



Improving Students' Academic Performance in Chemistry Through a Cooperative Learning Approach in Advanced Level Selected Public Secondary Schools in Rusizi District in Rwanda

^{1,2}Valens Mboniyintwari & ^{1,3}Wellars Utetiwabo

¹African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS),
College of Education, University of Rwanda

²Department of Science-Teacher Training College of Mururu

³Department of Science Education, School of Mathematics and Science Education, College of Education,
University of Rwanda

Email: vavantwari@gmail.com and w.utetiwabo@ur.ac.rw

Abstract: Different studies showed that Chemistry teachers in secondary schools often encounter challenges pertaining to devising suitable instructional approaches that improve students' academic performance. As a result, this study investigates the effect of cooperative learning (CL) on improving students' academic performance in Chemistry. The target population included 330 participants and was considered as the sample for the study. Employing a mixed research approach with quantitative and qualitative data, a questionnaire, Chemistry achievement tests, and structured interviews were used to collect data. Paired samples *t*-test results indicated a significant effect of cooperative learning among students in the experimental group compared to their counterparts in the control group. Results showed various challenges that hinder Chemistry cooperative learning, such as a lack of resources, large class size, internet connectivity, and language barriers. The study results advocate for urgent collaboration of different stakeholders in education to address these pressing challenges and suggest that a cooperative learning approach can be used as imperative towards improving students' academic performance in Chemistry.

Keywords: Cooperative learning, academic performance, Instructional strategy, Teaching and learning

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1. Introduction

Globally, teaching science lessons necessitates a teacher's ability to devise a suitable teaching and learning approach (Iqbal *et al.*, 2021). Approaches to learning have been considered influential in teaching Chemistry in secondary

schools globally (Walter, 2018). It has been argued in the literature that teaching Chemistry requires the adoption of a multifaceted approaches due to the abstract nature of Chemistry concepts (Wasielewski *et al.*, 2020) thus teachers' ability to devise an appropriate approach to teaching and learning is central to delivering instructional content successfully.

Cooperative learning (CL) has been defined in the literature as the learning in small groups where students are involved in collaborative work to support each other in the learning process (Ghaith, 2018). Cooperative learning has often been associated with high levels of cognitive development (Li *et al.*, 2024), social interaction (Bjørn *et al.*, 2024), and enhanced teamworking spirit (Renjie *et al.*, 2024). Students in a cooperative learning environment can achieve learning objectives in their respective groups, thus becoming an effective modality of instruction delivery that fosters deep learning (Beigzadeh *et al.*, 2024). The approach emphasizes the interdependence among students during discussions around the assigned topic, and it promotes communication skills as well as confidence (Zhan *et al.*, 2024).

A teacher's choice of teaching approach can affect the learning process either positively or negatively, depending on how the approach aligns with student learning needs (Varas *et al.*, 2023). Cooperative learning comes into play as a promising approach to learning when it is well structured (Bassachs *et al.*, 2020). Through cooperative learning employing well-structured small groups, students can acquire interpersonal skills and other academic benefits (Gillies, 2014). Through this approach, teachers impart their knowledge to students, inculcate the 21st century skills into them, and assess the internalization of the learnt content for students. Cooperative learning has been regarded as an approach that can help students' engagement and mutual support towards a common goal, which is better academic achievement (Jaiswal *et al.*, 2021).

1.2 Research objectives

- i. To investigate the extent to which teachers use a cooperative learning approach in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda.
- ii. To examine the impact of the cooperative learning approach on students' academic performance in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda.
- iii. To assess challenges teachers encountered when implementing a cooperative learning approach in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda.

1.3 Research questions

- i. To what extent do teachers utilize the cooperative learning approach in the Chemistry subject at selected advanced secondary schools in Rusizi District, Rwanda?

- ii. What is the effect of the cooperative learning approach on students' academic performance in the Chemistry subject at selected advanced secondary schools in Rusizi District, Rwanda?
- iii. What challenges do teachers encounter when implementing the cooperative learning approach in the Chemistry subject at selected advanced secondary schools in Rusizi District, Rwanda?

2. Literature Review

This section discusses critically different scholars' views about Chemistry cooperative learning as follows:

First and foremost, cooperative learning has been associated with improved communication skills (Bores-García *et al.*, 2021), collaboration (Warsah *et al.*, 2021), interdependence (Cañabate *et al.*, 2021). The cooperative learning approach offers full interactions among students to help each other achieve the learning objectives (Slavin, 2011). The cooperative learning approach is one of the approaches that can create enough chances for students to equally share knowledge within the academic environment (Sharan, 2010).

As a student-centered approach, cooperative learning incorporates students' prerequisite knowledge in the learning process, and they become regulators of the learning process under the guidance of the teacher (Bächtold *et al.*, 2023). It has been reported in previous studies that cooperative learning encourages active participation and arouses students' interest and motivation toward learning science subjects, Chemistry in particular (Iyamuremye *et al.*, 2023). This approach has been instrumental in improving students' academic performance, where failure or poor performance in Chemistry has been observed (Manyilizu, 2023). Another study that employed quasi-experimental research designs has been conducted to evaluate the effectiveness of cooperative learning in enhancing students' performance in Chemistry (Kekeba *et al.*, 2024). Empirical evidence indicates that cooperative learning correlates with students' conceptual understanding and correctness during science classroom sessions (Ndebil & Ali, 2024).

