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Investigating The Impact of Acquired Fundamental Laboratory Skills in Chemistry on The Student's Actual Academic Achievement in Rutsiro District of Rwanda

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Abstract

The enhancement of fundamental laboratory abilities in advanced learners has multiple implications for academic performance. Corrective action is necessary for secondary school pupils who are taking chemistry as a core subject because of their poor performance in the subject. The aim of this study was to find out how advanced-level learners learned fundamental laboratory skills in chemistry and how those skills affected their academic performance in two secondary schools. In the investigation, an empirical method was applied. Quantitative data were collected and analysed during the data-gathering processes. From the Rutsiro district of Rwanda, mathematical-chemistry-biology and physics-chemistry-biology combinations in chemistry were studied by a sample of senior five learners in advanced secondary education who were studying chemistry as a core subject. Quantitative data were gathered using a closed questionnaire and a positivist approach that uses deductive research. The theory was the starting point, and it was determined whether or not practical laboratory skills had been established. There were186 respondents in the target group, of which 80 were chosen from several secondary schools, one of which was a boarding school (the School of Excellence) with a fully functional chemical lab and the other a 12-year-old BE (Basic Education) that had chemistry kits but no chemistry lab. The Statistical Package for Social Sciences (SPSS) was used to analyse the data. The results of the paired t-test show that the test mean difference ($M = 1.363$) is less than the school mean difference ($M = 1.463$). At the 0.001 level of significance, the results of the analysis suggest that the scores for the two means differed statistically significantly ($t (79) = 0.000$, $n = 80$, $P < 0.001$). The results of the statistical test indicate that students' views towards chemistry were somewhat influenced by the fundamental laboratory chemistry practical skills taught in schools. Students who failed practical tests for basic laboratory skills may not have access to well-equipped labs, but their interest in chemistry can be sustained through practical work.

Keywords: Developed fundamental skills; Practical work; Laboratory; Student’s performance

Introduction

Competence-based curriculum (CBC) can be used in secondary schools to teach chemistry, just like other experimental sciences, both theoretically and practically when experiments are involved. Like experimental science, chemistry requires its students to conduct a great deal of practical work and view demonstrations of the subject, as noted by Alanazi (2022). Additionally, Shana and Abulibdeh (2020) contend that engaging in practical work can stimulate students' curiosity about science and help them see it as an interesting subject. An experiment is a test conducted in carefully monitored settings to verify a hypothesis, prove a known fact, or assess the effectiveness of an innovative idea (Kamonmarttayakul et al., 2021).

Students can gain valuable learning experiences via laboratory activity, which serves as a link between the conceptual and the real world as well as between the molecular and macroscales. In addition to increasing students' scientific skills, lab work is crucial for catching their attention (Anwar et al., 2023). The central topic of this research is defined as the fundamental or basic abilities required of students in order to perform chemistry lab work.

For instance, because chemistry is an experimental science, students in advanced secondary schools at senior five (S5) must be able to use a weighing balance to determine the mass of substances, depending on the topics they have covered in their studies found in the Rwanda national curriculum. They should also be aware of the functions of lab apparatus and know how to use them, even if they can only use one. Research indicates that students' lack of academic preparation for laboratory work and the associated risks are the root of the problem with lab work (Sokol et al., 2022). Students are typically the ones involved in laboratory accidents because they lack awareness of the level of risk involved in not understanding worker safety in the lab. (Yuliani et al., 2020). The majority of students may see this as a positive step in the correct direction, but I also saw the report in this research as a tool for noticing the sufficient fundamental skills for laboratory chemistry obtained by attending laboratory work in secondary school.

Nonetheless, most of them encounter particular difficulties in their search for science education, particularly with regard to chemistry. For example, a Rwandan student who excels in chemistry enrols in laboratory and health-related specialised courses. Fewer students are able to pursue careers in chemistry, specifically as a result of their poor performance (MINEDUC, 2018). Although chemistry is a relatively important subject, it is disheartening to see that students' performance in the subject has not improved significantly during examinations, which leads to a national scarcity of experts and insufficient healthcare facilities (Doreen, et.al., 2023).

