RESEARCH ARTICLE

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Teacher Self-regulatory Skills and Science Students' Practical Achievement on Rate of Chemical Reaction in Senior Secondary School, Uyo, Nigeria

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ABSTRACT

Effective engagement in practical work enables science students to acquire abilities, skills, competence and understanding of laboratory practical knowledge. The study investigates teacher self-regulatory skills in laboratory practice and students' academic achievement on the rate of chemical reaction in science. Eighty (80) science teachers and eighty (80) senior secondary science students were randomly selected from fourteen schools in Uyo Local Government Area of Akwa Ibom State, using the technique of purposive sampling. Three research questions and three hypotheses tested at a 0.05 level of significance guided the study. The study utilized ex-post facto design as the independent variables of teacher self-regulatory skills, gender and experience are variables that have already occurred, and the researchers had no direct control over them. A 20-item multiple choice Achievement Test on Rate of Chemical Reaction and Questionnaire on Teacher Self-regulatory skills were instruments used for data collation. Mean, Standard Deviation, t-test and multivariate analysis of variance were used for analysis. Results show that teacher self-regulatory skills have a significant effect on practical achievement on rates of chemical reactions. There exists no significant difference in the achievement mean scores of science students based on gender with regards to teacher self-regulatory skills.; but the significant difference exists in the achievement mean scores of science students based on teachers' teaching experience given their self-regulatory skills. Recommendations amongst others were that science teachers should apply effective use of self-regulatory skills in teaching and understanding of the rate of chemical reactions.

Keywords: Chemical Reaction, Practical Achievement, Science Students, Self-regulatory Skills.

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I. Introduction

A. Teachers' Self-regulatory Skills

Self-regulatory skill is the proficiency a teacher needs to equip learners with key practical skills to apply in different learning contexts. These skills play important role in the way students learn. Teachers require expertise, careful planning, and implementation of these skills for science practical. Self-regulatory skills enable teachers to plan beforehand, reflect and set goals. A wide range of motivational, metacognitive, cognitive, behavioral, and emotional competencies is required by teachers to achieve the goals of lesson objectives in science practicals. Pintrich (2008) and Karlen *et al.* (2020) define self-regulatory skills as the active, constructive process teachers use to set learning goals for monitoring, regulating, and controlling learners' motivation, cognition, and behavior. Panadero (2017) and Schloemer and Brenan (2006) also posit that self-regulatory skills like setting of goals, planning, self-monitoring, reflective practice, self-motivation, attention control, and self-evaluation promote effective implementation of practical lessons in science. These skills assist critical thinking that is purposeful to promote the right judgment that results in interpretation, analysis, and evaluation, as well as considerable explanations for basing judgments (Abrami *et al.*, 2015). Self-regulatory skills are teachers' credentials for the expertise needed to explore diverse methods, tackle learning difficulties, and create enabling environment necessary to simplify a concept. Skills enable teachers to conduct laboratory practicals with advance planning, monitoring instruction, and taking time to reflect, evaluate and revise their teaching practices. Science teachers are advised to appropriately utilize self-regulated skills for improving students' performance.

Teachers equipped with self-regulatory skills are able to teach and model these skills for their students. In other words, when teachers know how to structure a learning environment by applying a good sense of judgment derived from knowledge of self-regulated skills; students learn about

setting goals for their learning and correcting errors. For instance, they say to themselves; 'today, I will study rates of chemical reactions; I will start the experiment on conditions necessary for chemical reactions to take place. In doing this, learners are able to repeat a learning effort to ensure a full understanding of the rate of chemical reactions. This is because the ability of teachers in cultivating self-regulated skills is linked with their individual self-regulation and students' achievement (Kramarski & Michalsky 2009; Kramarski & Revach, 2009). If these skills are properly harnessed, educational objectives and contents are effectively translated from the curriculum to good laboratory practice. This makes the instructional procedure easy to follow and undertake. When strengthened, a herculean task becomes easy, and this helps to control behaviour that makes long-term right judgment stick.

