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RESEARCH ARTICLE

SCIENCE LABORATORY PRACTICES AND STUDENTS' ATTITUDES IN CHEMISTRY IN PUBLIC SECONDARY SCHOOLS IN RWANDA A CASE OF NGOMA DISTRICT

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Abstract

This study investigated the science laboratory practices and students' attitudes in chemistry in public secondary schools in Rwanda, specifically inNgoma district. Descriptive research designs using mixed approach were used. The study encompassed both quantitative and qualitative sources of data that were collected with a questionnaire and an interview guide as the chosen research tools. The target participants comprised 735 participants including 719 students, 8 teachers, 4 deans of studies, and 4 head teachers from 4 public secondary schools in Ngoma district. To obtain the sample size, purposive and random sampling techniques were employed. The sample of 213 was determined with the help of the Slovin's formula. Statistical analysis was achieved using Statistical Product and Service Solutions (SPSS) after coding, editing, and processing of the raw data. Outputs of descriptive statistics and the relationship between science laboratory practices and students' attitudes in chemistry were estimated. The findings were portrayed using tables with a subsequent careful interpretation and discussion. 149 (74 %) perceive science laboratory practices as the determinant of students' motivation towards learning science subjects, and equally as the key factor to enhancing intellectual development in science subjects. 144 (72 %) held that science laboratory practices improve students' problem-solving skills while 142 (71 %) emphasized that science laboratory practices help students develop experimental skills. Importantly, a strong Pearson correlation was obtained ($r = .969$, $p = .031$) between science laboratory practices and students' attitudes in Chemistry subject. The study findings are important to educational planners and curriculum designers, as the findings serve as the guide for them during incorporation of practical content into the curriculum either during design or during modification of the existing one.

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Introduction:-

Inclusion of science subjects in the curricular activities in the curriculum of secondary education emphasizes the perceived benefits of science education. The intention of curriculum designers to incorporate science content in the curriculum might have been rooted in the need of the society that requires scientific methods to be handled effectively and efficiently. From the very start of the eighteenth hundred years to date, instructors and scientists have concentrated on the worth of laboratory practices and their significant influence on scientific skills acquisition in science subjects.

According to Ong et al. (2022) students are prepared for the present reality of work in the current era by opening them to various facets of employments in the chemistry fields such as chemical engineering and medical related areas among other various applications. Chemistry knowledge and skills gained through the education process allow school leavers/graduates to have access to job opportunities in different domains such as teaching, manufacturing industries, food processing, beverage industries, and pharmaceuticals-related opportunities. Learning through laboratory practices enhances students' intellectual ability, and conceptual understanding of complex concepts, and instills into students problem-solving skills. Kapici et al. (2019) emphasized that hands-on skills develop from continuous practical activities based on students' inquiry in science subjects.

For many years the science laboratory practices have been regarded as an important aspect of chemistry subject integrating theoretical and practical course content thereby facilitating students to engage actively in learning endeavors (Kargar et al., 2022; Ong et al., 2022; Zuin et al., 2021).Successful learning process incorporates cognitive, affective, and psychomotor domains and is complex in nature.For science specifically, the disposition is portrayed as pessimistic emotion about science (Hernández-Barco et al., 2021).

Educators, who utilize conventional teaching modalities such as memorization observe that students are very disinterested in science learning and generally show negative attitudes toward science subjects (Chua & Karpudewan, 2017). The study further exposed that factors like science learning environment and students' motivation are important in designing learning experiences. Teachers' ability to design instructional content that allows students to experience active learning is also the key point to addressing barriers to science education.

Notwithstanding the fact that previous studies have indicated that teaching methodologies adopted by the teacher influence students' overall perception of the presented instructions, students' attitudes also constitute a barrier in the course science core subjects. Tinapay et al.(2021) showed that positive attitudes of students are linked to active participation in a cooperative environment while students could develop negative attitudes in an environment dominated by the teacher.

In United States, contribution of laboratory practices in chemistry education have recently been a topic of academic discussion with an aim of evaluating the effectiveness of laboratory-based teaching and learning sciences toward real life expectations (Anderson et al., 2022) . A study by a researcher in England advances that STEM education requires a deliberate decision of teachers to integrate theories and practice during instructional content delivery, and further discusses the role of practical aspects of science subjects (Gamage et al., 2020). The study emphasized that teaching sciences should incorporate activities that teach experimental procedures helping students to synthesize what they observe by acquiring desirable communication skills and laboratory practices.