Chemistry instruction in secondary schools aims to improve student achievement, but Rwandan students have historically performed poorly on national science exams (MINEDUC 2018) and dropped out of chemistry (MINEDUC 2020). To remain competitive in science-oriented jobs, remedial measures must be implemented, including providing highly qualified workers with science and technology training and a solid understanding of chemistry. Chemistry is one of the science courses that opens doors to many careers for secondary school students who want to work in medicine, health science, agriculture, animal medicine, pharmacy, etc. (Kayitesi et al., 2022).

The term "chemistry laboratory practical skills" usually refers to the aptitude for specific tasks in the laboratory. Here, a range of abilities, including experimentation, lab procedures, appropriate tool usage, analytical methods, and problem-solving strategies, are essential for successful chemistry coursework and help students advance their ability to comprehend and conduct scientific inquiry. As a result, students learn by understanding while simultaneously developing their analytical abilities to solve problems
(Garminovich, 2020). Even though laboratory activities are crucial for understanding chemical concepts, they stand out as learning opportunities where students engage with various tools and materials to investigate occurrences (Shana & Abulibdeh, 2020). In order to understand the material in chemistry, the laboratory offers possibilities to "learn by doing"(Mas'ud et al., 2022)

In Rwanda, students enrol in advanced chemistry combinations after completing basic general education courses; however, in secondary schools, poor performance in chemistry continues to be a problem, either at the district level or at the level of individual schools. Ekici & Atasoy (2023) and Ndihokubwayo et *al.* (2022) noted that chemistry is generally a difficult subject to study; thus, students must regularly get chemistry instruction in practical lessons, instructor demonstrations during practice of the material, and the use of learning resources to promote their acquisition of skills. Thus, it is crucial to conduct research to determine the practical skills acquired in basic chemistry labs and how they affect the academic achievement of higher-level secondary school learners. Therefore, the aim of this study is to record secondary school students' fundamental laboratory skills; to ascertain how advanced students who are majoring in chemistry in schools with well-equipped labs and schools lacking a significant lab developed their fundamental skills; and to look into how these developed skills affected the students' practical academic performance.

The fundamental laboratory skills used in this research was based on Salin (2012), which are using a burette, making a standard solution, weighing with an analytical balance, heating substances using a Bunsen burner, using a dropper to measure and transfer liquid, heating with a hot plate or heating mantle, using beakers for holding liquid or solid samples, measuring volumes, using test tubes to burn tiny amounts of substances, using a test tube holder, using crucible tongs or beaker tongs, peaking powder of solids, and filtering.

The goal of the current study was to find out how advanced-level learners learned fundamental laboratory skills in chemistry and how those skills affected their academic performance in two secondary schools. Three goals guided the study: first, to record secondary school students' fundamental laboratory skills; second, to ascertain how advanced students who are majoring in chemistry in schools with well-equipped labs and schools lacking a significant lab developed their basic skills; and third, to look into how these developed skills affected the students' practical academic performance.

Methodology

Research Design

This study employed a deductive research design to examine the essential practical abilities developed among students at an advanced level (S5) in the lab and their influence on secondary school academic performance. This design involved gathering and assessing data from an accurate representation of the entire group in order to analyse the overall population of the study. A questionnaire and a practical test were used to gather data for research in 12 YBE without a lab but equipped with chemistry kits, as well as in a boarding school with a lab. It examined the state of chemistry instruction in secondary schools today using both qualitative and quantitative methodologies to achieve goals.

Research Paradigm

The term paradigm, which is frequently used in studies on education, refers to the worldview of the researcher (Miedema, 2023). Positivism was considered in this study. This study utilised a positivist approach, focusing on the truth found in respondents by observing and recording the impact of fundamental laboratory skills on the students' actual academic achievement in the Rutsiro district of Rwanda through closed-ended questions.

Targeted Population

There were 186 senior five (S5) students with Advanced levels from two secondary schools in Rwanda's Rutsiro district as the study's population.

