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Students' Attitudes and Perceptions of Classroom Learning Environment: An Analysis of their Interrelationship and Influence on Academic Achievement in Biology

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Abstract

Background/purpose. In the context of education, the perceived classroom learning environment (CLE) and attitudes have a significant impact. There is a connection between the two that cannot be broken. Given this relationship, both are relevant components in Biology teaching and learning. Thus, this study examined the relationships among students' perceptions of CLE, attitudes towards Biology, and their influence on students' academic achievement in Biology.

Materials/methods. A correlation research design was adopted for the study. The study's target population comprised all senior two secondary school students studying biology in the Nyamagabe district of Rwanda. A purposive sampling technique was used to select 7 boarding secondary schools, with a total of 449 students. The What Is Happening in this Class (WIHIC) and Biology Attitude Questionnaire (BAQ) were the data collection instruments. Descriptive statistics, t-tests, correlational analyses, and multiple linear regression were used to analyze the data.

Results. The study revealed that students' perceptions of CLE, attitudes towards Biology, and their academic achievement in the subject were significantly and positively correlated. Both CLE and attitudes positively predicted students' academic achievement in Biology. Gender significantly affects students' perceptions of the CLE, with females having more favorable attitudes than males.

Conclusion. The study results indicated a positive and significant association between learning environment, attitudes, and academic achievement in Biology. Thus, the more students perceive the CLE favorably, the more likely they are to develop positive attitudes toward biology, which in turn enhances their academic achievement, and vice versa.

1. Introduction

The field of Biology learning has undergone several evolutionary shifts due to advancements in molecular Biology and biotechnology. These shifts have a significant impact on almost every aspect of daily life, including the criminal justice system, energy, environment, health, and food production (Borgerding et al., 2013). Biology is a valuable school subject, as it equips students for careers in pharmacy, agriculture, and medicine, among others (Uitto, 2014). It also helps students learn how to balance human demands with the preservation of the environment and natural systems (Mutanen & Uitto, 2020; Tsevreni, 2021).

Despite the importance of Biology, research worldwide reveals an unsatisfactory performance of students in the subject over time, particularly in the majority of underdeveloped nations (Joda, 2019). Such a situation is impacted by the students' attitudes toward biology (Acarlı & Acarlı, 2020; Ahmad et al., 2022; Burks, 2022; Mehmood & Anwer, 2020). The poor performance has led students to develop negative attitudes and eventually give up learning Biology (Adejimi et al., 2022; Byukusenge et al., 2022; Etobro & Fabinu, 2017). This situation is worrisome, as students' underperformance could impede the nation's drive for progress in Biology-related fields.

In Rwanda, like in other developing countries, Biology teaching and learning are not favorable. This is because Biology is predominantly taught through traditional expository methods that prioritize teacher dominance, knowledge acquisition, and preparing students for national exams (Byukusenge et al., 2022; Manishimwe et al., 2023; Ntawuhiganayo & Nsanganwimana, 2022). In this learning climate, effective teaching and learning are not possible, as it only favors. Such a way of teaching favors memorization of facts and promotes lower-level reasoning, as learners remain passive recipients of knowledge (Hamzah et al., 2022; Yang, 2015). This is contrary to learner-centered pedagogy, in which students are actively engaged in learning to enhance conceptual understanding (Kwok, 2024).

The process of teaching and learning cannot occur in a vacuum. It results from interactions among classroom members and elements. The classroom is the main setting for important learning and teaching activities, where a teacher guides and involves students in structured lessons (Aluri & Fraser, 2019). The teaching-learning exercise involves students, teachers, content, the learning process, and the environment itself (Gupta & Sharma, 2023). The learning environment refers to the conditions in which teaching and learning activities take place (Gupta & Sharma, 2023; Malik & Rizvi, 2018). The teacher's role is to help students achieve educational and didactic objectives, while students' role is to respond to the teacher's requests and meet their learning expectations (Gupta & Sharma, 2023). Thus, for students, the classroom learning environment (CLE) has a big impact on learning outcomes.

Various factors affect students' academic achievement, including student-teacher and student-student interaction, gender, teaching and learning strategies, attitudes, and the learning environment (Ali et al., 2015; Fraser, 2019; Sibomana et al., 2021). Among these factors, the way students perceive the learning environment is most often cited as the influencing factor. This is because it affects both cognitive and affective students' learning outcomes (Fraser, 2019; Rogers & Fraser, 2022). Besides, a more pleasant learning environment enhances learners' engagement and attitudes, which, in turn, improves learning outcomes (Bizimana et al., 2022; Malik & Rizvi, 2018). Thus, because Rwandan secondary school students' achievement in Biology is low, their perceptions of the CLE are an important source of information for understanding and interpreting their attitudes towards and academic achievement in Biology.