Rizki *et al.* (2024) concentrated on the improvement of students' critical thinking and problem-solving abilities through cooperative learning. They concluded that cooperative learning settings promote more in-depth participation and thought-provoking dialogues. The influence of cooperative learning in remote learning environments, especially during the COVID-19 pandemic, was examined in Baum's (2020) study. It emphasized the difficulties and effective approaches to upholding cooperative norms in online learning.

Gabriel *et al.* (2018) conducted a study concerning cooperative learning and individualized instruction, aiming at investigating the impact of these approaches on students' academic performance in Chemistry. The study revealed that group learning approaches not only enhance knowledge acquisition but also facilitate positive social interactions among students. Furthermore, individualized instruction accommodates the distinct learning needs of each student, allowing them to progress at their own pace. A mix of these approaches has been effective in helping students understand complex Chemistry concepts, with improved academic outcomes compared to traditional teaching methods.

The systematic review of Cooperative Learning in Physical Education from 2014 to 2019 by Bores-García *et al.* (2021) indicated that most studies focus primarily on secondary education, often involving short-term interventions. The analysis identified a predominance of qualitative and mixed methods, emphasizing sports and motor skills while neglecting body expression. Furthermore, social learning emerged as the primary focus, particularly aspects related to student motivation and teacher-student interactions. However, the short duration and fragmented nature of many interventions raise valid concerns about their effectiveness and application.

A study has been conducted to investigate how teachers' professional and pedagogical skills affect the application of cooperative learning methods and enhance student engagement and performance in science (Geletu, 2022). Utilizing randomized controlled trials, the study found that implementing cooperative learning significantly boosted students' engagement and academic achievements compared to traditional lecture methods. This emphasizes the importance of teachers developing their competencies to adopt active learning strategies effectively, thereby satisfying various learners' needs in the classroom.

The investigation undertaken by Simesso *et al.* (2024) explored the impact of cooperative learning on students' Chemistry achievement and retention, contrasting it with traditional teaching methods. Utilizing a quasi-experimental design, the study involved 128 students divided into experimental and control groups. Results indicated that those engaged in cooperative learning significantly outperformed their peers taught via lecture-based methods, both in achievement and retention tests, suggesting that interactive learning strategies enhance students' understanding and recall of scientific concepts.

Sibomana *et al.* (2021) examined how cooperative learning (CL) influences Chemistry students' academic performance in Rwandan upper secondary schools. The research utilized a quasi-experimental design, involving 257 students who were divided into two groups: one that received instruction through cooperative learning and

another that used traditional teaching methods. Results from the study revealed that students taught via cooperative learning scored significantly higher than those taught with conventional methods, indicating that cooperative learning can enhance academic achievement in Chemistry. This study explored how cooperative learning improves students' academic performance in Chemistry in advanced level in selected public secondary schools in the Rusizi District in Rwanda.

3. Methodology

3.1 Research design

The study investigated the effect of teachers' use of the cooperative learning approach on students' performance in Chemistry in secondary schools located in Rusizi District. The four schools were in Bugarama, Nkanka, Kamembe, and Nkombo sectors. While a survey research design, which provided insight into both exploration and explanation comprising quantitative data, was used to address the first and second research objectives, a quasi-experimental research design was used to compare students' performance after being taught with different instructional strategies, specifically a lecturing method for the control group and a cooperative learning approach for the experimental group.

3.2 Sampling and samples

Our study used purposive sampling because we selected Chemistry teachers as well as students from different combinations who study Chemistry as a core subject, which is examinable in the National Examination. Thus, this kind of sampling was used to get the sample of three hundred and twenty-four (324) student-participants and six (6) teacher-participants from four public secondary schools, including three boarding schools and one day school in Rusizi District in Rwanda.

Several important factors were considered while choosing the schools for this study to guarantee the research's applicability and efficacy. First, because the goal of the study is to enhance academic performance in Chemistry, only secondary schools that have Chemistry combination in their Advanced Level (A' Level) were included. In keeping with the goal of determining the impact of cooperative learning where it is most needed, priority was given to schools with a history of poor to average performance in Chemistry. At least one school was chosen from each of the four sectors to provide equal representation and to illustrate the variety of locations and situations found in Rusizi District, such that School A ranked 202 (with 57.43%), School B ranked 201 (57.44%), School C ranked 583 with 47.38%, and School D ranked

86 (63.24%). All the purposively selected schools were used as a sample for the research.