Sample Size

In this study, 80 students from two secondary schools participated, with 20 selected in combination with MCB (Mathematics, Chemistry, and Biology) and 20 selected in combination with PCB (Physics, Chemistry, and Biology). Purposive sampling was used, with five senior chemistry students chosen based on their participation and knowledge of fundamental chemistry laboratory skills. The sample size was determined using Sloven's formula (1), with 186 students, 62% girls and 38% boys, included in the study. Sloven's formula was utilised to determine the sample size from the population using an 8.5% margin of error and a confidence interval of 95%. The formula used was:

$$n = \frac{N}{(1 + N \times e^2)} \quad (1)$$

where: N = population size, n = sample size, e = margin error.

The detailed information of the sample is shown in table 1.

Table 1: Summary of information about participants in this study

Secondary schools	Options	Lab materials equipped	Learners
School A	PCB	Not	20
	MCB	Not	20
School B	MCB	Yes	20
	PCB	Yes	20
Overall = 2	2		80

Methods and Procedures for Gathering Data

Data collection tools

This study used a questionnaire and a practical test to gather data for research in 12 YBE without a lab but equipped with chemistry kits, as well as in a boarding school with a lab. Three sections (A, B, and C) were used to gather research data in order to address these research questions. The purpose of Sections A and B was to determine how fundamental laboratory skills changed over time among senior five students studying in two different secondary schools who were advanced learners pursuing chemistry as a major subject in schools with substantial chemistry labs and schools without such labs. Section C concerns the practical test of chemistry. The questionnaire items are shown in Table 2.

The questionnaire in Table 2 was designed to find out the development of fundamental laboratory abilities in chemistry among advanced learners and their impact on the academic achievement of S5 students in chemistry in Rutsiro. The students' questionnaire had more questions in section B, which evaluates basic chemistry laboratory skills, than sections A and C. It covered the personal data of the respondents and applied a five-scale rating developed by Likert, requiring respondents to respond according to how they agreed or disagreed with the state therein. Depending on how much the respondent agrees or disagrees with the statement, codes 1, 2, 3, 4, and 5 correspond to strongly disagree, disagree, undecided or not sure, agree, and strongly agree, respectively.

The 43 questions in three sections (A, B, and C) of this questionnaire on the table 2 were used to analyse and interpret the data. Section A connects theoretical lessons with practical and consists of 10 questions; Section B assesses essential skills in chemistry laboratory settings with 19 questions; and Section C offers a 14-question practical test in chemistry.

Table 2: Questionnaire items for students' development of fundamental laboratory skills.