In Kenya, studies have been conducted to relate laboratory practices and students' motivation, attitude and achievement (Chala, 2019). It is not surprising that literatures in this regard indicate that despite the inadequacy of physical laboratory resources (Gladys, 2021; Othoo et al., 2019), teachers should find ways to teach chemistry subject through practical activities, which may be achieved through improvisation of teaching and learning materials.

Ogembo et al. (2015)) examined the attitudes and performance of instructors and students in Chemistry in secondary schools located in Kwale County, Kenya. Students' attitudes on chemistry were gauged using eleven items. The purpose of the study was to find out whether students thought chemistry was a significant subject, whether they loved the theoretical and practical teachings of the topic, and who had an impact on their choice of subject and length of study time. Laboratory exercises were an essential component of teaching chemistry and are the preferred method of learning for many students, even if theoretical knowledge is also necessary for them to participate in practice.

Ankwasiize and Bazirake (2017) conducted a study using a cross-sectional survey design with the primary purpose of evaluating hands on learning methods and students' performance in Chemistry the ordinary level in the Kira Municipality in Uganda. Inappropriate usage of teaching and learning methods negatively affects students' performance in chemistry. The study emphasizes teachers' use of experimental projects in a science laboratory environment as a way forward to teaching chemistry subject.

In order to determine what needs to be done to change the way that students are taught laboratory biosafety and protective consciousness, another study was carried out in Uganda to evaluate the practices and attitudes of medical laboratory students toward biosafety and bio-risk management during the internship (Padde et al., 2022). The study stressed that to increase competency and proficiency among laboratory professionals and ensure adherence to biosafety requirements during clinical practice after the course, training should instruct students on how to operate standardized laboratory procedures and conduct bio-risk assessments promptly and correctly.

Rwanda has shifted from traditional teaching approach, which was predominantly teacher-centered to student-centered modality (Mbarushimana & Kuboja, 2016; Ndihokubwayo et al., 2021). Since 2015, traditional teacher-centered instructions have been changed to competence-based instructions, and currently competence-based curriculum is being implemented in Rwanda education system countrywide (Mbarushimana & Kuboja, 2016).

Contextually, learning experiences should equip students with the required skills to cope with the labor market requirements hence a knowledge-based economy (Pham & Jackson, 2020). The teaching and learning sequences have been designed to reflect on students' commanding skills after completing the learning cycle thus a student remains the focus during the whole process of instruction with active involvement (Nicol et al., 2020). From the shift from an old-fashioned teaching style up to recently, research outputs have been increasing in the pursuit of suitable approaches to improve students' study attainment (Byusa et al., 2020; Iyamuremye et al., 2022). For science content, laboratory practices in a competence-based curriculum dominate (Antonova et al., 2022) following its potential influence on students' acquisition of practical skills in natural sciences, chemistry subject in particular.

The government of Rwanda has set long-term goals and specific short-term objectives to achieve vision 2050 with one of the pillars stating that the mission of the Ministry of education is to promote skilled human capital through the transformation of citizens by providing reasonable access to high-quality education. Importantly, lowering illiterate people, enhancing technology-based services, and develop in learners improved thinking skills, socially acceptable values and norms constitute the core tasks in the Rwandan education system. Education for all (EFA) should consider the relevance of curriculum implementation to ensure that learning outcomes match with skills acquired in the labor markets. In this regard, acquired practical skills would depend on inquiry-based laboratory practices as the teaching approach, which in turn imparts practical skills to students. Afterward, the acquired practical skills would help school leavers and graduates to competent on the international stage. Both REB and RTB are focusing on imparting to students' hands-on skills based on practice that is believed to minimize the unemployment rate, therefore, teaching should be practice-oriented rather than theory dominated to minimize the gap in practical skills. This research was conducted to shed light on teaching and learning chemistry through laboratory activities and attitudes, which could be exhibited by students exposed to laboratory practical activities in chemistry subject.

