G-CARD
GITOYA CENTRE FOR ACADEMIC RESEARCH AND DISSEMINATION

East African Journal of Education and Social Sciences
EAJESS March-April 2026, Vol. 7, No. 2, pp. 16-23.
ISSN: 2714-2132 (Online), 2714-2183 (Print). Published by G-Card
DOI: https://doi.org/10.46606/eajess2026v07i02.0487.

Influence of Enhanced Instructional Strategies on Academic Performance in Chemistry among Secondary School Students in Kirehe District, Rwanda

***Edissa Yamuragiye**
ORCiD: https://orcid.org/0009-0003-6437-7210
African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science, University of Rwanda
E-mail: yamuragiyeddissa195@gmail.com

Irénée Ndayambaje
ORCiD: https://orcid.org/0000-0002-5300-9063
African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science, University of Rwanda
E-mail: irenee.ndayambaje@gmail.com

***Corresponing Author:** yamuragiyeddissa195@gmail.com

Abstract

The teaching and learning of Chemistry in secondary schools continue to face challenges associated with poor academic performance, partly due to limited use of instructional materials. In response, this study examined the influence of enhanced instructional strategies on students' academic performance in Chemistry in Kirehe District, Rwanda. The study used a quasi-experimental design, involving control and experimental groups. The study involved 260 Senior Two students selected from four public secondary schools, where 130 students formed the control group and 130 students formed the experimental group. Data was collected using a Chemistry Achievement Test administered before and after the intervention. The experimental group was taught using enhanced instructional strategies such as laboratory experiments, visual aids, simulations and improvised teaching resources while the control group was taught using conventional teaching methods. The study used the independent samples t-tests to analyze the data. The pre-test results revealed no statistically significant difference between the two groups, indicating baseline equivalence. However, the post-test results showed a statistically significant difference in favor of the experimental group (M = 48.47, SD = 12.47) than those in the control group (M = 28.29, SD = 6.95), with the p-value of .000. The study concludes that enhanced instructional strategies significantly improve students' academic performance in Chemistry and recommends increased provision of enhanced instructional strategies for improved learning outcomes.

Keywords: Instructional materials; instructional strategies; learners' performance; pedagogical tools.

How to cite: Yamuragiye, E. and Ndayambaje, I. (2026). Influence of Enhanced Instructional Strategies on Academic Performance in Chemistry among Secondary School Students in Kirehe District, Rwanda. East African Journal of Education and Social Sciences 7(2), 16-23. **DOI:** https://doi.org/10.46606/eajess2026v07i02.0487.

Introduction

Instructional materials have been regarded as indispensable in teaching and learning processes (Donkor (2010). In order to effectively impart knowledge and guarantee that students have understood the content delivered, it is always recommended that teachers use suitable instructional materials, particularly in science related subjects (Effiong & Igiri (2015). Instructional materials facilitate teaching and learning activities, thereby making learning more concrete and less abstract, thus help in achieving learning objectives (Pett & Wilson (1996).

According to Ogawa (1995), science is understood as "knowledge achieved through the study of the operation of general laws of nature, especially knowledge which is obtained, tested, approved and accepted through scientific method. Science subjects taught in secondary schools, such as biology, chemistry and physics, are essential to human beings as they provide foundational knowledge for understanding life, matter and natural phenomena. For instance, industrial and technological advancements have increased the use of chemicals and manufactured products in food processing, pharmaceuticals and the production of other goods. Owing to its central role in these fields, scholars argue that chemistry should be compulsory at certain levels of education (Abdu, 2011).

Chemistry is concerned with the composition, structure, and properties of natural substances, which makes it a subject of paramount importance to all people and in almost every sphere of human endeavor. Human beings depend on organic compounds and other chemical substances in the production of essential items like soap, oils, hydrogenated oil, plastics, lubricants, petroleum jelly, ceramics and detergents.

