

EFFECTIVENESS OF SELF-REGULATORY LEARNING APPROACH IN IMPROVING LEARNING OUTCOMES OF SENIOR SECONDARY SCHOOL STUDENTS IN BIOLOGY

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Abstract

The study investigated the effectiveness of self-regulatory learning approach in improving learning outcomes of senior secondary school students in biology. A sample of 234 students from four co-educational senior secondary schools was drawn for the study. Four research hypotheses were generated to guide this study. The data were tested using t-test and Analysis of Co-variance (ANCOVA) The results of H_{01} : ($t\text{-cal} = -.610$; $df = 232$; $P > .05$). Since the p -value of 0.542 is greater than alpha (0.05), the null hypothesis hereby accepted. Students who received instruction in SRLA strategies had significantly higher scores in biology test than those who did not receive instruction. H_{02} : shows that the F -calculated due to teaching methods is .364 while the critical value at alpha level of 0.05 is .000. Since the p -value (.000) is less than alpha (0.05), the null hypothesis hereby rejected. Hence there was a significant difference between the mean achievement scores of male and female students taught using SRLA compared to those taught using lecture method. H_{03} : shows that there was a significant difference in the achievement scores of male and female students instructed using the SRLA and those taught using lecture method ($t\text{-cal} = 1.69$; $df = 122$; $P > .05$). Since the p -value (.095) is greater than alpha (0.05), the null hypothesis hereby rejected. H_{04} : revealed a significant interaction between gender and teaching methods on students' achievement in Biology, F (.629) with level of significance being 0.430. This indicates that there was a significant interaction effect of teaching method and gender on the mean achievement scores of students in biology. Based on the findings, it was concluded that SRLA significantly enhances students' achievement in Biology.

Keywords: Self-Regulated Learning Approach, Lecture Teaching Method, Conventional Teacher Expository Method

Introduction

Biology as one of the science subjects that is compulsory for Senior Secondary School students and majority of other students in Arts and Commercial classes choose as alternative and it is regarded as the most simple science subject. Biology is defined as the study of life or living things. It is concerned with the structure, behaviour and origin of plants, animals and their relationship with their environment. Biology as a natural science concerned with study of life and living organisms including the structures, functions, growth, evolution, distribution, identification and taxonomy. It is also a natural science concerned with the study of living things in our environment. Biology is the apiculture of all studies in faculties of science education, health, pure or applied science. It is a core subject compulsory to all science students in secondary schools in Nigeria (Delphonso, 2018).

Biology plays key role in industrialization and other sectors of the economy. It is a practical subject which equips students with concepts and skills that are useful in solving the day-to-day problems of life. The study of biology aims at providing the learner with necessary knowledge with which to control or change the environment for the benefit of an individual, family or community. The study

of biology in senior secondary schools can equip students with the useful knowledge that will enable them face the challenges of life before and after graduation.

The results of such studies linked the poor performance to poor quality of science teachers, large and overcrowded classrooms and lack of suitable and adequate science equipment, students' misconceptions derived from religious, cultural and societal related sources (Salami, 2012). Hackling & Rennie, 2001; Darling-Hammond, 2007 and Delphonso, 2018). Aladejana (2008) and Delphonso (2015) and Delphonso (2018) explain that teaching still retains the old conservative approach of teachers acting as repertoire of knowledge and students the dormant recipients. Delphonso (2018) further states that the traditional teacher-centered teaching approach which favours passive reception of knowledge is still in vogue in most of our secondary schools all over the country and such an approach has been criticized for its neglect of students' learning from a variety of sources.

A positive attempt to improve students' learning of Biology concept will therefore involve the use of strategies that are tailored towards constructivism that will help to modify students' misconceptions. The process of modifying misconceptions with scientifically acceptable concepts is called "conceptual change". Constructivism is one of the pedagogical tools used to promote conceptual change among learners. The unique features of conceptual change instruction are (1) students exhibit their conceptions explicitly so that they become conscious of their own ideas and thinking including groups and (2) that students are constantly engaged in evaluating and revising their conceptions. Since learners engage in activities that aid the processing of information and mental activities that will assist them to acquire, organize, structure instill and retrieve incoming knowledge efficiently (Park, 1995), learning therefore, depends on the use of appropriate thinking strategies that will promote meaningful learning where teachers go about teaching for conceptual change by making use of teaching methods that emphasize constructivist philosophies.