Table 1: Target population in science combination with the Chemistry subject, in the selected schools

SN	Schools	Options & Numbers	Number of teachers
1	School A	S ₄ MCB: 28 S ₄ PCB: 28 S ₅ MCB: 32 S ₅ PCB: 32	1
2	School B	S ₄ PCM: 22 S ₄ PCB: 22 S ₅ PCM: 14 S ₅ PCB: 14	2
3	School C	S ₅ MCB A: 21 S ₅ MCB B: 21	1
4	School D	S ₄ MCB A: 34 S ₄ MCB B: 34 S ₅ PCM: 11 S ₅ PCB: 11	2
Total		324	6

Source: primary data (2025)

3.3 Data collection tools

Questionnaire and Chemistry achievement tests (CATs) were used to collect data, and the collected data were quantitative in nature. Descriptive statistics were used to analyze quantitative data acquired from questionnaires. Pre-post students' scores were computed through a paired samples t-test for measurement of the effect of the intervention, which is a cooperative learning approach, on students' academic performance to establish the mean difference and p-values. The findings were displayed

through tables and were interpreted in accordance with the statistical results generated by statistical product and service solutions (SPSS).

3.4 Data collection methods

A structured approach was employed to gather data, with methods tailored to factors such as respondent availability, time constraints, and cost considerations. Paper-based questions were used for gathering information from participants, particularly when assessing multiple

variables. Questionnaires were self-designed and personally distributed during field visits. Participants were required to ascertain the strength of their answers following a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The data collection procedure followed the objectives of the study. First, a five-point Likert scale questionnaire was used to assess the extent to which teachers in the selected schools use a cooperative learning approach when delivering Chemistry instructional content. Pre-post Chemistry achievement tests were designed before and after intervention, referred to herein as a cooperative learning approach, to investigate its impact on students' academic performance in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda. To test the relationship between variables, students of senior four and five were treated with different teaching approaches. Therefore, students were dispatched into groups, namely, control and experimental groups. A cooperative learning approach was used to treat students within an experimental group, while those in the control groups were taught using lecturing. Thereafter, a post-test was administered to both groups to compare their performance using a paired samples t-test. Furthermore, a structured interview was used to assess challenges teachers encountered when using cooperative learning in teaching Chemistry lessons.

3.5 Ethical considerations

The study was conducted following research protocol, guidelines, and ethics for carrying out investigations encompassing human subjects in Rwanda. The approval of conducting the research was obtained from the ACEITLMS research committee, and research authorization letter was sought from the District. These approvals were presented to headteachers of respective schools. A consent form for participants was obtained from respective school headteachers and participating teachers, and the research process adhered to academic writing guidelines. Following these ethical guidelines ensured that

the researcher collected data by respecting data integrity and honesty.

4. Results and Discussion

Demographic characteristics included 2 female and 4 male teachers, corresponding to 33 % and 67 %, respectively. This ensured gender balance during exploration of the topic under investigation. Among participants, 1 (20 %) had experience in the interval of $\geq 10 < 15$ years while others had teaching experience in the interval of $\geq 5 < 10$ years. This helped the researcher to gain insights from a balanced sample having varying teaching experience, enhancing the reliability of the findings. Furthermore, 1 (17 %) taught year four and five, 2 (33 %) taught year four, while 3 (50 %) taught year five. This helped in understanding the effectiveness of the intervention across various years of study. Teacher-participants had different levels of maturity, 1 (17 %) was in the interval $\geq 35 < 40$ years old, while < 30 years old, and finally 4 (67 %) were in the interval of $\geq 30 < 35$ years old. This ensured the researcher that perspectives were from participants with varying maturity.

The study considered senior four and five students as potential participants because they need more attention to prepare for national examinations and application of the skills acquired during schooling after graduation. Figure 4.5 indicates that 168 (52 %) and 156 (48 %) were from senior four and five, respectively. Student-participants were categorized into males and females (Figure 4.6), 147 (45 %) were females while 177(55 %) were males. This ensured gender balance. Among student-participants, 94 (29 %) were less than 17 years, 207 (64 %) were between 17-19 years while 23 (7 %) had above 19 years, it is worth noting that this was not a factor for participation because year of study regardless of the age was considered.

The first specific objective was to investigate the extent at which teachers use cooperative learning approach in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda.

Table 2: Teachers' utilization of the cooperative learning approach in Chemistry

S/N	Statements	SA	A	M	Std. deviation
		F & %	F & %		
Utilization of the cooperative learning approach in Chemistry					
1	Designing activities	4 (66.7)	2 (33.3)	4.66	.52
2	Sharing resources and information	5 (83.3)	1 (16.7)	4.83	.41
3	Assessing cooperative tasks	4 (66.7)	2 (33.3)	4.66	.52
4	Assigning specific role in group activities	6 (100.0)	0	5.00	.00
5	Effective communication	3 (50.0)	3 (50.0)	4.50	.55
6	Ensuring conflict resolution	4 (66.7)	2 (33.3)	4.66	.52
7	Encouraging collaboration	4 (66.7)	2 (33.3)	4.66	.52
8	Promoting teamwork	2 (33.3)	4 (66.7)	4.33	.52
9	Evaluating group's performance after activities	3 (50.0)	3 (50.0)	4.50	.55
10	Maintaining improved group dynamics	3 (50.0)	3 (50.0)	4.50	.55
11	Creating an environment that fosters open communication among students	5 (83.3)	1 (16.7)	4.83	.41
12	Encouraging students to ask questions and provide feedback to each other	5 (83.3)	1 (16.7)	4.83	.41