Statement	Strongly Disagree 1	Disagree 2	Undecided (Not sure) 3	Agree 4	Strongly Agree 5
SECTION A: Connecting theory and practice in chemistry					
1. I enjoy studying chemistry in practice as my major subject.	**1**	**2**	**3**	**4**	**5**
2. Chemistry inspires and engages me constantly as an experimental science.	**1**	**2**	**3**	**4**	**5**
3. One of my most enjoyable and fascinating activities is performing practical laboratory chemistry.	**1**	**2**	**3**	**4**	**5**
4. I enjoy taking chemistry chapters that involve lab work.	**1**	**2**	**3**	**4**	**5**
5. I am aware of the principles when working in the chemistry lab.	**1**	**2**	**3**	**4**	**5**
6.Practices of chemistry improve my academic achievement.	**1**	**2**	**3**	**4**	**5**
7. I find that the extraction method for isolating chemicals from plant sources is one of the most significant chemistry lab procedures.	**1**	**2**	**3**	**4**	**5**
8. I am interested in studying organic chemistry laboratory procedures since they use the distillation process to separate the components of liquid mixtures.	**1**	**2**	**3**	**4**	**5**
9. My favourite and most fascinating lab chemistry exercise is the melting point practical since it allows me to compare which crystals melt more quickly than others.	**1**	**2**	**3**	**4**	**5**
10. My understanding of the chemistry subject has improved as a result of the laboratory work.	**1**	**2**	**3**	**4**	**5**
SECTION B: Assessing fundamental laboratory abilities in chemistry					
1. I enjoy doing experiments in chemistry.	**1**	**2**	**3**	**4**	**5**
2. I can measure the volume of liquid in the chemistry lab by using a burette.	**1**	**2**	**3**	**4**	**5**
3. I'm certain that I can't measure a substance's mass in a lab using an analytical balance.	**1**	**2**	**3**	**4**	**5**
4. Using a dropper is a simple task for me in the laboratory.	**1**	**2**	**3**	**4**	**5**
5. I know how to use a pipette to transfer a tiny amount of liquid.	**1**	**2**	**3**	**4**	**5**
6. During titration, I am aware that a beaker may hold the required volume of solution.	**1**	**2**	**3**	**4**	**5**
7. I can prepare a copper (II) hydroxide solution in a test tube.	**1**	**2**	**3**	**4**	**5**
8. Since I can use my hand to hold the heated test tubes, I cannot use a test tube holder.	**1**	**2**	**3**	**4**	**5**
9. I'm not sure how to use a funnel and filter paper simultaneously during an experiment.	**1**	**2**	**3**	**4**	**5**
10. Using a scoopula or my hands, if I'm wearing gloves, I can reach a certain solute concentration.	**1**	**2**	**3**	**4**	**5**
11. A tripod stand can hold a beaker of wire gauze for support while it heats up.	**1**	**2**	**3**	**4**	**5**
12. Lab experiments in chemistry aid in a thorough comprehension of the subject.	**1**	**2**	**3**	**4**	**5**
13. I find it simple to operate the lab instrument known as a micropipette, which is used to precisely and accurately transfer liquid in the microliter range.	**1**	**2**	**3**	**4**	**5**
14. You cannot store numerous sets of test tubes in a test tube rack in a laboratory.	**1**	**2**	3	**4**	**5**

15. A test tube rack may accommodate several sets of test tubes at once.	**1**	**2**	3	**4**	**5**
16. To handle various materials at high temperatures, such as picking up flasks, beakers, and test tubes, crucible tongs are essential.	**1**	**2**	3	**4**	**5**
17. You can carry a beaker around without it coming into contact with your hands by using beaker tongs.	**1**	**2**	3	**4**	**5**
18. I'm positive that high boiling, low flammability liquids aren't heated quickly with Bunsen burners.	**1**	**2**	3	**4**	**5**
19. I find it hard to defend the use of a ring stand as a piece of equipment in a laboratory.	**1**	**2**	3	**4**	**5**
SECTION C: Chemistry practical test	For every question below, highlight the letter that corresponds to the right response.				
1. The following equipment is required when measuring 5 grams of sodium chloride:	(a)weighing balance	(b) spoon	(c) beaker	(d) holder for test tubes	
2. Which procedures/methods must you adhere to while creating a standard solution?	(a) dilution method	(b) analytical method	(c) weighing method only	(d) both the procedure of diluting and weighing	
3.The substance silver chloride is...	(a) blue	(b) green	(c) white	(d) yellow	
4.Solution A has a PH centre of 3	(a) solution A is a strong base	(b) It is not an acid solution	(c) solution A is a weak base	(d) Solution A is a strong acid	
5.The litmus paper is defined as:	(a) paper that remains unchanged when material is added	(b) the litmus paper serves as a display for the PH range of a scale.	(c) the material used to determine whether a substance is basic or acidic is known as a litmus paper.	(d) the litmus paper cannot distinguish between an acidic and a basic solution	
6.The gases sulphur dioxide and carbon dioxide are...	(a) the oxides of bases	(b) the acidic oxides	(c) the oxides that are neutral	(d) are both included in amphoteric oxides	
7. One kind of indicator that can be utilised to titrate strong bases and weak acids is...	(a) whichever indicator	(b) phenolphthalein	c) the indicator called methyl orange	d) there isn't a good indicator provided	
8. The following represents the molarity of the solution of substances:	(a) mass of the solvent relative to the mass of the malar	(b) molar mass of the solute	(c) ratio of solute mole to solution volume	(d) moles of solution relative to the entire solution volume	
9.The end point in titration means...	(a) the stage at which the indication changes colour	(b) the point at which the colour indicator stays the same	(c) the point where amount of titrant is enough to complete neutralisation	(d) the point at which the titrant's concentration is sufficient to completely neutralise	
10.A titration experiment may be used to...	(a) finding the equivalent position	(b) figuring out the sample's concentration	(c) only the volume of the unidentified concentration	(d) the true responses are a and b.	