The method of interest in this study is Self-Regulated Learning Approach (SRLA) is based on the constructivist learning theory approach. The strategies focus on active learning and the individual construction of knowledge by the students through different interactive patterns (Adeleke, 2005; Adesoji, 2008; Bamidele, 2010; Salami, 2012 & Delphonso, 2015). This instructional approach has been found to provide opportunities for students to confront their own beliefs with ways to resolve any conflict between their beliefs and scientific concepts they encounter in their Biology classes. Hence, students are encouraged to accommodate the new science concepts with what they already know and to make the necessary and appropriate connections between the concepts learned in the classroom with everyday life.

Self-regulated learning is a cognitive and metacognitive process that plays a critical role in academic achievement. It involves actively monitoring and controlling one's own learning, including setting goals, strategizing, and evaluating progress. It is a process in which individuals take an active role in their own learning (Beishuizen & Steffens, 2011; Banarjee & Kumar (2014).

However, there is still a lack of research specifically examining the effect of self-regulated learning on academic achievement in secondary students studying biology. This study aims to fill this gap in the literature by investigating the relationship between self-regulated learning and academic achievement in a sample of secondary students studying biology. By understanding this relationship, educators can better support students in developing self-regulated learning skills and promoting academic achievement in this subject.

Theoretical Framework

The theoretical framework of this study is based on constructivist theory. A basic assumption in teaching for conceptual change is “the key constructivist idea that construction of new conceptions (learning) is possible only on the basis of already existing conceptions.

Piaget’s Genetic Epistemology is fundamentally constructivist. It emphasizes that assimilation, accommodation, disequilibrium and equilibrium are important components in the conceptual change process. Von Glaserfeld (1988) describes constructivism as a theory of knowledge which is rooted in philosophy, psychology and cybernetics. Yager (1991) claims that constructivist theory of knowing and ability to cope depends on equilibrium state while the equilibrium is like a balance beam. According to Slavin (1987), there are two major theoretical perspectives related to cooperative learning -- motivational and cognitive. The motivational theories of cooperative learning emphasize the students' incentives to do academic work, while the cognitive components emphasize the effects of working together.

Teaching strategies based upon cognitive dissonance and its resolution has been used as the basis for developing teaching strategies designed to teach for conceptual change. These teaching strategies are derived from a Piagetian constructivist view of learning; they involve creating situations where learners’ existing conceptions about particular phenomena or topic are made explicit and then directly challenged in order to create a state of cognitive conflict. It is, therefore, against this premise that Self-Regulated Learning Approach (SRLA) is one of the appropriate and effective teaching strategies that guide the learners to attain goals that cannot be obtained working alone or competitively.

Based on the foregoing, the theoretical thrust of this study is derived from previous works of Dewey (1938); Piaget (1930), (1973) and Vygotsky (1978); the relevance of this research study to such previous works is in the areas of cognition, logic reasoning, schema, problem-solving, groupwork, collaboration, memory inference and concept formation.

Problem

Over the years, it has been observed that teaching still retains the old conservative approach of teachers acting as repertoire of knowledge and students the dormant recipients. She further states that the traditional teacher-centered teaching approach which favours passive reception of knowledge is still in vogue in most of our secondary schools all over the country and such an approach has been criticized for its neglect of students’ learning from a variety of sources. As long as the teachers hold on to the traditional approach of content delivery of concepts, principles and theories of Biology, the academic achievement of the students is likely to be poor. It is reasonable therefore, to utilize a sequential and logical Self-Regulated learning Approach (SRLA) that is effective in modifying or changing students’ original conceptions (misconceptions) in a way that can improve students’ learning and performance in Biology.

Aim and Objectives of the Study

The aim of this study is to investigate the effectiveness of Self-Regulatory Learning Approach (SRLA) in improving learning outcomes of senior secondary school students in biology. Therefore, the specific objectives of this research are to:

- i. determine the pre-test score of students taught using Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM) with
- ii. Conventional Teacher Expository Method (TEM); compare the effect of Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM).
- iii. determine the effect of Self- Regulated learning Approach (SRLA) on the achievement score of male and female students in Biology.
- iv. examine the interaction effect of gender and Self- Regulated learning Approach (SRLA) on students' achievement in Biology.

Research Questions

In the context of the above objectives the following research questions will be used to guide the studies.

- i. What is the pre-test score of students taught using Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM)?
- ii. What is the effect of self-regulated learning approach (SRLA) and those taught using Lecture Teaching Method (LTM)?
- iii. What is the effect of Self- Regulated learning Approach (SRLA) on the achievement scores of male and female students in Biology?
- iv. What is the interaction effect of gender and Self- Regulated Learning Approach (SRLA) on students' achievement in Biology?

