aloud thinking finished better than the ones in other groups in recalling the related laws and mathematical execution and conceptual information. In the same vein Hafizah, Kani and Shadrill (2015) asserted that there is a significant improvement in student's problem solving behaviour when taught with thinking aloud strategy.

On the other hand self-assessment is metacognitive strategy that learners use to plan, monitor, control and evaluate their learning Nbina and Viko (2010) revealed that instruction in the metacognitive self-assessment strategy improve students chemistry achievement and self-efficacy and there is interaction between gender and teaching method. Feldkamp (2013) studied the effect of self-assessment on

student's learning in chemistry. The result of the study revealed that self-assessment slightly improved student's scores on summative assessment.

Nwokoch and Ahiaikwo (2013) studied the use of stereochemistry models in teaching organic compounds nomenclature and located that the used of stereochemistry version improves pupil overall performance in organic compounds nomenclature and there may be no sizable difference inside the overall performance among boys and girls. Sakrin, Laorthip and Vinch (2014) affirms that when Organic Chemistry is taught with innovative strategies it promotes student's learning achievement and retention of Organic Chemistry concepts. In the same vein, Olatoye, Aderogba and Aanu (2011) determined that cooperative and individualized coaching methods has great consequences on students' success in organic chemistry and there no interaction impact among treatment and gender. Gaffoor and Shina (2014) studied gender and concept mapping in identifying student's difficulties in high school organic chemistry. The result revealed that there is no gender effect on achievement in organic Chemistry and there is interaction between gender and teaching method and it is in favour of the girls.

Aim and Objectives of the Study

The aim of this study was to determine the effect of gender and teaching strategies such as thinking aloud and self assessment on students' achievement in organic compounds nomenclature. Specifically, the study was designed to:

1. Examine whether the performance of students taught with thinking aloud metacognitive teaching strategy differ from those taught with discussion strategy in organic compounds nomenclature.
2. Find out whether the performances of students in self assessment metacognitive teaching strategy differ from those in discussion strategy in organic compounds nomenclature.
3. Find out the effect of thinking aloud, self assessment and discussion strategies on students' achievement in organic compounds nomenclature.
4. Determine the interaction effect of teaching strategies and on students' achievement in organic compound nomenclature.

Research Questions

Based on the stated objectives the following research questions guided the study

1. To what extent does the performance of students in thinking aloud metacognitive teaching strategy differ from those in discussion strategy in organic compounds nomenclature?
2. What is the difference in performance of students taught using self assessment metacognitive teaching strategy and those taught using discussion strategy in organic compounds nomenclature?
3. What is the effect of thinking aloud, self assessment and discussion strategies on students' achievement of organic compounds nomenclature?
4. What is the interaction effect of teaching strategies and gender on students' achievement in Organic compounds nomenclature?

Hypotheses

To answer the research questions of the study the following hypotheses were formulated and were tested at 0.05 level of significance.

1. The performance of students taught using thinking aloud metacognitive teaching strategy do not significantly differ

from those taught using discussion strategy in organic compounds nomenclature .

2. The performance of students taught using self assessment metacognitive teaching strategy do not significantly differ from those taught using discussion strategy in organic compounds nomenclature.

3. There is no significant difference in the performance of organic compounds nomenclature among students taught using thinking aloud, self assessment and discussion strategies.

4. There is no significant interaction effect of teaching strategies and gender on students' achievement in organic compounds nomenclature.

Methodology

A quasi experimental, the pre-test post test non-equivalent control group design was used for the study, since there was no randomization of the subjects into groups. The population of the study comprised of 600 SSII chemistry students in the 14 public senior secondary schools that offer chemistry in EMOLGA of Rivers State. 175 students were sampled for the study from three schools in EMOLGA. One instrument was used for the study the Organic Nomenclature Achievement Test (ONAT). The instrument consisted of 50 multiple choice items and short answer type questions carefully drawn from WAEC and NECO past question papers and from the investigator's design who is also a specialist in Chemistry made up the instrument. Before, administering the test items, the questions were subjected to content and face validity by other experts in chemistry so as to ascertain their appropriateness. 0.95 was the reliability index using Kuder Richardson 21. This indicated that the tool was very reliable. Just before the commencement of the treatment which lasted for three weeks, the subjects in the experimental and control groups were given the ONAT based on the topics selected for the study. This was to determine the equivalence of the two groups and Organic compounds nomenclature was the topic used in the study. The control group was taught using discussion strategy and experimental groups were instructed using the thinking aloud and self assessment metacognitive strategies.