In Rwanda, several recent studies have sought to identify teaching strategies that can improve students' attitudes toward Biology and academic achievement in the subject (Bizimana et al., 2022a; Nkundabakura et al., 2023; Manishimwe et al., 2023; Ntawuhiganayo & Nsanganwimana, 2022).

Unfortunately, research on classroom learning environments and their impact on learners' attitudes and learning outcomes is scarce. However, Aluri and Fraser (2019), Amponsah et al. (2018), and 2022) urged that students' attitudes and achievement are both influenced by the learning environment, and that this should be considered. Consequently, to respond appropriately, it is preferable to understand the learning environment students encounter in the Biology classroom, evaluate how they perceive it, and assess how it influences their attitudes towards Biology and academic achievement.

While research on the learning environment field has seen tremendous growth in developed countries, such research is scarce in developing countries and is mostly focused on Mathematics. Therefore, the lack of these kinds of studies necessitated this study. The study will also add to the available information on CLE by exploring its effects on students' attitudes, along with gender differences, an endeavor that has not received attention before. In addition, the results of this study could serve as a foundation for the enhancement of Biology teaching and learning in classrooms. Given the above premises, this research aimed to examine (1) how students in Rwandan lower secondary schools perceive their Biology CLE and their Biology attitudes, (2) the link between their perceptions of Biology CLE, attitudes, and achievement in Biology, and (3) gender differences in perceptions of Biology CLE.

2. Literature Review

2.1. Classroom Learning Environment

Many researchers have defined the term "classroom learning environment". For instance, Fraser (2019) considered it a place where students and teachers interact with one another and use a variety of tools to engage in learning activities. Ezike (2018) and Radovan and Makovec (2015) define CLE as the social, psychological, and psychosocial environments in which teaching and learning activities occur. The authors state that the sociological nature includes the level of classroom interaction involving the teacher and the students. It refers to the degree of amicability between the teacher and students in the classroom. The psychological environments include distractions, motivation, curiosity, and anxiety-related indices, which can influence how easy or difficult learning is in the classroom. The psychosocial aspect incorporates learners' views of the course and educational program, as well as the connections among learners and teachers. It is evident from the foregoing that a teacher's rapport with students in the classroom can shape students' attitudes toward Biology.

Knowledge of the learning environment can help stimulate students' involvement in the learning process, influence students' behavior, and assist them in developing cognitive perceptions (Damaianti et al., 2019). Perception of the CLE refers to how students and their teachers see various aspects of the learning situation in their classes (Tshewang et al., 2017). Perceptions of CLE, as noted by Tshewang et al. (2017), may be positive or negative. Positive perceptions reflect positive feelings, attitudes, and emotions, whereas negative perceptions reflect negative sentiments, attitudes, and emotions towards something or someone. The foregoing suggests that the positive perceptions of the CLE variables could influence desirable learning outcomes, and vice versa.

Seven scales are used to categorize students' perceptions of the CLE. These include Student Cohesiveness, Teacher Support, Investigation, Involvement, Task Orientation, Collaboration, and Equity (Koul et al., 2018). Student Cohesiveness (SC) refers to the relationships among students and the degree to which they assist one another (Aluri & Fraser, 2019). Teacher Support (TS) is the degree to which students believe their teacher supports, connects with, and cares about them (Koul et al., 2018). Involvement (IN), on the other hand, is defined as simultaneously involving attentive interest, participating in learning activities, and enjoying the class (Cohn & Fraser, 2016). Investigation (INV) refers to the extent to which students apply exploration and experimentation approaches (Aldridge et al., 2013). Task Orientation (TO) refers to the importance of accomplishing assigned tasks and ensuring one stays on topic (Yerdelen & Sungur, 2018). Cooperation (CO) refers to the extent to which students collaborate with and learn from one another rather than compete with one another in the learning context (Yerdelen & Sungur, 2018). Equity (EQ) refers to the extent to which students perceive that they are being treated fairly by the teacher (Aldridge et al., 2013).