Problem Statement

Within the context of chemistry teaching in Rwanda, it is important to integrate science laboratory practices into teaching to improve students' attitudes towards chemistry subject. Science laboratory practices are considered effective in developing students' attitude in chemistry subject (Musengimana et al., 2022). Hence, to teach certain content and improve students' attitudes, teachers need to integrate science-based teaching approaches in which students engage into laboratory activities. Irwanto and Prodjosantoso (2018) emphasized the role of laboratory activities in improving students' understanding of scientific skills to use in expanding their comprehension on chemistry.Research facility/laboratory disposition practices in science are a significant way to deal with educating and learning because of their capability to advance the acquisition of practical abilities, draw in, and stir the interest and perspectives of students toward learning science subjects.According to Sharpe and Abrahams (2020), laboratory practices is a major part of secondary school science curricular activities. A report by MINEDUC (2019) indicated that only 455 out of 1783 secondary schools that were operating have equipped laboratories and the statistics showed that the number of schools with equipped laboratory reached 21.6% in 2018 and 25.5% in 2019, which was below the ESSP target of 32.8% in 2019. According to Ndihokubwayo (2017) students' attitudes towards laboratory

practices is still the challenge in teaching and learning science subject due to the scarce in laboratory apparatuses. Students' attitudes have been one of limiting factors for enrollment in science combinations, and few students preferring taking science courses unpromising achievement due to the lack of interest in learning science (Mbonyiryivuze et al., 2021).The government of Rwanda has invested in the development of human resources with knowledge-driven economy as the core pillar in achieving National Strategic Transformation agenda (NST1) toward the vision 2050. Another pillar in the guiding document is human development, which encompasses three specific priorities including all-inclusive admittance to great training and a changed labor force for higher efficiency. Referring to the decision taken by NESA (2023) concerning the shift of practical examinations to theoretical alternatives in the National senior six national leaving examinations due to unequally participation of students into science laboratory practices nationwide. This study was conducted to relate science laboratory practices and students' attitudes in chemistry in public secondary schools in Rwanda.

Objectives of the study:-

1. To identify science laboratory practices in chemistry subject in public secondary schools in Ngoma district.
2. To assess the students' attitudes towards chemistry subject that are due to science laboratory practices in public secondary schools in Ngoma district.
3. To investigate the relationship between science laboratory practices and students' attitudes in chemistry in public secondary schools in Ngoma district.

Literature Review:-

Science laboratory practices toward teaching and learning science subjects

Science laboratory practices aim to increase students' sensitivity to learning experiences through the application of scientific approaches (Idiege et al., 2017). The American Association for the Advancement of Science (AAAS) classified science laboratory practices into fifteen components. According to Seetee et al. (2016), These include categorizing, observing, communicating, describing, drawing conclusions, defining operational definitions, analyzing data, experimenting, forming hypotheses, and controlling variables.

Students undertake science experiments as part of their education since that is how science works (Seage & Türegün, 2020). Science laboratory practices, which include inferring, measuring, predicting, observing, communicating, and testing, are some of the most important fundamental abilities needed for science laboratory practices (SLPs) (Odden et al., 2021). During science experiment activities, these abilities aid students in comprehending the scientific phenomenon under investigation, absorbing knowledge, and improving their sense of taking ownership of their own learnings (Dori et al., 2018).

Effect of science laboratory practices on students' attitudes

Abundant literatures exist concerning the effect of intensive lab practices on students attitudes concerning learning science topics (Duban et al., 2019; Liou, 2021) . A plethora of scientific investigation indicated that students through hands-on experiments acquire hands-on skills (Asheela et al., 2020; Chi et al., 2018). Saad (2020) emphasized that acquired skills change students' attitudes in the cognitive domain and can affect intellectual development, problem solving skills, self-efficacy, motivation, and interest. Students' acquisition of science laboratory practices such as Manipulation of lab-equipment, recording observed phenomena, ability to investigate measurable properties solving mathematical problems, performing analysis, and preparing laboratory reports and reporting the results indicate positive outcomes of science laboratory practices in view of students' attitudes particularly those falling into the cognitive domain.

Bradley (2021) emphasized that laboratory is operational students learning environment for enhancing favorable and positive attitudes among high school students. Higgins et al. (2019) reported that learners liked to utilize lab protocols to carry out experiments and found that they consider the lab as powerful, reasonable, and appealing because of the way that they can construct understanding and retain instructional content. The utilization of the laboratory facilities make students dynamic and receptive of educational instructions, gives them an inquiry space including imaginative ways of doing investigations (Kieferle & Markic, 2023). In the existing literatures, the acquisition of science laboratory practices have effect on students' learning process (Idul & Caro, 2022). Hence, the acquisition of science laboratory practices can emphatically affect students' attitudes toward science subjects by giving perception, and authenticity, and assisting students with creating reasonable understanding.