Research Hypotheses

In the context of the above research objectives and questions the following hypotheses will be tested:

- Ho1:** There is no significant difference between the pre-test score of students taught using Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM) and Conventional Teacher Expository Method (TEM);
- Ho2:** There is no significant difference between the effect of Self- Regulated learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM).
- Ho3:** There is no significant difference between mean achievement of male and female students taught Biology using Self- Regulated learning Approach (SRLA).
- Ho4:** There is no significant interaction between gender and Self- Regulated learning Approach (SRLA) on students' achievement in Biology.

Scope of the Study

This study examined the effectiveness of self-regulatory learning approach in improving learning outcomes of senior secondary school students in biology. Self-regulated learning Approach (SRLA) is a sequential and logical approach that is effective in modifying or changing students' original conceptions (misconceptions) in a way that can improve students' learning and performance in Biology and even modifies attitudes and improve retention capability) of Biology students in Epe environment. The geographical coverage of the study was restricted to Senior Secondary Schools located in Epe, Lagos State, South-western Nigeria.

Methodology

This study adopted the non-equivalent pre-test, post-test control group design. There were three groups in the study, two experimental groups and one control group.

The design for the study can be represented as:

Experimental Group I	O ₁	X ₁	O ₂	O ₃
Experimental Group II	O ₄	X ₂	O ₅	O ₆
Control Group	O ₇	X ₃	O ₈	O ₉

The study population comprised of all secondary school students in biology classes in Epe Local Government of Lagos State. The schools were randomly assigned to experimental and the control groups, four (4) intact senior secondary school two (SSII) classes were chosen at random from four (4) public mixed secondary schools. The sample consisted of 234 secondary school students in biology classes, with a total of 124 students in the experimental group and 110 students in the control group.

Instrument

The BAT consists of 30 multiple-choice questions derived from the instructional units. The instruments were trial-tested on a sample of 100 students outside the sampled locations in order to establish the reliability of the BAT. Using the Kuder-Richardson formula 21, a coefficient of internal consistency of 0.78 was attained.

Instructional Strategies Used

The study utilized the following instructional strategies included;

- i. Self-regulated learning Approach (SRLA).
- ii. Lecture teaching method (LTM).
- iii. Teacher Expository Method (TEM).

Data Collection

The procedure for collection of data was in three main phases and it lasted for eight weeks.

The phases were:

- i. Pre- test for the first one week
- ii. Treatment for next six weeks
- iii. Post-test for the last one week of the eight weeks.
- iv. Then a retention test was carried out two weeks after the post test.

Data Analysis

The data collected were analysed using Analysis of Variance (ANOVA), t-test and where significant difference occurred; the Scheffe Post-hoc test was used to determine the direction of the significance. All hypotheses were tested at $P < 0.05$ level of significance.

The Data obtained was analyzed using the SPSS statistical software (SPSS 22), including t-tests and ANCOVA, to determine the significance of the results. The collected data were analyzed using Analysis of Co-Variance (ANCOVA) to test hypotheses at 0.05 level of significance.

Results and Analysis

The study investigated the effectiveness of self-regulatory learning approach in improving learning outcomes of senior secondary school students in biology and four hypotheses were generated and tested.

Hypothesis One: Hypothesis states that there is no significant difference between the pre-test score of students taught using Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM) and Conventional Teacher Expository Method (TEM);

The findings of this study showed that there was no significant difference in the prior knowledge of students taught using Self-Regulated Learning Approach (SRLA), Lecture Teaching Method (LTM) and Teacher Expository Method (TEM). This implies that both groups have similar prior knowledge and thus suitable for the experiment. As a result, before the start of experimental application, these three groups are considered as equal in academic achievement. That is, the hypothesis is accepted. The findings is in accord with the cognitive psychologists with constructivists epistemological view, that students do not enter the class as a clean slate of mind, rather, they enter the class with a complex set of pre-conceptions (Ausubel, 1968; Ausubel, Novak and Hanesian, 1978; Brunner, 1960; Nassbaum and Novak, 1986; Strike and Posner, 1992; Oyedele, 1999; Delphonso, 2018).

Hypothesis Two: There is no significant difference between the effect of Self- Regulated learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM).