11. What is the term for the electrolysis negative electrode?	(a) the electrode of the cathode	(b) the electrode of anode	(c) the electrolyte	(d) the electrolytic cell
12.Electrolytes have the ability to conduct electricity by...	(a) electron movement from the anode to the cathode	(b) electrons moving from the cathode to the anode	(c) the answers are a and b.	(d) movement of atoms
13. Among these substances, which one is not an electrolyte?	(a) the diluted sulphury acid	(b) potassium bromide solution	(d) the element known as silver	(e) the diluted hydrochloric acid
14. Regarding the production of sodium chloride through direct interaction of sodium and chlorine, which statement is accurate?	(a) the reducing agent is sodium	(b) chlorine is reduced	(c) the reduced is sodium, and reducing agent is chlorine	(d) an oxidising agent is sodium, and the reduced substance is chlorine

Validity and Reliability of the study

The questionnaire underwent review by education specialists, was revised, and was approved by a supervisor to ensure its validity and assess the relationship between questions and objectives.

The University of Rwanda's Department of Chemistry Education confirmed the construct validity and content of an instrument. A pilot study was conducted, determining the questionnaire's reliability coefficient using Cronbach's alpha.

Data analysis

The purpose of the one-sample t-test is to ascertain whether there is a statistically significant difference between the means of two different samples. Therefore, it was used to investigate the attitude mean difference scores between school A and school B.

When comparing the two groups, it is sufficiently evident that there is a significant difference in the mean between the schools and the students' test scores to the paired t-test, indicating that the mean difference between the schools (MD = 1.463) is greater than the mean difference between the tests (MD = 1.363). The results of the analysis show that, at the 0.001 level of significance, there is a statistically significant difference in the scores for the two means ($t (79) = 0.000$, $n = 80$, $P < 0.001$). The result of the t-test found that there is a significant difference between school A and school B.

Results and Discussion

Recording of fundamental laboratory skills in chemistry for students in secondary education

Table 3 below provides information on respondents' proficiency with fundamental laboratory techniques in chemistry in both secondary schools in Rutsiro district.

Table 3: Students' fundamental laboratory skills in chemistry at School A and School B

Combinations	PCB, MCB	
	Learners having a sufficient background in chemistry lab	Inadequately skilled learners in basic chemistry lab
Secondary school B	27 to the 40	13 to the 40
Secondary school A	16 to the 40	24 to the 40

As basic experiments are necessary to teach students the contents of their core subject, the researcher learned a great deal about how the learners acquired this knowledge. The researcher concluded that without lab supplies, students were not able to understand chemistry. According to the results, chemistry classes did not give pupils the chance to work with materials. The goal of the study was to determine how advanced learners acquired fundamental laboratory skills in chemistry. Therefore, the learners asked the researchers to share all the knowledge to them. Their remarks were duly noted.

In this study, the term "chemistry laboratory basic skills" refers to the essential abilities and competencies required for any instructional context where students must eventually observe or work with the materials and objects under study. The author distinguishes this type of activity as "practical work" rather than "laboratory work" because it is not confined to a specific location. Although it may occur outside the classroom, such as at home or in the field, students can still observe or manipulate objects in a laboratory or educational institution.