At the end of the treatment, the instruments earlier on described were administered to assess the effectiveness of the three strategies utilized. Scores from the experimental and control groups formed the study data. Mean, SD, t-test and ANCOVA were the statistical tools used at $P \leq 0.05$

Results

Research Question 1: To what extent does the performance of students in thinking aloud metacognitive teaching strategy differ from those in discussion strategy in organic compounds nomenclature?

Table 1. Summary of ANCOVA analysis of thinking aloud metacognitive teaching strategy and discussion strategy.

Post test			
Strategies	N	Mean	SD
Thinking Aloud	51	33.61	7.27
Discussion	50	18.96	6.30

Source of variation	Sum of squares	df	Means squares	F	Sig
Pre-test scores	321.440	1	321.440	7.387	.088
Group	3402.815	1	3402.81	78.196	.000
Error	4264.637	98	43.517		
Total	80164.000	101			
corrected total	10003.168	100			

a. R square .574 (adjusted R squared= .565)

Hypothesis 1: The performance of students taught using thinking aloud metacognitive teaching strategy do not significantly differ from those taught using discussion strategy in organic compounds nomenclature.

Table 1 shows that the mean and SD for thinking aloud metacognitive teaching strategy were 33.61 and 7.27 respectively, while that of discussion strategy were 18.96 and 6.30. This indicates that students in thinking-aloud metacognitive teaching strategy had a higher mean score than those in discussion strategy. This implies that the performance of students in thinking aloud metacognitive teaching strategy differ from those in the discussion strategy. The summary of the ANCOVA analysis of comparative difference between thinking aloud metacognitive teaching strategy and discussion strategy shows a calculated $F(1,98) = 78.196$ at $P(0.000) < 0.05$ level of significance which means that the F is significant. Therefore the null hypothesis was rejected. This means that the performance of students taught using thinking aloud metacognitive teaching strategy differ significantly from those instructed using discussion strategy in organic compounds nomenclature.

Research Question 2: What is the difference in performance of students taught using self assessment metacognitive teaching strategy and those taught using discussion strategy in organic compounds nomenclature?

Hypothesis 2: The performance of students taught using self assessment metacognitive teaching strategy do not significantly differ from those taught using discussion strategy in organic compounds nomenclature.

Table 2. Summary of ANCOVA analysis of self assessment metacognitive teaching strategy and discussion strategy.

Post test			
Strategies	N	Mean	SD
Self-assessment	74	35.73	12.06
Discussion	50	18.96	6.30

Source of variation	Sum of squares	df	Means squares	F	Sig
Pre-test scores	2982.917	1	2982.917	37.638	.000
Group	2716.463	1	2716.463	34.276	.000
Error	9589.597	121	79.253		
Total	125016.000	124			
corrected total	20963.871	123			

a. R square .543 (adjusted R square = .535)

The results in Table 2 reveals that, the mean and SD for self assessment metacognitive teachings strategy were 35.73 and 7.27 respectively while that of discussion strategy were 18.96 and 6.30. This revealed that students in self assessment metacognitive teachings strategy had a higher mean score than those in discussion strategy. This implies that the performance of students in self assessment metacognitive teaching strategy differ from those in the discussion strategy.

Also the results in Table 2 show the summary of ANCOVA analysis on the comparative difference between self assessment metacognitive teaching strategy and discussion strategy. The calculated $F(1,121) = 34.276$ at $P(0.000) < 0.05$ level of significance. This means that the F was significant. Therefore the null hypothesis rejected. This implies that the performance of students taught using self assessment metacognitive teaching strategy differ significantly from those taught using discussion strategy in organic compound nomenclature.