One potential explanation for this finding is that Self-Regulated Learning (SRLA) helps students to become more proactive in their learning. By setting goals and monitoring their progress, students are more likely to take responsibility for their own learning and seek out additional resources to help them understand the material. This can lead to a deeper understanding of the subject and ultimately, better grades. These results align with previous research on the benefits of SRLA, and suggest that teachers should consider incorporating SRL strategies into their instruction. This is in accord with Chen and Zimmerman (2007) where they found that students who were trained in self-regulated learning strategies had more positive attitudes towards science, including biology, than those who were not. Similarly, studies by Sebesta & Bray Speth (2017) and Zimmerman, Bandura, and Martinez-Pons (1992) found that students who used self-regulated learning strategies, such as setting goals, monitoring progress, and seeking feedback, had higher academic achievement in biology compared to those who did not use these strategies.

Hypothesis Three: There is no significant difference between mean achievement of male and female students taught Biology using Self- Regulated learning Approach (SRLA).

The males had a slightly higher mean score than the females. This may be due to differences in motivation and learning styles between boys and girls. For example, boys may be more motivated by competition and individual achievement, leading them to take a more independent approach to learning. In addition, female students may face more challenges in biology due to societal expectations and gender stereotypes. In a similar research by Cheryan, Siy, Vichayapai, Drury & Kim (2011) it was shown that female students may be less likely to pursue careers in science and engineering due to societal pressures and stereotypes that these fields are more suitable for men. According to prior research, which supports these findings, certain aspects of self-regulation, such as

behavioural regulation or self-regulated learning, may be responsible for gender variations in academic accomplishment (Duckworth and Seligman, 2006; Kuhl and Hannover, 2012).

Hypothesis Four: There is no significant interaction between gender and Self- Regulated learning Approach (SRLA) on students' achievement in Biology.

The findings of this study revealed that there was a significant interaction between gender and teaching method on the academic achievement of secondary school students in biology. This means that the effect of teaching method on academic achievement varies depending on the gender of the student. For male students, the self-regulated learning approach was found to be more effective in improving their academic achievement. The result is in agreement with Ani, Obodo, Ikwueze & Festus (2021) and Dania (2014) where they found a significant interaction effect of treatment and gender on students' academic performance in Basic Science and Social Studies respectively.

In view of the above results, it implied that the SRL produced the best result. Indicating that this approach is the best suitable teaching approach to produce a change in the assimilation of biology concepts and theories.

Conclusion

The study investigated the effectiveness of Self-Regulatory Learning Approach (SRLA) in improving learning outcomes of senior secondary school students in biology and four hypotheses were generated and tested.

Ho₁ States that there was no significant difference in the Hypothesis states that there is no significant difference between the pre-test score of students taught using Self-Regulated Learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM) and Conventional Teacher Expository Method (TEM). The outcome of the result indicated that there was no significant difference in the results; this implies that before the start of experimental application, these three groups are considered as equal in academic achievement. That is, the hypothesis is accepted.

Ho₂: There is no significant difference between the effect of Self- Regulated learning Approach (SRLA) and those taught using Lecture Teaching Method (LTM). One potential explanation for this finding is that Self-Regulated Learning (SRLA) helps students to become more proactive in their learning. By setting goals and monitoring their progress, students are more likely to take responsibility for their own learning and seek out additional resources to help them understand the material. This can lead to a deeper understanding of the subject and ultimately, better grades. Therefore, the hypothesis was rejected.

Ho₃: There is no significant difference between mean achievement of male and female students taught Biology using Self- Regulated learning Approach (SRLA).

The males had a slightly higher mean score than the females. This may be due to differences in motivation and learning styles between boys and girls. For example, boys may be more motivated by competition and individual achievement, leading them to take a more independent approach to learning. Therefore, the hypothesis was rejected.

Ho₄: Which states that there is no significant interaction between gender and Self- Regulated learning Approach (SRLA) on students' achievement in Biology.

The findings of this study revealed that there was a significant interaction between gender and teaching method on the academic achievement of secondary school students in biology. This means that the effect of teaching method on academic achievement varies depending on the gender of the student. For male students, the self-regulated learning approach was found to be more effective in improving their academic achievement. Therefore, the hypothesis was accepted.

In conclusion, this study provides evidence that SRL can have a positive impact on the academic achievement of secondary school students in biology. Further research is needed to replicate these findings and explore the potential benefits of SRL in other subject areas. However, these results suggest that teachers should consider implementing SRL strategies in their classrooms as a way to help students succeed academically.