Beyond the formal school curriculum, chemistry, as a core component of STEM, functions as a critical driver of sustainable national development. Economic growth, often reflected in rising per capita income, is closely linked to a nation's employment potential, which can be significantly enhanced when graduates at both secondary and tertiary levels are equipped with relevant STEM knowledge and competencies (Umar, 2019). Empirical evidence indicates that STEM-related occupations not only expand employment opportunities but also offer comparatively higher earnings than non-STEM fields (Cover et al., 2011). Globally, increased participation in STEM education at secondary, tertiary and postgraduate levels is widely associated with strengthened national capacity and improved economic competitiveness. Furthermore, across varying levels of educational attainment, STEM professionals consistently command more attractive wages than their non-STEM counterparts (Langdon et al., 2011).

In the Rwandan context, students' academic performance has been shown to correlate significantly with satisfaction with the academic learning environment, including key facilities such as libraries, computer laboratories, and science laboratories (Karemera et al., 2003). Moreover, existing literature establishes a positive relationship between instructional materials and academic performance (Broadbent, 2017), with evidence indicating that inadequacy of such materials adversely affects achievement. Consequently, this study examined the influence of instructional materials on students' academic performance in Chemistry.

Literature review

This section reviews scholarly literature on the impact of instructional materials on students' academic performance in Chemistry. It examines how the availability, accessibility, and effective use of instructional materials influence teaching, learning, and students' achievement in Chemistry, while also identifying gaps in previous studies to justify the current study.

The Role of Instructional Materials in the Teaching-Learning Process

Instructional materials play a critical role in the teaching and learning process by improving retention and making learning more enduring (Udeagbala et al., 2020). Equally, they stimulate and sustain interest in learning by providing first-hand experience with the realities of the physical and social environment (Leidner & Jarvenpaa, 1995). Instructional materials refer to resources and tools utilized to facilitate the achievement of educational objectives. Beyond conventional visual aids, well-structured instructional notes, particularly those incorporating three-dimensional representations of content, can significantly enhance learner motivation and improve academic performance (Ngussa & Abel, 2017).

Teaching and learning aids foster lasting learning experiences and integrate effectively with sensory stimuli, thereby improving learners' attention and retention (Nasibi, 2015). Instructional aids, including textbooks, pictures, diagrams, flashcards and posters, play a pivotal role in the teaching–learning process when effectively planned and utilized, as they engage learners' visual and auditory senses, thereby enhancing comprehension and retention (Adeniyi-Egbeola & Yusuf, 2018). Hence, instructors should adopt innovative pedagogical strategies to foster an engaging and stimulating learning environment (Sluijsmans et al., 1998). Furthermore, modern instructional technologies, particularly computers, play a critical role in enhancing content delivery, facilitating school activities, promoting self-directed learning and improving instructional efficiency (Hwang et al., 2013).

According to Dhakal (2017), the role of instructional materials in enhancing learners' academic performance is undeniable. The effective use of educational materials is particularly important in improving the overall quality of students' learning opportunities, especially during the implementation of new instructional content.

Practice-Mediated Teaching and Learning

Delivery of instruction becomes meaningful when learners are actively involved in constructing their experiences (Eom et al., 2006). In this regard, both traditional physical laboratories and modern laboratories can play a big role.

Collaborative engagement between science teachers and students significantly enhances academic achievement (Tsybulsky et al., 2019). The practice-based approach, characterized by active participation and experiential learning, facilitates deeper understanding of content and improves students' performance (Lawal et al., 2013). Practical teaching has been widely recognized as an effective strategy for developing scientific skills (Slaouti & Barton, 2007). It promotes learner-centered knowledge construction through guided interaction with materials, enabling students to manipulate resources, articulate ideas and engage in problem-solving processes (Manches & O'Malley, 2012). Additionally, the effective utilization of chemistry laboratory apparatus strengthens learning outcomes, fosters scientific skills and attitudes and enhances the application of knowledge in real-life contexts (Oluwasegun et al., 2015).

Methodology

This section presents the methodology that guided the study.