According to Table 2, 66.7% strongly agree and 33.3% agree with a mean of 4.66 indicating a high level of agreement on the importance of designing activities within cooperative learning, with low variability (Std. deviation: .52). A strong consensus (83.3% SA) among teachers supports this approach. A mean of 4.83 suggests that sharing resources and information in a cooperative learning atmosphere is highly valued by participants, with low variability in responses (Std. deviation: .41). Participants perceived the assessment of cooperative tasks as linked to designing activities as Similar patterns are observed where 66.7 % strongly agreed to the item. With a mean of 4.66, showing strong support but a slightly higher variability in how teachers perceive its importance (Std. deviation: .52). All participants (100 %) hold the view that assigning specific roles in group activities is critical for effective cooperative learning with a mean of 5.00 indicating unanimous agreement, reflecting a strong belief in its necessity. Equal proportion of participants strongly agreed (50 % and agreed (50 %) that cooperative learning promotes effective communication with a mean of 4.50, suggesting that this aspect is recognized, but the higher

standard deviation (.55) indicated varied perceptions of participants.

Ensuring Conflict Resolution encouraging collaboration exhibited a strong agreement corresponding to 66.7% but with a lower mean of 4.66 indicating views are aligned with prior question items. 66.7 % responses from participants agreed that cooperative learning promotes teamwork with a mean of 4.33 reflecting moderate support. Strong agreement was at 33.3 % signalling areas for improvement in promoting teamwork. All participants (100 %) with a mean of 4.50 support the idea that evaluating group performance is essential in a cooperative learning environment. Similarly, participants hold the view that cooperative learning maintains improved group dynamics with a mean of 4.50. High agreement (83.3 %) indicated that in a cooperative learning environment, students experience open communication with a mean of 4.83 emphasizing its importance with low variability in responses. In the same vein, 83.3 % of participants indicate a shared belief in the value of cooperative learning toward encouraging students' feedback. It is worth noting that all aspects of cooperative learning investigated in this study,

align with participants' perspectives, which confirm the positive feedback of participants regarding the use of cooperative learning during classroom practices.

Table 3: Teachers' views on contribution of the cooperative learning approach on students' learning in Chemistry

		SA		A	
		F & %	F & %	M	S.D
1	Increased participation during group activities	6 (100)	0	5.00	.00
2	Improved confidence when working in groups	4 (66.7)	2 (33.3)	4.66	.52
3	understanding of Chemistry concepts through cooperative learning	1 (16.7)	5 (83.3)	4.83	.41
4	Grasping complex Chemistry topics when collaborating with their peers	4 (66.7)	2 (33.3)	4.66	.52
5	There has been a noticeable improvement in students' test scores since implementing cooperative learning	6 (100)		5.00	.00

Primary data, 2025

Table 3 shows that 100 % of participants confirmed that the intervention increased participation during group activities, 66.7 % strongly agreed that students experienced improved confidence when working in groups while 33.3 % agreed with the same assertion, 83.3 % agreed that understanding of Chemistry concepts through cooperative learning was enhanced while 17.3 % of participants strongly agreed with the same view, 66.7 % strongly agreed that grasping complex Chemistry topics when collaborating with their peers seemed easy while 33.3 % agreed with the same assertion. Finally, all participants strongly agreed that there has been a noticeable improvement in students' test scores since implementing cooperative learning. These findings indicate that

participants perceived cooperative learning as essential for teaching Chemistry, supporting its role in enhancing student engagement, confidence, understanding, and academic performance. The means for these responses ranged from 4.66 to 5.00, with standard deviations between .00 and .52, indicating strong agreement and low variability in the perceptions regarding the effectiveness of cooperative learning.

The second specific objective was to investigate the effect of cooperative learning approach on students' academic performance in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda.

Table 4: Paired samples correlation during pretest and posttest between control and experimental group from school

		A		
		Paired Samples Correlations		
		N	Correlation	Sig.
Pair 1	S ₄ PCB pretest & S ₄ PCB post-test	28	.243	.212
Pair 2	S ₄ MCB pretest & S ₄ MCB post-test	28	.450	.016
Pair 3	S ₅ PCB pretest & S ₅ PCB post-test	32	.156	.393
Pair 4	S ₅ MCB pretest & S ₅ MCB post	32	.341	.056

Primary data 2025

According to Table 4, paired samples analysed indicated non-significant correlations except pair 2, in which a slightly significant correlation ($r = .450$, $p = .016$) was obtained.