Teachers' self-regulatory skills do not work in isolation. It is worked on and improved over time. Teachers make learning happen as they employ resources and problems to proffer solutions to learning challenges. This builds students' confidence and boost their morale in learning. Many concepts in science are considered difficult and abstract by teachers and students alike. One of such is the rate of chemical reactions. Attention needs to be given to this concept to inspire students' interest in the subject. This will enable students to engage effectively with content to get results. Teachers saddled with the responsibility of imparting knowledge need professional and pedagogical content to understand what self-regulated skills are and be better equipped to help learners know how to learn. This means that teachers select varieties of ways to construct knowledge from a combination of experiences and engage learners to effectively interact with these experiences. The routines are practiced over time until learners achieve ease and mastery. Students think through problems and keep experiences memorable. Creating and identifying routines on specific areas students may be struggling with, may help students make the right decisions to work out specific goals for recall. Students taking a few minutes to make the right choices in a conducive atmosphere help them to work out specific goals over time to function effectively at learning. A teacher's ability to properly self-regulate skills enables students to remember routines and activities in and beyond the classroom. The teacher resourcefully develops routines to help learners struggling with self-regulation.

Skill is the ability to perform exercises. These exercises are hands-on projects that help teachers and learners to discover answers to underlying questions and potentials. Appropriate practical skills make teachers and students get familiar with the tools and equipment employed in instruction. Skills promote experiential learning, independence, confidence, and self-learning that develop over sessions to make students connect observation in theory to practice in manageable ways. Science is experimental and relevant and demands teachers' mastery of its contents to spur students' interest. No science course is complete without effective practical work. Its curriculum specifies contents for inquiry, knowledge generation and practical activities to aid learners' understanding of the chemical composition of matter. These science contents provide the basis to develop scientific skills, attitudes, and values to equip learners for problem-solving. Teaching and learning science require the regular and active participation of students to tackle problems and enable teachers' overall engagement to inspire students. (Greene, 2018) posit that learning science gives prospective actions to guide and motivate students' efforts towards goal achievement to facilitate successful practical completion. Students' engagement is thus, enhanced with better academic attainment for increased long-term participation (Godec, King & Seakins, 2018).

Science teaching aims to motivate teachers towards self-efficacy and ownership of content knowledge. This attracts students to study science and develops in them a sense of self-worth. Gaining an understanding of the practical experience of science enables students to construct mental images of actions on abstract and difficult concepts in science. These abstract concepts are important and demand the use of appropriate self-regulatory skills for understanding to be sufficiently grasped by students. Content learning difficulties as regards the mathematical nature of the rate of chemical reaction requires a high level of self-regulatory skills to help both teacher and student have knowledge about, and control over the teaching and learning process (Etiubon, 2011 & Afangideh, 2011). Akpan (2010) opine that the rate of chemical reaction as a science topic is perceived to be difficult to grasp by students. This is because it involves using complex mathematics and qualitatively explaining both rate equations and variables affecting the rate of reaction (Tastan, Yalcinkaya & Boz, 2010; Chatzistamatiou & Dermitzaki, 2013). This, therefore, makes it imperative for science teachers to find ways of overcoming difficulties associated with understanding and comprehension of the rate of the chemical reaction. Integrating teachers' self-regulatory skills to make learning meaningful is therefore needed and advocated. Monshi, Boori and Ghanizadeh (2011) show the significant relationship between the pedagogical success of teachers and their application of self-regulated skills in their teaching environment.

To demystify these, theoretical facts have to be experimentally demonstrated for scientific evidence because evidence concretizes facts. Practical work on the rate of chemical reactions engages students in hands-on, minds-on, and heads-on activities using a variety of regulatory skills to drive lessons home with procedural steps to adhere carefully to. Shana and Abulibdeh (2020) opine that science practical is necessary as it creates an opportunity for students to perform hands-on activities to gain real experience and knowledge. These activities help students to develop manipulative skills and attitudes that make science concepts simplified, thus reducing difficulty and abstraction. A deeper level of understanding that widens students' scope of thinking is achieved by students finding out things for themselves through experimentation techniques and methods that enable them to discover secrets. For instance, a spectacular fireball is produced by sprinkling milk powder over a flame. An increased surface area can also increase reaction rates (edu.rsc.org, 2021). This type of scientific evidence with concrete results eliminates misconceptions and students' interest is ignited and sustained. Practical work is encouraged, mastery of subject matter content improves,

scientific reasoning develops, students' positive attitude is promoted, motivation is enhanced and demonstrable materials for teaching enable the development of observational skills (Okam & Zakari, 2017, Etiubon *et al.*, 2021). Teachers' flexibility in managing learners' abilities influences laboratory practice.