Abdi (2014) reports that an eight-week study on 40 grade five students from two different classes selected by purposive sampling showed that students taught with inquiry-based learning performed better on tests than students taught with traditional methods. The majority of students (83.0% and 85.0%, respectively) agreed that the use of chemistry practical increases students' understanding of concepts and makes learning enjoyable, as further highlighted by Tahir Adamu Koki (2019) from Nigeria, who investigated the effect of chemistry practical on students' performance in the subject for 95 students and 113 teachers in 20 secondary schools.

This study focused on the three dimensions that serve as the basis for learning objectives related to student performance: academic competencies, cross-cutting concepts, the University of Rwanda Framework, and the CBC for Key Competencies for Lifelong Learning. Through our actions, we hope to prepare the students for lifelong learning (REB, 2015). Investigating and discussing the role of basic laboratory skills in chemistry in science education at the school level is another goal that this section considers (Efe & Abamba, 2023). Hence, this study examined the role of fundamental laboratory abilities in chemistry in the teaching and learning of science at the school level.

Finding out the improvement of fundamental laboratory abilities in chemistry at both schools with and without a chemistry lab

The goal of the study was to compare advanced students majoring in chemistry at schools with a chemistry lab to those without one in order to determine how their fundamental laboratory skills were developing. The research employed 29 closed-ended questions to gather information on the fundamental chemistry laboratory skills developed by senior fifth-grade students. Two parts of the questionnaire were involved: Section A, which is concerned with connecting theory and practice in chemistry, and Section B, which is related to assessing fundamental laboratory abilities in chemistry.

Table 4 below was used to describe the differences in terms of statistics between the two groups toward the fundamental laboratory skills.

Table 4: Comparison of mean data of School A and School B

	Mean	SD
School A	19.98	2.769
School B	21.83	1.973

According to the data above, there was a comparable difference between the mean score for schools B (M = 21.83, SD = 1.973) and A (M = 19.98, SD = 2.769). It was evident from the analysis of the data that School B's mean score was generally higher than that of school A, indicating a notable improvement in academic performance and a noticeable increase in fundamental laboratory practical skills.

Based on **the improvement of fundamental laboratory abilities in chemistry at both schools with and without a chemistry lab,** advanced learners are pursuing core subjects such as chemistry in their studies. Students studying chemistry can benefit from the experiences provided during practical.

For over a century, practical work has played a pivotal and unique role in the education of chemistry, spreading from elementary school to higher education (Koller et al., 2015). A fundamental aspect of chemistry as a core subject in schools is that students must engage in laboratory work in order to acquire the necessary knowledge in the subject. (Shana & Abulibdeh, 2020).

The ability to do specific lab operations is what Salin (2012) defines as basic laboratory abilities in chemistry. In order to perform well in advanced secondary school chemistry, students must be able to use a burette, create a standard solution, weigh with an analytical balance, use a dropper, heat using a hot plate or heating mantle, use beakers, measure volumes, use test tubes, use test tube holders, peak powder of solids, and filter.

Evaluating performance in relation to a chemistry practical test

This study was involved in evaluating performance in relation to a chemistry practical test. Section C of the questionnaire was used to evaluate students' performance on a chemistry practical test in order to ascertain how much both schools had improved their chemistry instruction. This section was regarded as a chemistry practical test. To determine whether there is a statistically significant difference between the means of two distinct samples, the one-sample T-test was used. Consequently, School A's and School B's attitude mean difference scores of the two groups were analysed using it. When comparing the practical test scores obtained from the questionnaire, there was a noticeable variation in the means. The results of the paired t-test show that the test mean difference (MD = 1.363) is less than the school mean difference (MD = 1.436). The analysis's findings also demonstrated a statistically significant difference in the scores for the two means at the 0.001 level of significance ($t(79) = 0.000$, $n = 80$, $P < 0.001$). According to the t-test results, School A and School B differ significantly from one another in the chemistry practical test.

The data is interpreted in Table 5 below to evaluate the performance of students taking chemistry in secondary schools as the core subject in the practical test.

Table 5: Analysing the results of two secondary schools with one sample test.