Methodology:-

Design

The purpose of this study was to investigate the relationship between science laboratory practices and students' attitude in chemistry subject in public secondary schools in Rwanda. A survey research design comprising quantitative and qualitative strategies was adopted. The researcher used the collected data to investigate the effects and relationship between variables of the study. As described by Apuke (2017), a survey research design allows the collection of information from a sample of individuals through their responses to questions. This type of research allows for a variety of methods to recruit participants, collect data, and utilize various methods of instrumentation. Therefore, the researcher formulated questionnaires and interview guide, which were administered to students, teachers, head teachers and dean of studies with intention of gathering views on science laboratory practices and their effect on students' attitudes from the selected public secondary schools in Ngoma District in Rwanda.

Population and sampling method

The exact sample size was calculated by use of the Slovin's formula from target population of 735 encompassing students, teachers, dean of studies, and head teachers. Equation 1 indicates the formula that was used.

$n = \frac{N}{1+Ne^2} \frac{735}{1+735\ (0.05)^2} = 213$ Slovin's Formula Equation 1

Where n = sample size, N = Total population, e = Margin of error which means that the degree of confidence is 95 %.

Instruments

Two sorts of research tools to be specific a questionnaire in the form of survey and interview were utilized to gather data from highlighted questions necessitating participants' views. A questionnaire comprised assumptions intending to evaluate understanding of students and teaching staff towards science laboratory practices effect on students' attitudes, there were two separate questionnaires one for students and another for teachers. Psychometric analysis was performed based on a measurement scale from one (1) to five (5) corresponding to the level of agreement. Question items ranged from those evaluating students' satisfaction with science laboratory practices (student attitude questionnaire) to question items evaluating teachers' consideration of factors holding back the use of laboratory practices during teaching and learning chemistry subject. Importantly, single interview guide was used as additional sources of information to collect qualitative data from dean of studies and head teachers from the selected public secondary schools and data were incorporated based on researchers' validation in the line of the research being conducted.

Results and Discussion:-

The study sought to investigate the relationship between science laboratory practices and students' attitudes in chemistry in public secondary schools in Rwanda. A case of Ngoma district.

Demographic Characteristics of Respondents

Descriptive statistics of the demographic characteristics of respondents are summarized under this subheading. Gender, affiliation, age category, study level for students, work experience and education background for head teachers, teachers and dean of studies were explored.

Participants' gender

Three quarters of head teachers corresponding to 75 % were male while female constituted one-quarter equivalent to 25 %. Similarly, three male and one female dean of studies accounting to 75 % and 25 % respectively participated in the study. On the other hand, four teachers participated into the study were equally accounted for in terms of gender making 50 % of male and 50 % of female. The researcher reached to one hundred and four male students corresponding to 52.7 % while ninety-seven female students participated. The total counts of male were 112 (52.6 %) while 101 (47.4 %) were female.

Participants' affiliation

Participants were taken from four different twelve-year basic education schools namely G.S Kibungo A, G.S Gahima, G.S Nyamgali, and G.S Gahurire. Four head teachers, dean of studies, and chemistry teachers were reached from each school each corresponding to 25 % of the total participants in each category. Of respondents in the student's category, 77 (38.3 %) were from G.S Kibungo A, 40 (19.9 %) were from G.S Gahima, 35 (17.4 %) were from G.S Nyamugali, and 49 (24.4 %) were from G.S Gahurire.

Student-participants' age category
The study encompassed student-respondents of different age categories, 133 of them were from 15 to 20 years old, 60 were below 15 years old while 8 were from 21 to 25 years old.

Study level of study participants
Student-respondents were from two levels of secondary education where 108 were from advanced level and 93 were from ordinary level.

Education background of participants-teachers category
Among four chemistry teachers who participated in this study, three of them are holders of the bachelor's degree (A0) while one holds an advanced diploma (A1).

Work experience of study participants-teachers category
Each of the four teachers who participated had a different work experience from others accounting for 25 % each.

Science laboratory practices in chemistry subject
Table 1:- Findings concerning identification of science laboratory practices in chemistry subject.