Research Question 3: What is the effect of thinking aloud, self-assessment and discussion strategies on students' achievement in organic compounds nomenclature?

Hypothesis 3: There is no significant difference in the performance of organic compounds nomenclature among students taught using thinking aloud, self assessment and discussion strategies.

Table 3A. Summary of ANCOVA analysis of thinking-aloud self assessment and discussion teaching strategies.

Post test			
Strategies	N	Mean	SD
Thinking Aloud	51	33.61	7.27
Self-assessment	74	35.73	12.07
Discussion	50	18.96	6.30

Source of variation	Sum of squares	df	Means squares	F	Sig
PER-TEST SCORES	2640.84	1	2640.841	35.920	.000
GROUPS	4367.200	2	2183.600	29.701	.000
Error	12571.830	171	73.519		
Total	185260.00	175			
Corrected Total	24382.080	174			

a. R squared = .484 (adjusted R squared = .475)

Table 3 shows the mean and SD for thinking aloud as 33.61 and 7.27 respectively while self-assessment has a mean and standard deviation of 35.73 and 12.07 respectively. The mean of self-assessment is slightly higher than thinking aloud this implies that the performance of students taught with self-assessment metacognitive teaching strategy was better than those in taught thinking aloud metacognitive teaching strategy in organic compounds nomenclature. Discussion strategy has a mean of 18.96 and standard deviation of 6.30, the lower mean scores shows that discussion strategy does not improve the students' achievement in organic compounds nomenclature.

The result from Table 3A shows that the F-value was 29.701 which is significant at 0.05 level of significance. The null hypothesis of no significant difference in the achievement of organic compounds nomenclature among students taught using thinking aloud, self assessment and discussion strategies was rejected and the alternate hypothesis which states there is significant difference in the performance of organic compounds nomenclature among students taught using thinking aloud, self assessment and discussion strategies was accepted. The post hoc analysis revealed that there was no significant difference between thinking aloud and self assessment. But there was significant difference between metacognitive teaching strategies (thinking aloud and self assessment) and the discussion strategy.

Table 3B. Post hoc analysis through the Least Significant Difference (LSD).

(I) TREATMENT	(J) TREATMENT	Mean Difference (I-J)	Std Error Std. Error	Sig.a
THINKING ALOUD GROUP	SELF ASSESSMENT GROUP	.687	1.629	0.675
	DISCUSSION METHOD GROUP	12.379*	1.748	.000
SELF ASSESSMENT GROUP	THINKING ALOUD GROUP	.687	1.629	0.675
	DISCUSSION METHOD GROUP	11.695*	1.783	.000
DISCUSSION METHOD GROUP	THINKING ALOUD GROUP	-12.379*	1.748	0.675
	DISCUSSION METHOD GROUP	-11.695*	1.783	.000

* The mean difference is significant at the .05 level

a. Adjustment for multiple comparisons: Least significant Difference (equivalent to no adjustments).

Research Question 4: What is the interaction effect of teaching strategies and gender on students' achievement in Organic compounds nomenclature?

Hypothesis 4: There is no significant interaction effect of teaching strategies and gender on students' achievement of organic compounds nomenclature.

Table 4. Summary of ANCOVA analysis for interaction effect of teaching strategies and gender.

Strategies	Gender	Mean	SD	N
Thinking Aloud	Male	34.32	7.92	31
	Female	32.50	6.15	20
Self-assessment	Male	36.31	11.33	36
	Female	35.18	12.85	38
Discussion	Male	20.03	6.34	29
	Female	17.48	6.09	21

Source	Sum of squares	df	Means squares	F	Sig	Partial Eta Square
PER-TEST SCORES	2748.136	1	2748.136	37.471	.000	.182
GROUP	4149.794	2	2074.897	28.291	.000	.252
Sex	188.383	1	188.385	2.569	.111	.015
GROUP*Sex	27.206	2	13.340	.185	.831	.002
Error	12321.192	168	73.340			
Total	185260.00	175				
Corrected Total	24382.080	174				

a. R squared = .495 (Adjusted R squared = .477)