B. Teachers' Role and Practical Work Experience

The teachers' role is crucial for practical lessons in science to improve students' academic performance. Laboratory practical may be tough and abstract, and learners want to find a way out of the problem. The manner teachers handle and teach laboratory experiences to their students help students build confidence to continue (Etiubon & Udoh, 2020). The teacher then becomes the manager of knowledge they look up to. To achieve lifelong goals, teachers' self-regulatory skills during laboratory activities is very essential to empower them in decision-making in the teaching /learning process. Teachers need skills to make flexible-structured schedules to accommodate learners who struggle with their academics. They need to be proficient in designing, planning, creativity, implementing, and assessing practical lessons in science. These skills include; preparation, designing, executing, organizing and adaptability skills. These skills assist teachers to transfer knowledge, motivate students, have students' attention and build confidence in students for improved performance (theeducationhub.org.nz). However, Millar (2010) observed that for many students, what goes on in the laboratory in form of practical science is said to contribute little to their learning of practical skills in science because teachers are not engaging with their self-regulatory skills. Teachers' use of self-regulatory skills during laboratory activities is, therefore, very essential to aid students in decision-making in the teaching /learning process. Students practice what they learn by integrating science theory into practice. They enjoy engagements as they practice activities by themselves. Learners are enabled to think creatively to solve problems and produce results. To promote understanding, good pedagogical content knowledge is transferred through self-regulated skills into teaching content. This provides an explanation for equipping students with dynamic ideas that motivate them for greater interaction and enthusiasm to explore.

Obanyan (2010) maintain that science teachers should have the ability in creating suitable learning experiences during practical to mirror an environment for exploring self, solving problems, reasoning inductively and self-regulatory skills in order to provide lifelong learning. Furthermore, enhanced performance and retention of concepts can be gained by deliberate practice and engagement in active learning by means of guided-discovery (Udo & Etiubon, 2011; Koole *et al.*, 2012). This comes with experience and confidence in carrying students along. With changing learning dynamics, science teachers need to improve on self-regulatory skills to make students learning interesting. They need to explore ways of truly changing work dynamics and helping students to learn better. Students are encouraged to write down their thoughts and questions anytime, rather than shouting them out. Whatever their opinion, at an opportune time, they are read out and listened to.

C. Teachers' Knowledge of Planning Skills for Practical Activity

Three phases framework of self-regulatory skills are suggested by (Zimmermann, 2010) to include; forethought, performance and self-reflection. The forethought phase requires teachers' goal-setting skills, planning skills and motivational skills to execute effective practical lessons. For a teacher to be effective he needs to set specific learning objectives which must be clear, precise and realistic. The teacher checks how these objectives have been achieved at the end of the lesson. This anticipates likely outcomes of the lesson. Teachers' planning skills before laboratory practice provide a good experience for students during science practical. The planning skills involve thinking out learning goals, choosing actions that activate background knowledge of the topic, selecting strategies and organizing instructional materials needed for practical lessons. With the laboratory being complex, teachers need knowledge content, apparatus, and equipment used for laboratory work to match content to be learnt. Pre-laboratory planning (Sirhan, 2007) is necessary to provide and assemble materials and equipment for learning practical activities. This is to minimize delays and disruptions during instructional delivery. Fathiah (2007) maintain that science teachers should be highly proficient in using equipment and installing apparatus. If teachers have challenges handling laboratory equipment, this will pose great challenges in teaching, practicing and assessing experiments. Van Beek and Wubbels (2014) opine that teachers' self-regulatory skills improve students' academic achievement. The objective of planning is to ensure good knowledge management of laboratory facilities and equipment for practical purposes.