Design

This study used the quasi-experimental research design, where non-equivalent groups were used to examine the impact of using enhanced instructional strategies on students' academic achievement. The choice of this design was important as it allows the comparison between groups. The intact groups were randomly assigned either control or experimental group. The control group was taught by using conventional teaching strategies while the experimental group was taught by using different instructional materials, such as laboratory experiments, 3D simulations, multimedia and teaching aids from local available materials. Before the intervention, both groups did a pre-test to establish the baseline academic performance. After the intervention, both groups were subjected to a post-test to measure changes in their academic performance between the two groups.

Population and Sampling

The study was conducted in four public secondary schools in Kirehe District, Rwanda. The target population comprised 743 Senior Two chemistry students. The schools were purposively selected due to their similar contexts, particularly limited laboratory facilities. Using the Yamane (1967) formula at a 5% margin of error, a sample of 260 students was obtained and proportionally distributed across the schools. Students were stratified by stream and selected through simple random sampling, with 130 assigned to the experimental group and 130 to the control group. Random assignment ensured comparable representation across schools and streams.

Research Instruments

Chemistry achievement tests assessed the effect of instructional materials, such as laboratory experiments, 3D simulations, multimedia and teaching aids from locally available materials compared to conventional teaching strategies. This was done before and after the intervention to establish changes in terms of students' performance after rounds of teaching and learning activities. The test items were carefully designed to ensure alignment with Senior Two Chemistry syllabus in Rwanda.

Validity and Reliability

Validity refers to the assurance that the instrument measures what it is intended to measure (Creswell & I Okulu e, 2025). To ensure the validity, the instruments were reviewed by experts in Chemistry education and assessment from the University of Rwanda, College of Education. The reviewers examined the instruments for clarity, objectivity, relevance and alignment with the Rwandan Competence-Based Curriculum. Based on the comments of the reviewers, revisions were made, including refining questions, improving language clarity and ensuring coverage of key concepts.

Reliability of the Chemistry Achievement Test was established through a pilot test, conducted at a school not included in the main study but shared similar characteristics with the sampled schools, particularly in terms of curriculum coverage, student level and learning environment. Both split-half reliability and Cronbach's alpha coefficients were computed. The split-half reliability was obtained by dividing the test into two equivalent halves and correlating the scores while Cronbach's alpha assessed the overall internal consistency of the items as it appears in Table 1. The coefficient value of above 0.7 shows that the instrument was reliable and appropriate for data collection.

Table 1: Reliability Statistics of the Chemistry Achievement Test

Reliability Measure	Coefficient Value
Split-half reliability	0.79
Cronbach's alpha	0.71

Ethical Consideration

Ethical considerations were strictly observed throughout the research process to ensure the protection of participants and the integrity of the study. Before data collection, the researchers obtained official permission from Kirehe District and from the administrators of the selected schools. Informed consent was obtained from all participants prior to their involvement in the study. Confidentiality and anonymity were maintained by assigning codes to participants instead of using their names. Participants were also informed of their right to withdraw from the study at any stage without facing any consequences. In addition, all materials consulted from existing literature were properly acknowledged and referenced using APA format. The researchers ensured proper paraphrasing and citation of sources to avoid plagiarism and uphold academic integrity.

Results and Discussion

This section presents the findings in line to the study specific objective, guided by one research question: Is there a significant difference in Chemistry academic performance between students taught using enhanced instructional materials and those taught using conventional teaching methods?

The research question sought to determine whether a significant difference existed in Chemistry academic performance between students in the experimental and control groups, as measured by their pre-test and post-test scores using an independent samples *t*-test. Students in the experimental group were taught using instructional materials, including laboratory experiments, 3D simulations, multimedia resources and locally available teaching aids while those in the control group received instruction through conventional teaching methods without enhanced instructional materials. To address this research question, the following null hypothesis was tested: There is no statistically significant difference in Chemistry academic performance between students taught using instructional materials and those taught using conventional teaching methods.

To test this hypothesis, pre-test scores in the control and experimental groups were compared in Table 2 to 3, using the independent samples t-test so as to establish whether the two groups w, ere statistically equivalent before the intervention.