N^{o}	Statement	SD	D	N	A	SA
		N^{1} (%)	N (%)	N (%)	N (%)	N (%)
1	Students are involved into experimental procedures that require the manipulation of laboratory equipment	0 (0)	1 (25)	0 (0)	2 (50)	1 (25)
2	Students keep and record observed phenomena during science laboratory practices.	1(25)	0 (0)	1(25)	1(25)	1 (25)
3	Students carry out independent investigation of measureable properties in chemistry during science laboratory practices	0 (0)	2 (50)	1 (25)	1 (25)	0 (0)
4	Students can analyze laboratory results using their own laboratory skills during science laboratory practices	1 (25)	0 (0)	1 (25)	2 (50)	0 (0)
5	Students remember to record laboratory results after completing science laboratory practices	0 (0)	1 (25)	1 (25)	1 (25)	1 (25)
6	Students possess skills to report laboratory results correctly after science laboratory practices	1 (25)	1 (25)	0 (0)	2 (50)	0 (0)

[1]Number and percentage of respondents
Source: primary data, 2023

According to Table 1, 1 (25 %) disagreed that students are involved in experimental procedures that require the manipulation of laboratory equipment, and 2 (50 %) agreed to the assertion while 1 (25 %) strongly agreed with the preset construct. When inquired if students keep and record observed phenomena during science laboratory practices, 1 (25 %) strongly disagreed, 1 (25 %) remained neutral, 1 (25 %) agreed while 1 (25 %) strongly agreed. Concerning carrying out independent investigation of measurable properties in chemistry during science laboratory practices, 2 (50 %) disagreed, 1 (25 %) remained neutral while 1 (25 %) agreed with the predetermined construct. The researcher also wanted to reveal the student's ability to analyze laboratory results using their own laboratory skills during science laboratory practices. The responses were that 1 (25 %) strongly disagreed, 1 (25 %) remained neutral while 2 (50 %) agreed with the researcher's statement. When asked about students remembering to record laboratory results after completing science laboratory practices, 1 (25 %) disagreed, 1 (25 %) remained neutral, 1 (25 %) agreed while 1 (25 %) strongly agreed with the assertion. Another important construct was about students' use of science process skills to report laboratory results correctly after science laboratory practices, when respondents are questioned about this construct, 1 (25 %) strongly disagreed, 1 (25 %) disagreed while 2 (50 % agreed) with the researcher's predetermined assertion.

Students' attitudes in chemistry that are due to science laboratory practices

Table 2:- Findings from students' attitudes questionnaire in chemistry subject that are due to science laboratory practices.

N°	Statement	SD	D	N	A	SA
		N[1] (%)	N (%)	N (%)	N (%)	N (%)
1	My motivation toward learning science subjects increased since I have started participating in the science laboratory practices	11 (6)	31 (15)	10 (5)	70 (35)	79 (39)
2	Engagement in the science laboratory practices has enhanced my intellectual development, and I can perform better in the class	10 (5)	31 (15)	11 (6)	75 (37)	74 (37)
3	Science laboratory practices facilitated me to improve problem-solving skills in science subjects	16 (8)	26 (13)	15 (8)	73 (36)	71 (35)
4	I have developed experimental skills because of laboratory practices I have involved in during the learning process	15 (8)	25 (12)	19 (10)	89 (44)	53 (26)

[1]Number and percentage of respondents
Source: primary data, 2023

The researcher wanted to explore how science laboratory practices increase students' motivation toward learning science subjects. It is indicated in Table 2, 11 (6 %) strongly disagreed while 31 (15 %) disagreed while 10 (5 %) remained neutral. Moreover, 70 (35 %) agreed while 79 (39 %) strongly agreed that students' motivation toward learning science subject is increased by being exposed to science laboratory practices. Second, the discourse was about understanding if science laboratory practices lead to enhanced intellectual development and better classroom performance. Regarding this construct, 10 (5 %) strongly disagreed while 31 (15 %) disagreed while 11 (6 %) remained neutral. More importantly, 75 (38 %) agreed, 74 (36.8 %) strongly agreed with the researcher's assertion. Third, the further concern was about illuminating one link between science laboratory practices and problem-solving skills. Responses obtained were as follows; 16 (8.0 %) strongly disagreed while 26 (12.9 %) disagreed, and 15 (8 %) remained neutral. Interestingly, 73 (36 %) agreed while 71 (35 %) strongly agreed with the predetermined statement. Lastly, an exploration of the influence of science laboratory practices on students' experimental skills was undertaken. It is revealed that 15 (8 %) strongly disagreed and 25 (12 %) disagreed while 19 (10 %) remained neutral. Remarkably, 89 (44 %) agreed while 53 (26 %) strongly agreed with the researcher's preset construct.