D. Teachers' Monitoring Skills for Practical Activities

Monitoring skills for practical work with self-regulatory skills is a sine-qua-non for laboratory sessions. Monitoring is the systematic process of collecting, analyzing, giving reports to update educational activities and using obtained information to routinely check on the attainment of educational progress. Teachers must be abreast with skills that engage learners for effective management of practical work. The more the teacher keeps track of what works and what does not work using a time frame; the more the teacher gains knowledge of the better performance of what works during different laboratory sessions. Monitoring skills give a teacher direction to guide and follow through with practical work. Lee (2012) emphasized the need for clear explanations and instructions before carrying out an activity. These skills increase learners' competence and enable them to carry out practical work alone. Teachers' failure to appropriately explain and monitor content procedures will mar understanding during laboratory work.

Practical work involves skills like manipulative skills that enable teachers to use and handle science apparatus, reagents and facilities involved in practical work. This must be in an approved manner as well as the ability to follow instructions and make accurate observations. This is a major skill checked during practical. Manipulative skills involve knowing to use instruments, how to adjust instruments and their safety settings, care of the instrument, storage/preservation of instruments and their proper

handling for a given task. Teachers must master basic manipulative skills to know what skills to monitor during experiments to pass to students for productive practical. During teachers' pre-service and in-service training, they are to be trained on the proper ways of fixing, preparing, and handling different substances and equipment involved in practical work.

During practical engagement on the rate of chemical reaction; manipulative activities are very essential for competence in setting and handling apparatus such as stopwatch, weighing substances, measuring volumes, accurate reading of meniscus, handling chemicals, lighting bunsen flame and plotting graphs. Teachers must have used, performed and carried out practical themselves, with manual guidelines to articulate activity effectively. Other activities are proper weighing and handling of substances with weighing paper or weighing bottle. The teacher checks to see balance at zero equilibrium before weighing at room temperature to avoid air convection currents. In volume measurements, proper reading of the volume and the ability to adjust desired volumes are skills teachers should know (Aniodoh, 2016). This approach aids problem-solving skills and determines the crucial aspect of the rate of chemical reaction requiring problem-solving at various stages of performance. Teachers can now use creative analytical ideas in trying out simpler ways to find a solution. Students need to follow step-by-step implementation of these guidelines to obtain accurate experimental results. This improves challenging situations and makes them flexible and easy to handle.

E. Teachers' Self-regulatory Skills and Teaching Experience

Teachers' self-regulatory skills tend to increase with additional years of teaching experience. It, therefore, means that increasing years of teaching experience make teachers become more self-regulated acquiring and using self-regulated skills in the teaching-learning process. Teachers' use of self-regulatory skills may lead to students' higher achievement in science. Supporting this, Nahid (2016) observe that there is a relationship between teachers' self-regulatory skills and teachers' years of teaching experience. The more the teachers were experienced, the more self-regulated they became. Babayigit and Guven (2020) also maintain that more experienced teachers use self-regulatory skills in their instructional practices that enhance students' learning and understanding leading to higher academic achievement among undergraduate science students. Pazhoman and Sarkhosh (2019) posit that there is a positive significant relationship between teaching experience and respect for self-regulatory skills, the more experienced teachers are, the more their chances of implementing instructional strategies (Mengistnew and Asrat, 2021) to enhance their effectiveness and students' achievement.

F. Gender and Teachers' Self-Regulatory Skills

Researches on gender-related studies are varied and inconclusive. Some studies show male dominance in related science subjects while others show female dominance in science-related subjects. Still, others show that no significant differences exist. Opdenakker and Van Damme (2006) report that the teacher's gender is irrelevant as regards the characteristics involved in classroom practice. They opine that self-regulated skills are beneficial to both gender and when put into use leads to students' high academic achievement.