Table 5: Paired samples differences between control and experimental groups from school A

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	S ₄ PCBpretest	7.1429	28	2.63473	.49792
	S ₄ PCBposttest	15.9286	28	2.90502	.54900
Pair 2	S ₄ MCBpretest	7.4286	28	2.60240	.49181
	S ₄ MCBposttest	12.8571	28	3.97878	.75192
Pair 3	S ₅ PCBpretest	8.5625	32	2.39539	.42345
	S ₅ PCBposttest	17.1250	32	2.09069	.36958
Pair 4	S ₅ MCBpretest	8.5625	32	2.39539	.42345
	S ₅ MCBpost	14.6875	32	2.66927	.47186

Primary data 2025

Table 5 indicates findings from different pretest and posttest findings. For pair 1 (M = 7.1429 SD = 2.63473, M = 15.9286, SD = 2.90502), pair 2 (M = 7.4286 SD = 2.60240, M = 12.8571 SD = 3.97878), pair 3 (M = 8.5625 SD = 2.39539, M = 17.1250 SD = 2.09069), pair 4 (M = 8.5625 SD = 2.39539, M = 14.6875 SD = 2.66927). The

correlation for pair 2 from students of S₄MCB for pretest and posttest was significant ($p = .016$, $p < .05$ $r = .450$) while other pairs exhibited non-significant correlations, indicating a significant effect of intervention, which is cooperative learning strategy under similar conditions.

Table 6: Paired samples test findings from school A

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	S ₄ PCBpretest - S ₄ PCBposttest	-8.78571	3.41410	.64520	-10.10956	-7.46186	-13.617	27	.000
Pair 2	S ₄ MCBpretest - S ₄ MCBposttest	-5.42857	3.64568	.68897	-6.84222	-4.01492	-7.879	27	.000
Pair 3	S ₅ PCBpretest - S ₅ PCBposttest	-8.56250	3.41663	.60398	-9.79433	-7.33067	-14.177	31	.000
Pair 4	S ₅ MCBpretest - S ₅ MCBpost	-6.12500	2.91548	.51539	-7.17614	-5.07386	-11.884	31	.000

Primary data 2025

Table 6 indicates paired samples mean (pair 1, MD = -8.78571, $t(-13.617)$, $p = .000$); (pair 2, MD = -5.42857, $t(-7.879)$, $p = .000$); (pair 3, MD = -8.56250, $t(-14.177)$, $p = .000$); (pair 4, MD = -6.12500, $t(-11.884)$, $p = .000$). The

differences obtained confirmed significant differences in students' scores hence significant effect of cooperative learning strategy applied prior to administering the post-tests.

Table 7: Paired samples correlation during pretest and posttest between the control and experimental group from school B

		Paired Samples Correlations		
		N	Correlation	Sig.
Pair 1	Pretest scoresS ₄ PCM & Posttest scoresS ₄ PCM	22	.405	.061
Pair 2	Pretest scoresS ₄ PCB & Posttest scoresS ₄ PCB	22	.007	.974
Pair 3	Pretest scoresS ₅ PCM & Posttest scoresS ₅ PCM	14	.057	.846
Pair 4	Pretest scoresS ₅ PCB & Posttest scoresS ₅ PCB	14	.162	.581

Primary data 2025

According to Table 7, the paired samples analyzed indicated non-significant correlations.

Table 8: Paired samples differences between control and experimental groups from school B

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest scoresS ₄ PCM	9.1818	22	2.44241	.52072
	Posttest scoresS ₄ PCM	11.5455	22	2.68554	.57256
Pair 2	Pretest scoresS ₄ PCB	10.2727	22	2.41388	.51464
	Posttest scoresS ₄ PCB	17.1818	22	2.44241	.52072
Pair 3	Pretest scoresS ₅ PCM	6.5714	14	2.27746	.60868
	Posttest scoresS ₅ PCM	17.4286	14	2.02729	.54182
Pair 4	Pretest scoresS ₅ PCB	7.5714	14	2.95386	.78945
	Posttest scoresS ₅ PCB	13.7143	14	2.30146	.61509

Primary data 2025

Table 8 indicates findings from different pretest and posttest findings. For pair 1 (M = 9.1818, SD = 2.444241, M = 11.5455, SD = 2.68554), pair 2 (M = 10.2727 SD = 2.41388, M = 17.1818 SD = 2.44241), pair 3 (M = 6.5714 SD = 2.27746, M = 17.4286 SD = 2.02729), pair (M = 7.5714 SD = 2.95386, M = 13.7143 SD = 2.30146). The

significance of mean differences is shown in Table 3. The correlation for pair 2 from students of S4MCB for pretest and posttest was significant (p = .016, p <.05 r = .450) while other pairs exhibited non-significant correlations indicating a significant effect of intervention, which is cooperative learning strategy under similar conditions.