Table 3:- Findings from teachers 'questionnaire concerning students' attitudes in chemistry subject that are due to science laboratory practices.

N°	**Statement**	A	SA
		N[1] (%)	N (%)
1	The use of science laboratory practices increases students' motivation during the learning process	0 (0)	4 (100)
2	Students' involvement into science laboratory practices improves their intellectual development	2 (50)	2 (50)
3	Science laboratory practices increase students' acquisition of problem-solving skills	1 (25)	3 (75)
4	Students' ability to conduct experiments is improved when students participate into science laboratory practices	2 (50)	2 (50)
5	Science laboratory practices arouse students' interest towards learning science subjects	2 (50)	2 (50)

[1]Number and percentage of respondents
Source: primary data, 2023

The study also considered teachers' consideration of science laboratory practices vis-à-vis students' attitudes. With help of five pre-formulated affirmative statements, obtained responses are depicted in Table 3 where 4 (100 %) strongly agreed that the use of science laboratory practices increases students' motivation during the learning process. They equally agreed, 2 (50 %) and strongly agreed, 2 (50 %) that science laboratory practices improve students' intellectual development, and three quarters of respondents strongly agreed while one quarter agreed that science laboratory practices help students acquire problem solving skills. Respondents equally agreed and strongly agreed that experimental skills are developed when students are involved in science laboratory practices. In the same vein, science laboratory practices arouse students' interest towards learning science subjects. Briefly, 100 % of the respondents agreed to the predetermined constructs in this study.

Relationship between science laboratory practices and students' attitudes in Chemistry

Table 4:- Descriptive statistics in terms of Means and standard deviations between science laboratory practices and students' attitudes in Chemistry.

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
Students' attitudes in chemistry subject	4.4000	.63246	4
Science laboratory practices	4.6667	.47140	4

Source: primary data, 2023

The two variables were first computed using Statistical Product and Service Solutions (SPSS) to have the mean and standard deviation of all responses for each variable under the study. The mean and standard deviation of all responses under the dependent variable which is students' attitudes in chemistry subject were obtained (M = 4.4, SD = .63) and for the independent variable which is science laboratory practices (M = 4.66; SD = .47) as depicted in Table 4.

Based on the five-point Likert scale responses, the average mean of responses shows that participants hold a positive mindset regarding the correlation of science laboratory practices and students' attitudes in chemistry subject.

Table 5:- Pearson correlation coefficients between science laboratory practices and students' attitudes in Chemistry.

Pearson Correlation coefficients			
		Students' attitudes in Chemistry subject	**Science Laboratory practices**
Students' attitudes in Chemistry subject	Pearson Correlation	1	.969*
	Sig. (2-tailed)		.031
	N	4	4
Science laboratory practices	Pearson Correlation	.969*	1
	Sig. (2-tailed)	.031	
	N	4	4
*. Correlation is significant at the 0.05 level (2-tailed).			

Source: primary data, 2023

As portrayed in Table 5, the strong Pearson correlation was obtained (r = .969, p = .031) between science laboratory practices and students' attitudes in Chemistry subject. Science laboratory practices are essential in teaching and learning science subjects as these practices positively influence students' attitudes, however, in this study, the findings revealed that from schools where the research was conducted, there is still a learning gap in terms of students' involvement into science laboratory practices.

Discussion:-

The findings reveal that the students involve into some science laboratory practices but their ability to carry out independent investigation of measurable properties, analysis of laboratory results and reporting laboratory results are still critical in some schools. The points of respondents who remained neutral is concerning because they preferred

that option following the inexistence of equipped laboratories, and students merely study theoretical chemistry. These findings show that there is no evidence that science laboratory practices are properly used in the schools where the current study was conducted.

The findings in line with the first of objective corroborate those obtained by García-Carmona and Acevedo-Díaz (2018) emphasizing the rationale to integrate practical content into secondary school science. The study findings advance the idea that theoretical content is enriched by practical content, hence improved science laboratory practices especially those requiring students' involvement. The findings of the current study are also authenticated by Setyawarno and Kurniawati (2022) who revealed that science process skills such as manipulation of laboratory equipment, and experimental skills require students' abilities to perform laboratory practice. Gericke et al. (2022) exposed that science laboratory practices hold exceptional position in teaching and learning science subjects especially secondary school chemistry content.