G. Rate of Chemical Reaction

The speed at which a chemical reaction proceeds is called Reaction rate. It is also described as the speed at which a reactant is converted into a product. In most cases, as the reaction proceeds, the reaction rates decrease. Reaction rates are expressed either in terms of product concentration (amount per unit volume) that is formed in a unit of time or the reactant's concentration consumed in a unit of time. If a reaction has a low rate, the molecules combine at a slower speed than a reaction occurring at a higher speed. During chemical reactions, reactants convert into products. The rate at which this occurs tells how fast a chemical reaction is taking place by indicating how much a reactant is consumed or how much a product is produced at a given time. Teachers need to help students in the description of simple methods for measuring mass loss especially if a product in gaseous form escapes, gas volume production, colour change, pH change and turbidity change if precipitate is formed. Teachers also help students to plot and create graphs of a relative number of species, such as mass and volume against time; this helps their understanding that reaction rate at a specific time is represented by the gradient to the curve at any point in time. They can explain and predict by identifying the factors affecting the rate of the chemical reaction. They are engaged to make sense of reactions and reaction profiles to identify activation energy and enthalpy change used in sketching a catalysed reaction on the uncatalyzed profile to show the difference (stem.org.uk 2021).

Rate of chemical reactions differs greatly during practical work. Reactions could be either fast or slow. This is based on if conditions are followed, a given reaction occurs at varying rates. This influences the degree of intellectual stimulation of how much activity a learner is engaged in. To some students, these actions may be quite confusing, and they may not be able to make meaning of the occurring dynamics of different rates of reactions. These different actions and reactions require teachers' effective applications of self-regulatory skills such as manipulative and problem-solving skills to enable teachers to use and handle science apparatus, laboratory substances, ability to follow instructions and make accurate observations. Students can make sense of this.

II. Statement of the Problem

Many concepts in science are considered difficult and abstract by teachers and students alike. These concepts need to be simplified to make understanding clearer to the learners. Only teachers can make this happen. Very little is known among science teachers in Nigerian secondary schools about self-regulated skills. To bring about change and improve learning, teachers themselves will need to affect and engage the atmosphere of teaching to include self-regulation. Teachers seek ways to create, solve and remove obstacles to learning with regulatory skills to meet the

yawning gap of skills inadequacy. Teachers have the responsibility to teach and demonstrate science knowledge, understanding and confidence but are not motivated to use self-regulatory skills. These self-regulatory skills are rarely integrated into educational teaching objectives of practical work to enhance learners' performance. The challenge, however, is that teachers themselves do not understand what self-regulatory skill entails and this poses difficulties integrating into science learning. Again, the science curriculum does not include the use of regulated skills, thus, creating a gap in understanding. This limits the teacher's freedom to learn and deploy self-regulated skills not stated as objectives in the school curriculum. There is, therefore, a need to give science teachers opportunities through expert coaching and drills on self-regulated skills to enhance students' performance. Most science teachers are not aware of the benefits of setting clear objectives for planning, monitoring, reflecting, motivating, and evaluating the problem-solving skills of learners during practical task. The dearth of an investigation into teachers' self-regulatory skills during practical activities on rates of chemical reactions echoes a clear need to undertake studies and appraise students' academic achievement.

III. Purpose of the Study

The study investigates teachers' self-regulatory skills in practical work and students' academic achievement at the rate of a chemical reaction. The objectives specifically are:

a. Determine the difference in the achievement mean scores of science students taught rates of chemical reactions based on teachers' self-regulatory skills.
b. Examine the difference in the achievement mean scores of science students taught rates of chemical reactions based on gender and their self-regulatory skills.
c. Assess the difference in the achievement mean scores of science students taught rates of chemical reactions based on teachers' teaching experience.

IV. Research Questions

a. What difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' self-regulated skills?
b. What is the difference in the achievement mean scores of science students taught rates of chemical reactions based on male and female teachers' self-regulatory skills?
c. What difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' teaching experience given their self-regulatory skills?

V. Research Hypotheses

a. No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' self-regulatory skills.
b. No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on male and female teachers' self-regulatory skills.
c. No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' teaching experience given their self-regulatory skills.

VI. Research Methodology

The ex-post facto design was used in this study. This design is used as the independent variables of teacher self-regulatory skills, gender and experience are variables that have already occurred and the experimenters have no direct control over these. The population for the study comprised all 212 science teachers and 2750 science students of senior secondary one (Physics, Chemistry and Biology) in the 14 public secondary schools in Uyo Local Government Area of Akwa Ibom State.

A. Sample and Sampling Technique

A sample of 80 science teachers and 80 senior secondary (SS1) science students were selected by purposive sampling technique from the study population.