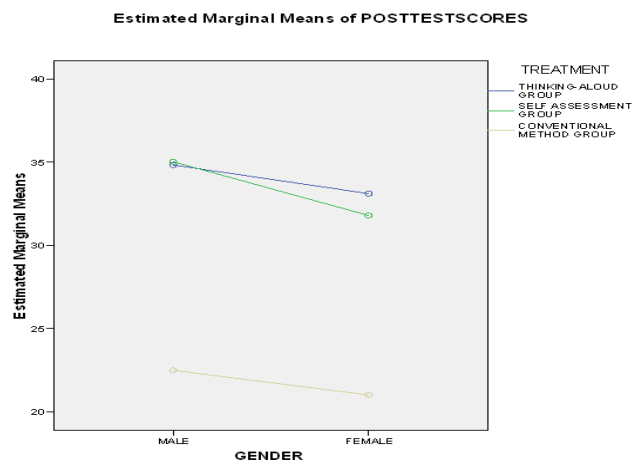


Fig 1. Graphical representation of interaction effect of teaching strategies and gender.

Table 1 shows that thinking aloud metacognitive strategy has mean and SD for male as 34.32 and 7.92 respectively while that of female were 32.50 and 6.15 respectively. The mean and SD for male students in self assessment metacognitive strategy were 36.31 and 11.33 respectively while that of female was 35.18 and 12.85 respectively. Discussion strategy has a mean and SD for male students as 20.03 and 6.34 while that of female 17.48 and 6.09. The performance of the male in all the strategies were slightly different from that of the female. This is an indication that the male learners performed higher than their female counterparts in the three strategies. Graphical representation clearly shows that there was interaction effect between thinking aloud and self assessment teaching strategies and gender on students' achievement in organic compound nomenclature. The graph is presented in Figure 1. To test the hypothesis ANCOVA analysis was performed on the relevant data $F(2,168)$ value for the interaction was 0.185 $P > 0.05$ therefore the null hypothesis is accepted this means that there is no significant interaction effect of teaching strategies and gender on students' understanding of organic nomenclature.

Discussion of Findings

To determine the effect of thinking aloud metacognitive teaching strategy and discussion strategy on students' achievement in organic nomenclature two categories of learners were instructed in organic nomenclature. One category was instructed with thinking aloud metacognitive teaching strategy and another category was instructed with discussion strategy. A pre-test was administered to the two categories of learners, and then followed by 3 weeks period of teaching and a post test was given. The scores got from the categories used were analysed. Revealed by the research results is that learners in the thinking aloud metacognitive teaching strategy had a higher mean score than the discussion strategy learners. The result was that, performance of students taught using thinking aloud metacognitive teaching strategy significantly differ from those instructed using discussion strategy in organic nomenclature. The significant result is because metacognition is a system that regulates and helps people to control their own cognitive performance. In thinking aloud metacognitive teaching strategy learners need to think critically before verbalizing their thought about a topic or question. The significant result is also due to fact that when students think-aloud the right answers or opinion will be taken or rewarded and wrong answers corrected. The result of this study was in agreement with what Hafizah, Kani and Shadrill (2015) found out that thinking aloud metacognitive teaching strategy significantly improves students' problem solving behaviour and understanding of problem. Also Jeon et al (2005) revealed that learners in thinking aloud had better performance in recalling related law, mathematical and conceptual knowledge than students in the other groups. The result has bearing with Sakrin, Laothrop and Vinich (2013) that teaching organic Chemistry with other innovative methods promote learners' learning achievement and ability to retain concepts in organic Chemistry.

However, the result of this study is in disagreement with Omwirhien (2015) who found out that discussion strategy enhances achievement and productivity in organic chemistry. The study's outcome also disagrees with Uzezi and Deya (2017) who found out that there is significant difference between students that belong to peer discussion group on the academic achievement in Chemistry.