Recommendations

Based on the results, findings and discussions of this study, the following recommendations are made;

- i. Science educators should not abandon the search for instructional strategies that could totally eliminate students' pre-instructional misconceptions and prevent the establishment of post-instructional misconception in Biology, in order to successfully accomplish the goals of Biology education.
- ii. As indicated from the findings in the study that the existence of post-instructional misconceptions related to evolution among students reflect the students' poor cognitive construction of their pre-instructional misconceptions in an attempt at conscious anchorage of new concepts of relevant concepts in their cognitive structure and a result hinders proper assimilation. This may be as a result of the complexity of the new concept and the poor quality and many pre-conception, and this probably accounts for the students' application of two logically incompatible instructional misconceptions in this study. Hence, biology teachers should learn and adopt to use it for teaching evolution and other similar complex biology theories and concepts.
- iii. It is also recommended that Biology teachers should be exposed to workshops and seminars where they will learn the use of cooperative teaching strategy in order to expose their students to this strategy in the classroom so as to promote social interaction, active students' participation, discovery learning, motivation learning by doing and learning by experience among students.
- iv. Federal and State ministries of education, education agencies and other stakeholders should formulate policy guidelines to guide the implementation process of the use of Cooperative learning strategy. In particular, the teachers would require training and reference materials on how to implement cooperative learning strategy which will make students good problem solvers.
- v. Teacher education programme in Nigerian tertiary institution should emphasize the use of cooperative method during science methodology classes so as to prepare teachers who can apply cooperative learning strategy to promote effective teaching and learning of Biology.
- vi. Textbook writers should shift emphasis from teachers' activities to students' activities that will promote learning by doing, discovery learning and further incorporate cooperative instructional strategy in Biology textbooks and including teachers' guide along with student copies.

References

- Al Asmari, A. (2013). Investigation of writing strategies, writing apprehension, and affective reactions. *Emotion*, 9, 123–127.
- Adeleke, M. A. (2005). Relative effectiveness of procedural and declarative learning strategies in improving problem-solving skills of secondary school students in Mathematics in Osun State, Nigeria. An unpublished Ph.D thesis submitted to the Department of Special Education and Curriculum Studies, Obafemi Awolowo University, Ile -Ife.
- Adesoji, F.A. (2008). Managing students' attitude towards Science through Problem solving Instructional strategy. *Anthropologists*, 10(1), 21-24.
- Aladejana, F.O, (2008). Blended learning and improved biology teaching in the Nigerian secondary schools. *Proceedings of the World Congress on Engineering and Computer Science 2008 WCECS*. October 22 - 24, 2008, San Francisco, USA.
- Alotaibi, K., Tohmaz, R. and Jabak, O. (2017). The relationship between self-regulated learning and academic achievement for a sample of community college students at King Saud University. *Education Journal*. 6(1), 28-37.
- Ani, M. I., Obodo, A. C, Ikwueze C. C. & Festus I. T. (2021). Effect of gender on basic science students' academic achievement in secondary schools. *Unizik Journal of Educational Research and Policy Studies*. 9:36-43
- Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston. <https://doi.org/10.1037/h0025943> <https://doi.org/10.1080/00461526809528961>
- Ausubel, D. P., Novak J. P. & Hanesian, H. (1978). *Educational psychology: A cognitive view*. New York: Holt Rinehalt and Winston.
- Bamidele, E.F. (2010). Effects of hierarchical, flowchart and spider concept mapping strategies on students' performance in secondary school Chemistry. An unpublished Ph.D thesis submitted to the Department of Special Education and Curriculum Studies, Obafemi Awolowo University, Ile -Ife.
- Banarjee, S & Kumar, S (2014) An Investigation into the Attitude of Secondary School Teachers towards Teaching Profession in Purulia District of West Bengal, India. *International Journal of Academic Research in Education and Review*. 2(3), 56-63
- Beishuizen, J., & Steffens, K. (2011). A conceptual framework for research on self-regulated learning. In R. Carneiro, P. Lefrere, K. Steffens, K. & J. Underwood (Eds.), *Self-regulated learning in technology enhanced learning environments: A European perspective*. Rotterdam: Sense Publishers.
- Bidjerano, T. (2005). Gender differences in self-regulated learning. Paper presented at the Annual Meeting of the *Northeastern Educational Research Association*, Kerhonkson, NY, USA. 19-21
- Bruner, J. (1966). *Towards a theory of instruction*. Cambridge: Harvard University Press.
- Chen, P. & Zimmerman, B. J. (2007). A cross-national comparison study on the accuracy of self-efficacy beliefs of middle-school mathematics students. *The Journal of Experimental Education*, 75:221-244
- Cheng, E. C. K. (2011). The role of self-regulated learning in enhancing learning performance. *The International Journal of Research and Review*, 6(1), 1–16

- Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science*, 2(6), 656–664.
- Darling-Hammond, L. (2007). Teacher quality and Students Achievement: A review of state policy evidence. *Education Policy Analysis Archives*. 8(1).
- Delphonso, B. T. (2018). Effectiveness of cooperative learning and conceptual change strategies in improving learning outcomes of prospective teachers with different religious inclination. *People: International Journal of Social Sciences*, 4(2), 315-329.
- Delphonso, B. T. (2015). Effectiveness of cooperative learning and conceptual change strategies in improving learning outcomes of colleges of education Biology students in south-western Nigeria, *Unpublished Doctoral Thesis, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria*.
- Dewey, J. (1938). *Experience and education*. Toronto: Collier-MacMillan Canada Ltd.
- Dania P. O. (2014). Effect of Gender on Students Academic Achievement in Secondary School Social Studies. *Journal of Education and Practice*. 5, 21
- Dent, A. L. & Koenka, A. C. (2016). The relation between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. *Educ Psychol Rev*, 28, 425–474.
- Duckworth, A., and Seligman, M. (2006). Self-discipline gives girls the edge: gender in self-discipline, grades, and achievement test scores. *J. Edu. Psychol*. 98, 198–208.
- Kuhl, P., and Hannover, B. (2012). Differenzielle benotungen von mädchen und jungen: Der einfluss der von der lehrkraft eingeschätzten kompetenz zum selbstgesteuerten lernen [Different grading for girls versus boys? Examining the impact of students' ability for self-regulated learning as perceived by their teachers]. *Z. Entwicklungspsychol. Pädagog. Psychol*. 44, 153–162.
- Nicol, D. J. & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, 31, 199-218.
- Nussbaum, J. & Novick, S. (1982). A study of conceptual change in the classroom. A paper presented at the Annual Meeting of the *National Association for Research in Science Teaching*. Lake Geneva, WI.
- Piaget, J. (1930). *The child's conception of physical causality*. New York: Harcourt Brace.
- Piaget, J. (1973): *Psychology of intelligence*. New Jersey: Littlefield, Adams and Co.
- Oyedele, V. I. (1999). Comparison of the effect of concept mapping and expository instructional strategies on the achievement of senior secondary school students in Biology. *Unpublished Doctoral Thesis, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria*.
- Oyovwi, E. O. (2019) Enhancing Biology students' academic achievement and attitude through self-regulated learning strategy in senior secondary schools in Delta Central Senatorial District. *Journal of Educational and Social Research*. 9(4): 149-156.
- Park, S. (1995). Implication of learning strategy research for designing computer-assisted instruction. *Journal of Research on Computer Education*, 25 (4).435-456
- Salami, M. O. (2012): Effect of modified laboratory learning approach on Biology process skills of secondary school students in Osun State. *An unpublished thesis submitted to the Department of Special Education and Curriculum Studies, ObafemiAwolowo University, Ile -Ife*.
- Sebesta, A. J. & Bray Speth, E. (2017). How should I study for the exam? Self-regulated learning strategies and achievement in Introductory Biology. *CBE-Life Sciences Education*. 16(2):30

- Slavin, R.E. (1995). Research on cooperative learning: Consensus and controversy. *Educational Leadership*, 47 (4), 52 - 54.
- Strike, K A. & Posner, G. (1992). Conceptual change and science teaching. *European Journal of Science Education*, 4, 231-
- Spinath, B., Freudenthaler, H. H. & Neubauer, A. C. (2010). Domain-specific school achievement in boys and girls as predicted by intelligence, personality and motivation. *Pers. Individ. Differ.* 48, 481–486. doi: 10.1016/j.paid.2009.11.028
- Von Glasersfeld, E. (1988): Cognition, construction of knowledge and teaching. Washington D.C.: *National Science Foundation*.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: MIT Press.
- Yarger, G.E. (1991): The constructivist learning model: Toward reform in science education. *The science Teacher*, September 1991, 52-57.
- Zimmerman, B. J., & Campillo, M. (2003). Motivating self-regulated problem solvers. In J. E. Davidson & R. J. Sternberg (Eds.). *The nature of problem solving* (pp. 239), New York: Cambridge University Press
- Zimmerman, B. J., & Schunk, D. H. (2011). Self-regulated learning and performance. In B. J. Zimmerman and D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance* (pp. 1-12). New York: Routledge.
- Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, 29(3), 663-676.