Table 9: Paired samples test findings from school B

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest scoresS ₄ PCM - Posttest scoresS ₄ PCM	-2.36364	2.80383	.59778	-3.60679	-1.12049	-3.954	21	.001
Pair 2	Pretest scoresS ₄ PCB - Posttest scoresS ₄ PCB	-6.90909	3.42135	.72943	-8.42603	-5.39215	-9.472	21	.000
Pair 3	Pretest scoresS ₅ PCM - Posttest scoresS ₅ PCM	-10.85714	3.13435	.83769	-12.66687	-9.04742	-12.961	13	.000
Pair 4	Pretest scoresS ₅ PCB - Posttest scoresS ₅ PCB	-6.14286	3.43863	.91901	-8.12826	-4.15745	-6.684	13	.000

Primary data 2025

Table 9 indicates paired samples mean (pair 1, MD = -2.36364, t(-3.954), p = .001); (pair 2, MD = -6.90909, t(-9.472), p = .000); (pair 3, MD = -10.85714, t(-12.961), p = .000); (pair 4, MD = -6.14286, t(-6.684), p = .000). The

differences obtained confirmed significant differences in students' scores hence significant effect of cooperative learning strategy applied prior to administering the post-tests.

Table 10: Paired samples correlation during pretest and posttest between the control and experimental group from school C

		Paired Samples Correlations		
		N	Correlation	Sig.
Pair 1	Pretest Scores A & Posttest scores A	21	.391	.080
Pair 2	Pretest scores B & Posttest scores B	21	.647	.002

Primary data 2025

According to table 10, paired samples analyzed indicated non-significant correlations except pair 2 in which a

slightly significant correlation (r = .647, p = .002) was obtained.

Table 11: Paired samples differences between control and experimental groups from school C

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest Scores A	8.1905	21	3.02686	.66052
	Posttest scores A	18.3810	21	1.62715	.35507
Pair 2	Pretest scores B	7.8095	21	2.52228	.55041
	Posttest scores B	15.0476	21	2.57830	.56263

Primary data 2025

Table 11 indicates findings from different pretest and posttest findings. For pair 1 (M = 8.1905 SD = 3.02686, M = 18.3810, SD = 1.62715), pair 2 (M = 7.8095 SD =

2.52228, M = 15.0476 SD = 2.57830). The mean difference is deemed significant.

Table 12: Paired samples test findings from school C

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Scores A - Posttest scores A	-10.19048	2.82168	.61574	-11.47489	-8.90606	-16.550	20	.000
Pair 2	Pretest scores B - Posttest scores B	-7.23810	2.14254	.46754	-8.21337	-6.26282	-15.481	20	.000

Primary data 2025

Table 12 indicates paired samples mean (pair 1, MD = -10.19048, t(-16.550), p = .000); (pair 2, MD = -7.23810, t(-15.481), p = .000). The differences obtained confirmed

significant differences for pair 2 concerning students' scores, hence a significant effect of cooperative learning strategy applied before administering the post-tests.

Table 13: Paired samples correlation during pretest and posttest between the control and experimental group from school D

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	Pretest scoresS ₄ MCB A & Posttest scoresS ₄ MCB A	34	.214	.225
Pair 2	Pretest scoresS ₄ MCB B & Posttest scoresS ₄ MCB B	34	.258	.140
Pair 3	Pretest scoresS ₅ PCM & Posttest scoresS ₅ PCM	11	.556	.076
Pair 4	Pretest scores S ₅ PCB & Posttest scoresS ₅ PCB	11	.105	.758

Primary data 2025

According to table 13, all paired samples analyzed indicated non-significant correlations.

Table 14: Paired samples differences between control and experimental groups from school D

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest scoresS ₄ MCB A	8.1176	34	2.60262	.44635
	Posttest scoresS ₄ MCB A	16.5882	34	2.48776	.42665
Pair 2	Pretest scoresS ₄ MCB B	8.4118	34	2.24442	.38492
	Posttest scoresS ₄ MCB B	13.3529	34	2.98362	.51169
Pair 3	Pretest scoresS ₅ PCM	8.0000	11	2.36643	.71351
	Posttest scoresS ₅ PCM	15.0909	11	2.73695	.82522
Pair 4	Pretest scoresS ₅ PCB	9.2727	11	2.24013	.67542
	Posttest scoresS ₅ PCB	17.4545	11	3.23616	.97574

Primary data 2025

Table 14 indicates findings from different pretest and posttest findings. For pair 1 (M = 8.1176 SD = 2.60262, M = 16.5882, SD = 2.48776), pair 2 (M = 8.4118 SD = 2.24442, M = 13.3529 SD = 2.98362), pair 3 (M = 8.0000

SD = 2.36643, M = 15.0909 SD = 2.73695), pair 4 (M = 9.2727 SD = 2.24013, M = 17.4545 SD = 3.23616). All pairs exhibited non-significant correlations.