A second finding of this study was that students in self assessment metacognitive teaching strategy had a higher mean score than those in discussion strategy. The performance of students in self assessment metacognitive teaching strategy differs from those in the discussion strategy. Further statistical analysis revealed that the performance of students taught using self assessment metacognitive teaching strategy significantly differ from those instructed using discussion strategy in organic compounds nomenclature.

Self assessment stimulates learners to exercise a variety of learning strategies and higher order thinking skills. It also develops appropriate study strategies and foster life learning. The result is in agreement with what Nbina and Vikoo (2010) found out instruction in metacognitive self assessment strategy significantly improved the Chemistry achievement of secondary school students.

The result was also in agreement with what Feldkamp (2013) revealed, that self assessment helped students' scores to get better on summative assessment when compared with units of similar perceived difficulties. The result of the study is also in agreement with what Nwokocha and Ahiakwo (2013) found out that when organic nomenclature is using other innovative methods other than the conventional method it improves performance in organic nomenclature.

The study is in also agreement with what Ogbeba and Adagba (2013) who found out that students taught using laboratory method achieved significantly higher than those students taught using discussion method. The result of this study disagrees with Aghaebrahimiya and Mirshahjafari (2014) that revealed that discussion teaching method increases the students' social skills and achievement. Uzezi and Deya (2017) also disagree with this finding as they found out that there is significant difference between students that belong to peer group on their achievement in chemistry.

The result showed that there was significant difference in understanding of organic nomenclature among students taught using thinking aloud, self assessment and discussion strategies as measured by their performance (Table 3). The significant performance lies between the metacognitive teaching strategies and the discussion. The significant result is because metacognition was a regulatory system that helps a person understand and control his or her own cognitive performance. It involves critical thinking above the ordinary level of thinking performance. The result was in agreement with Koch (2001) that metacognition is a hidden level of behaviour that involves focusing on thinking about thinking and its relation to intellectual performance. Loveth (2008) also found out that student who believe that they could succeed academically had higher motivational persistence in learning tasks and self-regulation make their brain "smarter". This is in line with what Cook et al (2013) that metacognitive teaching strategies fall under constructive perspective teaching style which holds that student must be actively engaged in the learning process and student should not be reduced to the terms of passive receivers of information. The result has bearing with Cook et al (2013) affirmed that teaching chemistry with metacognitive strategy will make them to learn better, retain and apply knowledge and also improve their performance. The result of the study was also in agreement with what Nwokocha and Ahiakwo (2013) found out that when organic nomenclature is taught using other innovative methods other than the conventional method it improves performance in organic nomenclature. Sakrin, Laothrop and Vinich (2014) agree that teaching organic

chemistry with other innovative method promote students learning achievement and retention of organic chemistry concepts.

The results also show that there is no interaction effect between gender and teaching strategies (Table 4). This was consistent with Nbina and Vikoo (2010) the interaction effect of self assessment and gender on chemistry students was not significant. Olatoye, Aderogba and Aanu (2011) also found out that there no significant interaction effect between treatment and gender in organic chemistry achievement. The finding disagrees with Gafoor and shilna (2014) who revealed that the interaction between gender and test formats in organic chemistry score is in favour of the girls

Conclusions

The study concludes that metacognitive teaching strategies such as thinking-aloud and self assessment have been identified in this study as an innovative teaching strategy that could bring about better understanding and achievement of students in organic compounds nomenclature. In addition self assessment model of metacognitive teaching strategies was found to have superior impact on students' achievement in organic compounds nomenclature when compared with thinking aloud metacognitive teaching strategy.

Recommendations

On the basis of the findings from this study it is recommended that;

1. Students should be taught using self assessment metacognitive strategy as this has been found to improve their performance.
2. Thinking – aloud and self assessment metacognitive strategies should be used in teaching chemistry in secondary school rather than the discussion strategy.
3. Chemistry teachers should use these strategies in teaching chemistry concepts since it has been found it dispel gender disparity.
4. In view of the effectiveness of metacognitive teaching strategies, teachers should be trained to acquire the skills needed for use of the metacognitive strategies which are also learners centred.