B. Instrument for Research

Instruments for data collection were Achievement Test on Rate of Chemical Reactions from content areas of collision theory and factors affecting rates of reaction consisting of 20 multiple-choice test items administered to students and a questionnaire on Teachers' self-regulatory skills that had mean ratings of four response options ranging from strongly disagree (1) to strongly agree (4) administered to teachers. Two lecturers of test and measurement and a lecturer from educational foundations in Faculty of Education, University of Uyo validated the instruments. The reliability of the instruments was established using Kuder- Richardson Formula-21 (0.79) and Cronbach alpha test (0.81) of internal consistency. The hypotheses for the study were tested at the 0.05 alpha level.

C. Research Procedure

Teachers' regulatory skills in the study involve goal-setting skills, planning skills, manipulative skills, monitoring skills, problem-solving skills, motivational skills and evaluative skills. Teacher demonstrates the use of self-regulatory skills using activity on rates of chemical reactions through the following:

Activity carried out: acid vinegar (acid) + sodium bicarbonate (base) forming carbon dioxide (gas) that blows up a balloon. A gas expands in the bottle and inflates the balloon. As more gas is created, the larger the balloon will inflate.

Goal setting skills: Achievable objectives are set for students to carry out practical activities on rates of chemical reactions.

Planning skills: The teacher sets up a laboratory for practical tasks by assembling materials and equipment needed. Teacher groups students for practical work. Equipment and chemical reagents are organized and put in place for the various group of students.

The teacher writes and specifies the step-by-step procedure to go through before carrying out an experiment on rates of a chemical reaction.

Manipulative skills: Teacher fixes apparatus for the assigned task by weighing chemical substances, measuring the volume of liquid, recording observation, demonstrating/regulating the use of bunsen burner/flame, using stopwatch and plotting of graph. Students are encouraged to do the same.

Monitoring skills: The teacher moves around the laboratory checking students' participation and involvement in carrying out the task and giving directions where necessary on how the experiment is carried out.

Problem solving skills: The teacher asks questions, poses problems for students to solve and assist them to understand methods of effectively solving the problems.

Motivational skill: Teacher spurs students to see assigned activities as fun and exciting in a friendly, conducive learning environment. This stimulates and inspires curiosity and makes the lesson interesting. Teachers encourage students to do, praising those who answer questions and encouraging others to participate in the activities.

Evaluative skills: The teacher appraises students' efforts, marks their laboratory manuals, and grades their performance accordingly.

D. Method of Analysis

Data from the Achievement test and the Questionnaire were analyzed using mean, standard deviation, t-test and multivariate analysis of variance.

1) Decision Rule:

Respondents to the questionnaire were grouped into high and low self-regulatory skills using the mean, that is; (4+3+2+1)/4 =2.5. Respondents that had 2.5 and above were considered high and those below 2.5 were considered low.

VII. Results

The research questions were answered with the use of mean and standard deviation. Hypotheses were tested at a 0.05 level of significance using Independent t-test Analysis and Multivariate Analysis of Variance.

A. Research Question One

What difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' self-regulated skills?

1) Results

Mean and standard deviation was used to answer the research questions. Hypotheses were tested at 0a .05 level of significance using Independent t-test Analysis and Multivariate Analysis of Variance.

TABLE I: Mean and Standard Deviation of Achievement Mean Scores of Science Students Taught Rates of Chemical Reactions by Teachers Having High and Low Self-Regulatory Skills

Teachers' Self-regulatory Skills	N	$\bar{X}$	SD
High	43	15.86	3.09
Low	37	12.81	4.38

Data in Table I show the mean difference of students' scores taught rates of chemical reactions by teachers having high self-regulatory skills as 15. 86 while those of teachers with low self-regulatory skills is 12.81. Students taught rates of chemical reactions by teachers with high self-regulatory skills performed better than those taught by teachers with low self-regulatory skills.

2) Hypotheses One

No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' self-regulatory skills.