**Table 15: Paired samples test findings from school D
Primary data 2025**

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest scores _{S₄} MCB A - Posttest scores _{S₄} MCB A	-8.47059	3.19313	.54762	-9.58472	-7.35645	-15.468	33	.000
Pair 2	Pretest scores _{S₄} MCB B - Posttest scores _{S₄} MCB B	-4.94118	3.23748	.55522	-6.07079	-3.81157	-8.899	33	.000
Pair 3	Pretest scores _{S₅} PCM - Posttest scores _{S₅} PCM	-7.09091	2.42712	.73180	-8.72147	-5.46035	-9.690	10	.000
Pair 4	Pretest scores _{S₅} PCB - Posttest scores _{S₅} PCB	-8.18182	3.73679	1.12669	-10.69223	-5.67141	-7.262	10	.000

Table 15 indicates paired samples mean (pair 1, MD = -8.47059, $t(-15.467)$, $p = .000$); (pair 2, MD = -4.94118, $t(-8.899)$, $p = .000$); (pair 3, MD = -7.09091, $t(-9.690)$, $p = .000$); (pair 4, MD = -8.18182, $t(-7.262)$, $p = .000$). Significant mean differences confirmed non-significant correlations between compared groups.

The third specific objective was to assess challenges encountered by teachers when implementing the cooperative learning approach in Chemistry, an interview was conducted with six participants:

What challenges do you face when implementing cooperative learning in your Chemistry classes?

The challenges we face in daily lessons include a language barrier, a large class size, where managing students constitutes a big challenge, and time management.

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *This cooperative learning activity helps learners to work hard and work in cooperation, leading to an understanding of the content.*

What additional support or resources would help you implement cooperative learning more effectively? *This approach will need books and other resources, such as ICT and language skills also should help in implementing this approach.*

What challenges do you face when implementing cooperative learning in your Chemistry classes?

Time management for the whole group is to be achieved, and group cooperation has achieved well. Class size is an issue

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *Group discussion went well, and self-confidence and mastery of the content were raised.*

What additional support or resources would help you implement cooperative learning more effectively? *Resources and internet connection.*

What challenges do you face when implementing cooperative learning in your Chemistry classes?

Insufficient time for covering the content and insufficient resources compared to the number of learners.

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *Group discussion went well, and learners participated actively and demonstrated mastery of the content.*

What additional support or resources would help you implement cooperative learning more effectively? *Insufficient resources, such as a computer, for facilitating cooperative learning and providing enough time for group discussion.*

What challenges do you face when implementing cooperative learning in your Chemistry classes?

Huge content and lack of resources, large class size.

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *This cooperative learning activity helps learners to work hard and work in cooperation, leading to success in Chemistry, active participation, self-confidence, and mastery of the content.*

What additional support or resources would help you implement cooperative learning more effectively? *Resources are needed, and lab materials for carrying out experiments.*

What challenges do you face when implementing cooperative learning in your Chemistry classes? *Many students in a group hinder the effectiveness of cooperative learning, and lack of a strong internet connection.*

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *Active participation, self-confidence, and mastery of the content.*

What additional support or resources would help you implement cooperative learning more effectively? *Wide ICT room for research, a wide laboratory for conducting distinct experiments.*

What challenges do you face when implementing cooperative learning in your Chemistry classes?

Slow learners did not participate well in their group discussion like others, and time management.

What do you consider as an example of a successful cooperative learning activity you have used in your classroom? *The class presentation was good, self-confidence was raised, and successful in Chemistry.*

What additional support or resources would help you implement cooperative learning more effectively? *Enough resources and lab materials for carrying out different experiments.*

4.1 Discussion

The use cooperative learning approach in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda was investigated. Constructs used to investigate the extent to which teachers use the cooperative learning approach turned around designing activities, sharing resources and information, assessing cooperative tasks, assigning specific roles in group activities, effective communication, conflict resolution, collaboration, teamwork, performance, improved group dynamics, open communication, and providing feedback. By using the Likert scale measurement, the findings indicated that respondents either agreed or strongly agreed on the fact

that the cooperative learning approach could influence students' learning when the constructs were used. The findings of this study are supported in the literature, for instance, the study conducted by (Simesso et al., 2024) concerning the contribution of using cooperative learning methods on students' achievement and retention in secondary schools during Chemistry lessons revealed that cooperative learning improved students' academic performance. The findings of this investigation demonstrated a significant difference between students instructed through cooperative learning and students instructed using lecture-based teaching in terms of their Chemistry achievement and retention ($t(126) = 5.544, p < 0.001$) and ($t(126) = 4.167, p < 0.001$), respectively. The Pretest, posttest, and retention test results of the treatment group showed a significant difference that favors the posttest ($r = 0.91, p < 0.001$) and retention test ($r = 0.81, p < 0.001$). Another study emphasized that cooperative learning strategies must be applied to make Chemistry more relevant, enjoyable, easy, and valuable for students. While recognizing the existence of other innovative teaching methods, a cooperative learning approach demonstrated that it could engage students in social interactions and promote effective learning. One of these teaching strategies is cooperative learning, which enables students to pick up knowledge from one another that they would not have acquired directly from teachers. All these results support the findings of the present study, making cooperative learning imperative in teaching and learning Chemistry with the goal to enhance academic performance.