REFERENCES

Aghaebrahimiya, N. & Mirshahjafari, E. (2014). Comparism of group discussion and lecture on the social skills of high school students in chemistry for the academic year 93-92. *International Journal of Academic Research in Progressive Education and Development*, 3 (4) 225 – 236.

Bahl, A. & Bahl, B.S. (2012). *Advanced Organic Chemistry*. New Delhi: Schand & CompanyLtd.

Carey, F. A. (2006). *Organic Chemistry*. New York: Mc Graw Hill Companies

Chinda,W.(2012).Male and Female Chemistry Students:The way for Excellent Performance. *African Journal of Professional Research in Human Development* ,8 (1), 16-26.

Cook, E., Kennedy, E. & Mc Guire, S.Y. (2013). The Effects of Teaching Metacognitive Learning Strategies on Performance in General Chemistry Course. *Journal of Chemical Education*, 90, 961 – 967.

Feldkamp, L.M. (2013).*Effects of Self assessment on Students Learning in High School Chemistry*. Unpublished Masters Degree Thesis Montana State University Bozeman Montana

Gafoor, K. A. & Shilna, V. (2014). Gender fair efficacy of concept mapping test in identifying student'sdifficulties a paper presented at collaborative International Conference on Learning Environment for Excellence Education SRM University Tamil Nadu India Held on 24 & 25th January 2014.

Hafizah, N., Kani, A & Shahrill, M. (2015). Applying the Thinking Aloud Pair Problem solving strategy in Mathematics Lesson. *Asian Journal of Management Science and Education*, 4 (2), 20 –29.

Jeon, K.,Huffman D. & Noh, T. (2005).The Effects of Thinking Aloud Pair Problem Solving of High School Students Chemistry Problem–Solving Performance and Verbal Interactions. *Journal of Chemical Education*, 82(10), 1558 – 1564.

Koch, A. (2001).Training in Metacognition andComprehension of Physics Texts. *Science Education*, 85, 758-768.

Lovett, M. C. (2016) .Teaching Metacognition Retrieved 10 January 2016 From <http://mdeucac.us/upload/Presentation/El/081/fso3/Metacognition/EII.pdf>.

Nbina, J.B. & Vikoo, B. (2010). Effects of instruction in metacognitive Self AssessmentStrategy on Chemistry Students Self Efficacy and Achievement. *Academia Arena*, 2(11), 1-10.

Nwokocha, O. & Ahiakwo, M. J. (2013). Using Stereochemistry Models in Teaching Organic Compounds Nomenclature: Effects on senior secondary students performance in Rivers State of Nigeria *African Journal of Chemistry Education*,3(2),91-105.

Ogbeba, J. & Adagba, M. (2013). Comparative Effects of the laboratory and Discussion methods on senior secondary students' achievement in chemistry. *Online Journal of Africa Affairs*, 2 (2), 64-69.

Olatoye, R.A., Aderogba, A.A. & Aanu, E.M. (2011). Effect of Co-operative and Individualized Teaching Methods on Senior Secondary School Students' Achievement in Organic Chemistry.*PacificJournalofScienceandTechnology*,12(2),310-319.

Omwirhiren, E.M. (2015). Enhancing Academic Achievement and Retention in Senior Secondary School Chemistry through discussion and lecture methods: A case study of some selected secondary school in Gboko, Benue State Nigeria. *Journal of Education and practice*, 6 (21), 155-166.

Sakiri, S., Laorthig, K. & Vinich, P .(2014).Enhancement of learning Achievement of Organic Chemistry using inquiring based semi small scale experiments (SSSEs) *Procedia Social and Behavioral Science*,116,769- 774.

Uzezi, J.G. & Deya, G.D. (2017).Relationship between peer group influence and students' academic achievement at secondary school level *American Journal of educational research*, 5 (4) 350-356.

West African Examinations Council Chief Examiner Report May/June 2010-2014