TABLE II: Independent T-Test Analysis of Achievement Test Scores of Science Students Taught Rates of Chemical Reactions based on Teachers' Self-Regulatory Skills (High and Low)

Teachers' Self-regulatory Skills	N	$\bar{X}$	SD	Df	t_{cal}	P_{cal}
High	43	15.86	3.09	78	3.64*	000
Low	37	12.81	4.38			

Data in Table II show that the calculated probability value (p-value) 000 is less than the alpha level of 0.05. The null hypothesis is therefore rejected. This shows that a significant difference exists in the mean achievement scores of science students taught rates of chemical reactions based on teachers' self-regulatory skills.

B. Research Question Two

What is the difference in the achievement mean scores of science students taught rates of chemical reactions based on male and female teachers' self-regulatory skills?

TABLE III: Mean and Standard Deviation of Science Students Scores Taught Rates of Chemical Reactions based on Gender of Teachers' Self-Regulatory Skills

Self-regulatory Skills	Teachers' Gender	N	$\bar{X}$	SD
High	Male	23	15.65	2.90
	Female	20	16.10	3.35
Low	Male	16	12.75	4.89
	Female	21	12.86	4.07

Data in Table III show the mean achievement scores of students taught rates of chemical reactions by male teachers having high self-regulatory skills as 15.65 and their female counterparts having high self-regulatory skills as 16.10. The table also shows that the mean achievement scores of students taught by male teachers having low self-regulatory skills are 12.75 and their counterparts by females having low self-regulatory skills are 12.86. This indicates that science students taught by female teachers with high and low self-regulatory skills performed better than their male counterparts.

1) Hypotheses Two

No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on male and female teachers' self-regulatory skills.

Data in Table IV show that the calculated P-value (0.732) for gender is greater than the alpha level (0.05). The null hypothesis is therefore retained. This implies that no significant difference exists in the mean achievement scores of science students taught rates of chemical reactions with respect to gender-based on teachers' self-regulatory skills.

TABLE IV: MULTIVARIATE ANALYSIS OF VARIANCE OF ACHIEVEMENT TEST SCORES OF SCIENCE STUDENTS TAUGHT RATES OF CHEMICAL REACTIONS BASED ON GENDER OF TEACHERS' SELF-REGULATORY SKILLS

Source Of Variation	SS	Df MS	F_{cal}	P_{cal}
Self-regulatory Skills	184.90	1 184.90	12.91*	0.001
Gender	1.680	1 1.68		
Self-regulatory Skills	0.57	1 0.57	0.12 NS	0.732
*Gender	1088.59	76 14.32	0.04 NS	0.842
Residual	1275.80	79 16.15		
Total				

*Mean difference is significant at 0.05 level of significance.
NS = not significant at 0.05 level of significance.

C. *Research Question Three*

What difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' teaching experience given their self-regulatory skills?

Data in Table V show the mean achievement scores of students taught rates of chemical reactions by teachers having 1-10 years of teaching experience with high self-regulatory skills is 9.00. Teachers with 11-20 years of experience are 15.29 while those with experience of 21 years and above are 16.83. The table also showed that the mean achievement scores of students taught by teachers having 1-10 years' experience with low self-regulatory skills are 7.00. Teachers with 11-20 years of experience have 14.17 while those with 21 and above years are 15.00.

TABLE V: MEAN AND STANDARD DEVIATION OF SCIENCE STUDENTS TAUGHT RATES OF CHEMICAL REACTIONS BY EXPERIENCED TEACHERS HAVING HIGH AND LOW SELF-REGULATORY SKILLS

Self-regulatory Skills	Teachers' Experience	N	$\bar{X}$	SD
High	1–10 years	2	9.00	2.83
	11–20 years	17	15.29	2.47
	21 and above years	24	16.83	2.75
Low	1–10 years	9	7.00	1.87
	11–20 years	17	14.17	3.01
	21 and above years	11	15.00	3.38

1) *Hypotheses Three*

No significant difference exists in the achievement mean scores of science students taught rates of chemical reactions based on teachers' teaching experience given their self-regulatory skills.