To investigate the potential impacts of cooperative learning on students' academic achievement in the chosen secondary schools, action research was first carried out. Pairs of control and experimental groups made up the four schools under investigation. After being kept in their individual classrooms and given a pretest based on a typical teaching methodology, the students were subsequently instructed using a cooperative approach. Before implementing cooperative learning, a pretest was given. To create the foundation for comparing the academic performance of the control and experimental groups, the scores from the pretest and posttest were calculated using paired sample t-tests. We referred to the formative assessment carried out during the investigation as pre-tests and post-tests. The second objective of the study was to investigate the effect of the cooperative learning approach on students' academic performance in Chemistry at selected advanced secondary schools in Rusizi District, Rwanda. To investigate the effect of the cooperative learning method on students' academic performance in Chemistry, paired sample t-tests were used to measure the difference in performance among students in control and experimental groups, through pretests and post-tests administered during classroom sessions. The findings

revealed significant differences in mean scores for control and experimental groups between pre- and post-tests for pairs from 4 different secondary schools considered (refer to Tables 1-12). It was also noted that obtained means were different, and significant mean differences emphasized the effect of CL on students' academic performance during post-tests.

Several important debate topics can be investigated, considering the interview results: Large class sizes and time management were cited by both participants as major obstacles. Language limitations were specifically mentioned as a challenge by participant 1. Examples of effective cooperative activities

The necessity of ICT (information and communication technology) resources was alluded to by participant 1. Through group discussions, Participant 2 saw gains in self-assurance and content mastery. Examining teacher training on cooperative learning techniques could be helpful considering the issues raised. By addressing the issues and possibilities mentioned by the participants, these conversation topics may provide a greater understanding of the methods and frameworks required to improve cooperative learning in Chemistry classes.

The interviews reveal several interrelated challenges and needs identified by Chemistry educators regarding the implementation of cooperative learning in their classrooms. These can be categorized into three primary themes: resource availability, classroom dynamics, and time management.

Educators consistently expressed a need for sufficient resources, including technology and materials, to facilitate cooperative learning effectively. Participant 2 highlighted the necessity of a reliable internet connection as essential for implementing modern cooperative strategies, such as using educational software or online research. Similarly, Participant 4 called for specific lab materials to enhance hands-on learning experiences. Without adequate resources, educators struggle to create engaging and productive cooperative activities that benefit all students.

Several participants noted that large class sizes can dilute the effectiveness of cooperative learning. For instance, participant 5 mentioned that having "many students in a group" can hinder learning outcomes. This sentiment was echoed by Participant 4, who referred to the "huge content" being difficult to manage in large groups. Nonetheless, examples from participants indicate that well-structured activities, such as group discussions, can foster active participation, mastery of content, and self-confidence among students. Time constraints emerged as a significant barrier for educators. Participants 3 and 4 specifically mentioned that insufficient time for group discussions limits opportunities for in-depth learning and effective

cooperation. Effective cooperative learning requires time not only for students to engage meaningfully with their peers but also for teachers to guide and facilitate these discussions. Despite the noted challenges, several participants reported instances of successful activities that led to increased learner enthusiasm and mastery of content. For example, group discussions were cited as effective in encouraging participation and fostering a sense of collaboration among students.

The interview findings highlight critical needs and challenges faced by educators in implementing cooperative learning in Chemistry classes. Participant 5 emphasizes the importance of having a spacious ICT room for research and a well-equipped laboratory to facilitate various experiments, suggesting that physical space and resources significantly influence the effectiveness of collaborative learning experiences. In contrast, Participant 6 addresses the challenge of varying student abilities, noting that slow learners often struggle to engage during group discussions, which can hinder the overall effectiveness of cooperative activities. Yet, they also cite successful class presentations as an example of effective cooperative learning, which fostered self-confidence and improved comprehension of Chemistry concepts. This dual perspective underscores the necessity for adequate resources and tailored support structures to ensure that all students, regardless of their pace of learning, can participate effectively in collaborative settings.

5. Conclusion and Recommendations

5.1 Conclusion

Based on the findings from the first objective of the study, the majority of the teacher-participants use cooperative learning during teaching and learning activities. They demonstrated that they remain committed to using cooperative learning to enhance students' learning. The findings regarding the second specific objective reveal that, generally, students performed better when exposed to a cooperative learning approach, hence its effectiveness in enhancing students' academic performance. On the other hand, cooperative learning as an imperative teaching and learning approach has been hindered by challenges, including language barriers, time management, and class size, among others.

5.2 Recommendations

For the cooperative learning approach to be applied successfully in secondary schools, the following recommendations should be considered as follows:

- 1. Recommendations to the Ministry of Education**

The Ministry of Education, in partnership with stakeholders in education, should plan regular workshops to help teachers grow professionally, especially by acquiring skills in teaching and learning approaches.

2. Recommendations to School Head Teachers

Headteachers should work closely with teachers to ensure that teachers are using teaching and learning methodologies that help students to be actively engaged and facilitate their learning, hence improving academic performance.

3. Future Research

Future research should focus on exploratory studies on how cooperative learning affects students' motivation toward learning Chemistry, as well as how cooperative learning improves students' retention of learned Chemistry concepts.

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