Table 2: Group Statistics for Pre-test

	Treatment Groups	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	Control Group	130	20.64	9.26	0.81
	Experimental Group	130	20.87	7.95	0.70

Table 3: Independent Sample t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	**Sig.**	**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Equal var. assumed	1.452	.229	-0.213	258	.832	-0.230	1.080	-2.357	1.897
Equal var. not assumed			-0.213	252.417	.832	-0.230	1.080	-2.357	1.897

The results in Table 2 indicate that the control group and the experimental group had relatively similar levels of academic performance before the intervention. The control group obtained a mean score of 20.64 (SD = 9.26) while the experimental group obtained a mean score of 20.87 (SD = 7.95). The slight difference in mean scores with the p-value of .832 suggests that the two groups were academically comparable at the beginning of the study. The standard deviations further indicate that the spread of scores within both groups was relatively similar. Therefore, the findings imply that the two groups started from nearly the same baseline level of Chemistry achievement before the introduction of instructional materials.

To test the hypothesis, post-test scores of students in the control and experimental groups were compared after the intervention, using the independent samples t-test as seen in Table 4 and 5. The intervention involved teaching the experimental group using enhanced instructional materials, such as laboratory experiments, 3D simulations, multimedia and selected teaching aids from locally available materials. On the other hand, the control group was taught using conventional teaching methods. Teachers in the experimental group facilitated interactive learning activities, including practical demonstrations and guided experiments supported by the instructional materials. In contrast, students in the control group were taught the same Chemistry content using conventional teaching methods characterized mainly by teacher-centered instruction, note-taking and textbook explanations without extensive use of enhanced instructional materials.

Table 4: Group Statistics for Post-test

Post-test	Treatment Groups	N	Mean	Std. Deviation	Std. Error Mean
Post-test Scores	Control Group	130	28.29	6.95	0.60
	Experimental Group	130	48.47	12.47	1.09

Table 5: Post-test Levene's Test for Equality of Variance

Levene's Test for Equality of Variances			t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal var. assumed	31.684	.000	-24.00	258	.000	-30.180	1.257	-32.655	-27.705
Equal var. not assumed			-24.00	210.436	.000	-30.180	1.257	-32.658	-27.702

The results presented in Table 4 indicate a substantial difference in post-test performance between students in the control group and those in the experimental group after the intervention. Students in the experimental group obtained a significantly higher mean score (M = 48.47, SD = 12.47) compared to students in the control group (M = 28.29, SD = 6.95). Although the experimental group showed slightly higher variability in scores, the overall performance was markedly better than that of the control group. These findings suggest that the use of instructional materials during the teaching and learning process greatly enhanced students' academic achievement in Chemistry compared to the conventional teaching approach.

The findings in Table 5 show that the control group scored the mean of 28.29 while the experimental group scored 48.47. The mean score for the control group increased by 7.65 (from 20.64 to 28.29) while that for the experimental group increased by 27.6 (from 20.87 to 48.47).

The p-value in the Levene's test for equality of variance is .000, which is less than the critical value (.05), leading us to opt the p-value for equal variance not assumed in the t-test for equality of means, which is .000, less than the critical value still, signifying that the two groups scored significantly different in their performance, the experimental group scoring higher than the control group. The p-value of .000 leads to the rejection of the null hypothesis, concluding that there is a significant difference in Chemistry academic performance between students taught using enhanced instructional materials and those taught using conventional teaching methods.

The results suggest that the instructional materials used in the experimental group had influenced the students' performance. These findings match with what Musengimana et al. (2022) contends that the use of enhanced instructional strategies in the teaching and learning transactions increases chances for students to perform better. Similarly, the study by Batamuliza et al. (2024) established that learners taught using enhanced instructional materials performed better than those taught using teacher-centered approaches. Furthermore, Nkundabakura et al. (2023) contended that enhanced teaching strategies are essential for effective teaching and learning to be realized. The findings are supported by the constructivist learning theory, which suggests that learners develop understanding more effectively when actively involved in the learning process through interaction with learning resources and practical experiences (Iyamuremye et al., 2025).