TABLE VI: MULTIVARIATE ANALYSIS OF VARIANCE OF ACHIEVEMENT TEST SCORES OF SCIENCE STUDENTS BASED ON TEACHERS' EXPERIENCE GIVEN THEIR SELF-REGULATORY SKILLS

Source Of Variation	SS	Df MS	F_{cal}	P_{cal}
Self-regulatory Skills	184.96	1 184.96		
Experience			24.22*	000
Self-regulatory Skills	520. 93	2 260.47		
*Experience	4.81	2 2.40	34.11*	000
Residual	565.10	74 7.64	0.32NS	0.731
Total	1275.80	79 16.15		

*Mean difference is significant at 0.05 level of significance.
NS Not significant at 0.05 level of significance.

Data in Table VI show that the calculated P-value (000) of teachers' experience is less than the alpha level P< 0.05. The null hypothesis is therefore rejected. This implies that a significant difference exists in the mean achievement scores of science students taught rates of chemical reactions based on teachers' teaching experience given their self-regulatory skills.

VIII. DISCUSSION OF FINDINGS

The result of the study show that a significant difference exists in the achievement mean scores of students based on teachers' self-regulatory skills. This may be due to the fact that teachers' regulatory skills enable teachers to gain a better understanding of students' needs; have a deeper sense of the teaching and learning process in order to take appropriate action leading to successful and effective teaching. These skills facilitate students' understanding of science concepts of rates of chemical reactions taught and to achieve better. Monshi *et al.* (2011) showed that there was a significant relationship between teachers' pedagogical success and their application of self-regulated skills in their teaching environment. Through such skills teachers structure their environment, set goals, plan, monitor, evaluate, manage and actively control the learning process leading to students' academic achievement. Supporting this finding, Van Beek and Wubbels (2014), found that teachers' self-regulatory skills improved students' academic achievement.

With regards to gender, the results showed that there is no significant difference in the achievement mean scores of science students taught rates of chemical reactions based on the gender of teachers on their self-regulatory skills. This may be due to students being exposed equally to the same learning environment and apparatus for teaching rates of chemical reactions. Opdenakker and Van Damme (2006) reported that the teachers' gender is non-relevant with respect to classroom practice characteristics. They opined that self-regulated skills are beneficial to both gender and when put into use leads to students' high academic achievement. The findings also showed a significant difference in the achievement means scores of science students based on teachers' teaching experience given their self-regulatory skills. This may have been so because teachers' self-regulatory skills tended to increase with additional years of teaching experience. It, therefore, means that increasing years of teaching experience made teachers become more self-regulated acquiring and using self-regulated skills in the teaching-learning process. The teachers' use of self-regulatory skills led to students' higher achievement in science. Supporting this finding, Nahid (2016) observed that a relationship exists between teachers' self-regulatory skills and teachers' years of teaching experience. The more the teachers were experienced, the more self-regulated they became. This finding also agrees with Babayigit and Guven (2020), Mengistnew and Asrat (2021) that more experienced teachers use self-regulatory skills in their instructional practices to promote students' learning and understanding leading to the effectiveness of teaching rates of chemical reactions and higher academic achievement among science students. Based on research findings, it is recommended that self-regulatory skills be integrated into teacher training programmes for quality teaching of science in Nigeria secondary schools.

IX. CONCLUSION

From the findings of this research, it is concluded that teachers' self-regulatory skills improved students' achievement in science. Students tutored by teachers with

high self-regulatory skills achieved better than students taught by teachers with low self-regulatory skills. Experienced teachers with long years of teaching practice impacted greatly on the students.

X. Recommendations

a. Science teachers should make effective use of self-regulatory skills in the teaching of rates of chemical reactions and other science concepts to enhance teaching and learning quality.

b. Researches on teachers' self-regulatory skills should be sponsored by school administrators and non-governmental educationally-based agencies to provide opportunities for teachers on knowledge of self-regulatory skills to achieve teaching objectives and goals.

c. Workshops, seminars and conferences should be organized on self-regulatory skills to provide opportunities for teachers to critically examine the concepts, theories, procedures and application of self-regulatory skills and improve on their instructional skills.

d. Teacher training institutions should integrate self-regulatory skills in course programmes, guide, and practical manual of teachers for proper inculcation of self-regulatory skills for lifelong teaching and learning.

Conflict of Interest

There is no conflict of interest while undertaking this study.

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