Schools	df	Sig.(2-tailed)	Mean difference
	79	.000	1.436
Test marks	79	.000	1.363

The statistical data indicates that there is a correlation between students' academic accomplishment and their mastery of fundamental chemistry practical abilities, as shown in table 5. The statistical findings from comparing the two groups towards the practical test in chemistry show that students from School B, which has a well-equipped lab, passed 85% and failed 15%, while students in School A, which has no well-equipped lab but has chemistry kits, passed with 42.50% and failed with 57.50%, as shown in Figure 1.

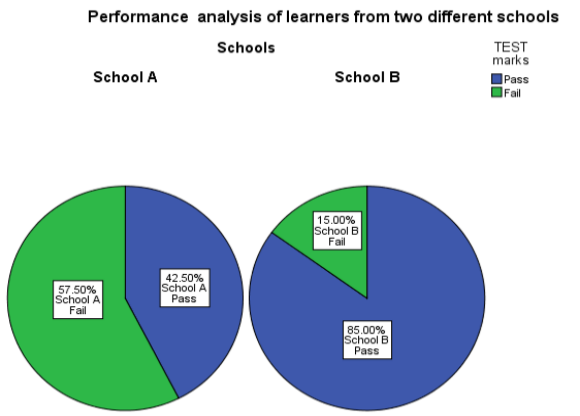

Figure 1: Comparison of students' achievement on a practical chemistry test between School A and School B

The contrasting performance of learners on a chemistry test of practical indicates the impact of basic skills developed on academic performance, allowing for determination of their success**.**

The major goals of teaching science, and chemistry in particular, are to help students become engaged, feel committed and self-assured, acquire scientific literacy, and have a positive attitude towards science. When students are in a well-equipped laboratory, they perform better on average and have a more positive attitude towards chemistry than when they are in an inadequately equipped laboratory (Iyamuremye et al., 2023).

The practical chemistry test results show that schools A and B differ significantly from one another. Both the experimental and control groups showed improvements. However, the experimental group's attitude had changed more than the control groups in terms of chemistry. $P < 0.001$ in the one-sample t-test results thus demonstrated their statistical significance. The results of this study revealed that students' grades in practical chemistry at both secondary schools A and B differ significantly from one another. (Okafor, 2021). Practical work enhances motivation and a positive mindset, therefore improving learning and increasing students' achievements in chemistry.

Conclusion

Based on the findings, this study concluded and detected that learning chemistry was more enjoyable and comprehension was improved with practical. As a result, it also supports students in applying what they have learned in class to real-world situations, particularly in chemistry, and encourages them to conduct in-depth research, all of which have an impact on their academic achievement.

The study concluded that fundamental laboratory skills improved students' performance in chemistry. This study highlights the importance of motivation and an optimistic outlook in enhancing learning and raising students' achievement levels. Teaching science, particularly chemistry, aims to help students become engaged, feel committed, acquire scientific literacy, and have a positive attitude towards science. A well-equipped laboratory leads to better performance and a more positive attitude towards chemistry.

Furthermore, this study concluded that chemistry attitudes significantly influenced students' views towards learning in general and science in particular. Over and above that, this study evaluated the impact of practical chemistry laboratory skills on students' performance. It suggests adding hands-on activities to pique students' interests and encourage chemistry.

Recommendations

Based on its findings, the study suggests the following: By engaging in practical work, students can sustain their positive interest in science. To ensure that students' learning and academic performance continue to improve, teachers should stick to teaching science through the laboratory method. Principals should keep creating a supportive laboratory environment in their schools so that educators and students can keep pushing for better teaching and learning, learning objectives, and academic success in science education. For their laboratory classes, science teachers instructing in chemistry should have preparation time to gather supplies and equipment.

Implications of the Research Results

The study's findings can benefit various stakeholders in education, including students, instructors, planners, auditors, instructors, and chemistry officials. It raises awareness about the challenges faced by advanced chemistry students and draws attention to problem-solving strategies. The findings support the practical approach of chemistry teachers, allowing training facilities to focus on fundamental laboratory skills. It may also aid school inspectors in modifying their inspection methodology to better assess the practical and skill acquisition processes.

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