Conclusions and Recommendations

This study concludes that the use of enhanced instructional strategies significantly improves students' academic performance in Chemistry in secondary schools, particularly in Rwanda. This conclusion is based on the finding that students in the experimental group, who were taught using enhanced instructional strategies, achieved significantly higher academic performance than their counterparts in the control group who received conventional instruction. The superior performance of the experimental group may be attributed to the active learner engagement, practical learning experiences, and deeper conceptual understanding fostered by the enhanced instructional strategies. The study therefore affirms that enhanced instructional strategies are effective pedagogical tools for improving students' achievement in Chemistry and should be promoted in secondary school teaching and learning.

Based on the study's findings, the study recommends that schools and education stakeholders enhance the availability and utilization of instructional materials to support effective Chemistry teaching and learning. School administrators and policymakers should ensure equitable access to essential resources, such as laboratory equipment, textbooks, multimedia technologies and locally available teaching aids, particularly in resource-constrained schools. Furthermore, teachers should receive continuous professional development to strengthen their capacity to effectively integrate enhanced instructional strategies in classroom sessions. The study further encourages teachers to adopt innovative, learner-centered and practical teaching approaches that promote active participation and deeper conceptual understanding.

References

Abdu, B. (2011). Chemistry education and entrepreneurial development in Nigeria: Issues and challenges. Coconut Volume, 4(1), 107–114.

Adeniyi-Egbeola, F. O., & Yusuf, M. (2018). Resources and Strategies for Teaching English Vocabulary in the Primary and Junior Secondary Schools in Nigeria. NIU Journal of Social Sciences, 4(1), 279–288.

Batamuliza, J., Habinshuti, G., & Nkurunziza, J. B. (2024). Exploring lower secondary school teachers' perceptions of integrating simulations into chemistry instruction. Frontiers in Education, 9, 1484495. https://doi.org/10.3389/feduc.2024.1484495.

Broadbent, J. (2017). Comparing online and blended learner's self-regulated learning strategies and academic performance. The Internet and Higher Education, 33, 24–32. https://doi.org/10.1016/j.iheduc.2017.01.004.

Cover, B., Jones, J. I., & Watson, A. (2011). Science, Technology, Engineering, Mathematics (STEM) Occupations: A Visual Essay. Monthly Lab. Rev., 134, 3.

Creswell, J. W., & Inoue, M. (2025). A process for conducting mixed methods data analysis. Journal of General and Family Medicine, 26(1), 4–11. https://doi.org/10.1002/jgf2.736.

Dhakal, H. R. (2017). Classroom discourse in Nepalese schools: A cultural perspective.

Donkor, F. (2010). The comparative instructional effectiveness of print-based and video-based instructional materials for teaching practical skills at a distance. The International Review of Research in Open and Distributed Learning, 11(1), 96. https://doi.org/10.19173/irrodl.v11i1.792.

Effiong, O. E., & Igiri, C. E. (2015). Impact of instructional materials in teaching and learning of biology in senior secondary schools in Yakurr LG A. International Letters of Social and Humanistic Sciences, 62, 27–33.

Eom, S. B., Wen, H. J., & Ashill, N. (2006). The Determinants of Students' Perceived Learning Outcomes and Satisfaction in University Online

Education: An Empirical Investigation*. Decision Sciences Journal of Innovative Education, 4(2), 215–235. https://doi.org/10.1111/j.1540-4609.2006.00114.x.

Hwang, G.-J., Yang, L.-H., & Wang, S.-Y. (2013). A concept map-embedded educational computer game for improving students' learning performance in natural science courses. Computers & Education, 69, 121–130. https://doi.org/10.1016/j.compedu.2013.07.008.

Iyamuremye, A., Twagilimana, I., & Niyonzima, F. N. (2025). 8Bs instructional model for knowledge construction using web-based discussion tools. Discover Education, 4(1), 185. https://doi.org/10.1007/s44217-025-00614-3.

Karemera, D., Reuben, L. J., & Sillah, M. R. (2003). The effects of academic environment and background characteristics on student satisfaction and performance: The case of South Carolina State University's School of Business. College Student Journal, 37(2), 298–309.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). STEM: Good Jobs Now and for the Future. ESA Issue Brief# 03-11. US Department of Commerce.