Briefly, 149 (74 %) perceive science laboratory practices as the determinant of students' motivation towards learning science subjects, and equally as the key factor to enhancing intellectual development in science subjects. On the other hand, 144 (72 %) held that science laboratory practices improve students' problem-solving skills while 142 (71 %) emphasized that science laboratory practices help students develop experimental skills.

The study findings revealed that engaging students into science laboratory practices determines how well students are motivated towards learning chemistry. In a similar vein, participants revealed that laboratory practices enhance students' intellectual ability. While most participants emphasized the effect of science laboratory practices on problem-solving skills and experimental skills, some of participants hold a different view of science laboratory practices. The findings of this study corroborate those obtained by yang et al. (2021) which indicated that laboratory experiments enhance students' motivation towards learning science subjects, and help students develop their mental ability. Empirical evidence (Makransky et al., 2019; Partovi & Razavi, 2019) have correlated learning science through experimentation and acquisition of problem-solving skills that facilitates students cope with real societal pressing challenges. The findings presented herein substantiate existing empirical studies when considering the aspect of using science laboratory experimentation to develop in students the ability to internalize concepts that require science process skills.

The findings discourse in this study is supported by research findings of the study conducted by Diwakar et al. (2023). His study endeavored to explore how laboratory practices affect students' acquisition of experimental skills, hence enhanced intellectual development. The findings also are validated by those found in a study carried by Esparza et al. (2020) who revealed that laboratory practices enhance students' motivation and interest in science education.

Science laboratory practices are essential in teaching science subjects according to Diwakar et al. (2023), although not all schools attach great importance to practical part of the curriculum content. It is quite recommendable that integrating practices with theories inevitably affects students' attitudes in chemistry subject. The findings of this study are in line with the study conducted by Tempelman et al. (2023) who maintained that laboratory is place where students put into practice what they have learnt theoretically hence improving their attitudes towards learning science subjects.

Summary of Findings and Conclusion:-

The findings of this study, in line with the first objective concerning identification of science laboratory practices revealed that laboratory practices exist in the surveyed schools. Although 75 % of the respondents revealed that students are involved in science laboratory practices requiring them to manipulate laboratory equipment, students are not facilitated to acquire all the science laboratory practices. The results also show that two schools' respondents do not fully assist their students in investigating measurable properties in chemistry; however, in interviews with the head teachers and deans of studies at two of the four schools, they explained that while reagents and laboratory equipment have been brought to the school, a lack of lab infrastructure prevents teachers from engaging students in laboratory activities. However, these results demonstrate that there is no proof that science laboratory techniques are properly applied in the schools where the current study was done. While respondents did not sufficiently affirm that students are able to interpret and report laboratory data, respondents did not provide any evidence to support this. The second objective was to ascertain students' attitudes in chemistry that are due to science laboratory practices. The findings of the study indicated that students hold positive mindset about science laboratory practices, and they

conceive the concept of laboratory practices as a determinant of motivation and interest, enhanced intellectual development, improved problem-solving skills, and a way forward to acquiring experimental skills. The findings from the third objective which was to establish the relationship between science laboratory practices and students' attitudes in chemistry subject in the surveyed schools showed a strong and significant Pearson's correlation ($r = .969$, $p = .031$) thus confirming irreplaceable and commending role of science laboratory practices towards successful teaching and learning science subjects, chemistry in particular.

Recommendations:-

Grounding on the findings of the current study, the researcher recommends that effort should be directed to science laboratory practices to improve students' attitudes in chemistry subject. As the findings shed light on the consideration of science laboratory practices by teachers during teaching and learning, the Ministry of Education, Rwanda education board, and NESA should work together to provide necessary laboratory equipment, reagent, and infrastructure to allow teachers involve students into science laboratory practices. The findings further recommend students to maintain their positive mindset towards science laboratory practices. Finally, curriculum designers should find these findings more relevant to help them integrate theoretical and experimental content when planning, designing, modifying existing science subject content. There is also a need to inculcate in students the appreciation of science laboratory practices in their early age to help them maximize their potential in scientific inquiries.

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