Lawal, S. A., Choudhury, I. A., & Nukman, Y. (2013). A critical assessment of lubrication techniques in machining processes: A case for minimum quantity lubrication using vegetable oil-based lubricant. Journal of Cleaner Production, 41, 210–221. https://doi.org/10.1016/j.jclepro.2012.10.016.

Leidner, D. E., & Jarvenpaa, S. L. (1995). The Use of Information Technology to Enhance Management School Education: A Theoretical View. MIS Quarterly, 19(3), 265–291. https://doi.org/10.2307/249596.

Manches, A. and O'Malley, C. (2012). Tangibles for learning: A representational analysis of physical manipulation. Personal and Ubiquitous Computing, 16(4), 405–419. https://doi.org/10.1007/s00779-011-0406-0.

Musengimana, J., Kampire, E. and Ntawiha, P. (2022). Rwandan secondary school students' attitudes in learning chemistry: Explored with task-based instruction. Heliyon, 8(9), e10509. https://doi.org/10.1016/j.heliyon.2022.e10509.

Nasibi, M. (2015). Education for social transformation: The role of history and government in secondary school curriculum in Kenya. International Journal of Innovative Research and Development.

Ngussa, B. M. and Abel, C. (2017). Significance and adequacy of instructional media as perceived by primary school pupils and teachers in Kinondoni District, Tanzania. International Journal of Educational Policy Research and Review, 4(6), 151–157.

Nkundabakura, P., Nsengimana, T., Nyirahabimana, P., Nkurunziza, J. B., Mukamwambali, C., Dushimimana, J. C., Uwamariya, E., Batamuliza, J., Byukusenge, C., Nsabayezu, E., Twahirwa, J. N., Iyamuremye, A., Mbonyiryivuze, A., Ukobizaba, F. and Ndihokubwayo, K. (2023). Usage of modernized tools and innovative methods in teaching and learning mathematics and sciences: A case of 10 districts in Rwanda. Education and Information Technologies, 28(9), 11379–11400. https://doi.org/10.1007/s10639-023-11666-z.

Ogawa, M. (1995). Science education in a multiscience perspective. Science Education, 79(5), 583–593. https://doi.org/10.1002/sce.3730790507.

Oluwasegun, G., Ohwofosirai, A., & Emagbetere, J. (2015). The impact of physics laboratory on students offering physics in Ethiope West Local Government Area of Delta State. Educational Research and Reviews, 10(7), 951–956. https://doi.org/10.5897/ERR2014.1943.

Pett, D. and Wilson, T. (1996). Color research and its application to the design of instructional materials. Educational Technology Research and Development, 44(3), 19–35. https://doi.org/10.1007/BF02300423.

Slaouti, D. and Barton, A. (2007). Opportunities for practice and development: Newly qualified teachers and the use of information and communications technologies in teaching foreign languages in English secondary school contexts. Journal of In-Service Education, 33(4), 405–424. https://doi.org/10.1080/13674580701687807.

Sluijsmans, D., Dochy, F. and Moerkerke, G. (1998). Creating a Learning Environment by Using Self-, Peer- and Co-Assessment. Learning Environments Research, 1(3), 293–319. https://doi.org/10.1023/A:1009932704458.

Tsybulsky, D. and Muchnik-Rozanov, Y. (2019). The development of student-teachers' professional identity while team-teaching science classes using a project-based learning approach: A multi-level analysis. Teaching and Teacher Education, 79, 48–59. https://doi.org/10.1016/j.tate.2018.12.006.

Udeagbala, I. R., Onwuka, L. N. and Ugwude, D. I. (2020). Role of Instructional Materials in Improving Pupils with Dyslexia in Public Primary Schools in Ekwusigo LGAof Anambra State. Journal of Early Childhood and Primary Education, 2(2), 1–12.

Umar, Y. (2019). STEM education as a catalyst for national development: Problems and prospects in Nigeria. International Learning Science and Mathematics Journal, 14(3), 48–59.