2.2. Attitude Towards Biology

Attitude is defined as a person's propensity to arrange their ideas, emotions, and actions in connection to psychological objects (Ogunleye & Babajide, 2020). In a similar vein, attitudes are mental, emotional, and behavioral dispositions toward a specific behavioral goal (Jain, 2014). Attitudes are also a person's likes or dislikes of a particular thing, person, or event (Karpudewan & Meng, 2017). From the above definitions, it is clear that the attitude combines sentiments, beliefs, and personal values, and that science is considered similarly.

Research has shown that learners do not have innate attitudes. They learn them later in life, between the ages of 10 and 14 years (Anayo, 2023; Okun & Rijavec, 2022) based on experiences within their environment. Therefore, since attitudes form early, it is crucial to support and preserve positive attitudes, as it is hard to change them after that period. According to Jones (2012), some attitudes stem from students' learning experiences, skills, and knowledge, while others stem from other sources. As a result, a student's attitude toward a subject is a useful tool for enhancing their performance in it.

Studies have demonstrated that students' academic performance is largely determined by their attitudes toward learning a subject (Bii & Chris, 2019; Murphy et al., 2018). Therefore, having a positive attitude towards a subject is a prerequisite for success in it. Regarding Biology, studies have evaluated students' attitudes toward the subject and academic achievement (Mehmood & Anwer, 2020; Onel & Durdukoca, 2019; Zia et al., 2023). They all reported that attitude is a significant predictor of students' academic achievement. Besides, Ahmad et al. (2022) and Kurniawan and Anggraini (2020) concluded that students' positive attitudes towards Biology highly correlate with academic achievement in Biology. This is because students who have positive attitudes towards a subject spend more time studying it and achieve better learning outcomes, which in turn spark their interest and increase their likelihood of continuing to study that subject in the future (Astalini et al., 2018). Therefore, a lack of desire to spend more time studying a subject will result in poor academic achievement.

2.3. Attitudes and Academic Achievement

Academic achievement refers to the capacity to demonstrate the accomplishment of academic objectives for which learning experiences were developed (Neji & Joda, 2016). Academic achievement is also defined by Ezekannaya (2016) as learning outcomes that show how well a person has achieved particular objectives that were the main focus of activities in instructional environments, particularly in school, college, and university. It measures the knowledge gained through the formal teaching and learning process and is usually indicated by test scores, exam marks, grade points, averages, and degrees (Anayo, 2023). In this study, academic achievement was measured by lower secondary school students' grade marks in the Biology subject.

One of the main purposes of science education is to inculcate in students positive attitudes toward science to create and tailor their interest in pursuing science disciplines in their further education. This is because a lack of positive attitudes toward science, coupled with young learners' low interest in pursuing science-related subjects, may pose a serious threat to a nation's economic prosperity (Kennedy et al., 2016). Therefore, it is important to understand how attitudes and achievement in science are related among learners.

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According to Ahmad et al. (2022), students' attitudes are vital indicators of academic achievement; thus, teachers must emphasize their attainment. Various aspects of attitudes are known to affect students' academic attainment significantly. For instance, studies by Chi et al. (2017) and Hacieminoglu (2016) revealed that students' interest in, enjoyment of, and perceived value of subjects, as well as career choices, were positively correlated with achievement. Similarly, the study by Zheng et al. (2019) found that students' interest in science was positively associated with their science achievement. Likewise, Wang and Liou (2017) found that students' perceptions about the utility value of science have a significant positive effect on their science achievement.

However, other studies found no significant relationship, or even a negative one, between students' attitudes towards science and achievement. For example, studies by Brooks (2011) and Salmi et al. (2016) found that enjoyment of science lessons, interest in science, and career aspirations in science were negatively associated with science achievement. These contradictory results necessitate conducting a comprehensive, well-researched study to determine the relationship between students' attitudes and academic attainment in lower secondary schools in the Nyamagabe district of Rwanda.

2.4. Classroom Learning Environment, Attitudes, and Academic Achievement

Researchers have explored the associations between CLE and their affective and cognitive outcomes. For instance, a study by Karpudewan and Meng (2017) in Malaysia examined the correlation between lower secondary school students' perception of CLE and attitudes toward learning science in 21st-century science lessons. The findings revealed a positive, significant correlation between students' perceptions of CLE and their attitudes. Besides, cooperation, equity, and investigation were identified as significant predictors of attitudes.

In the USA, Rita and Martin-Dunlop (2011) investigated the association between high school students' perceptions of CLE and cognitive achievement in Biology. The findings indicated a statistically significant association between CLE and achievement. Three factors here, namely the support of the teacher, investigation, and equity, were found as substantial predictors of students' achievement in Biology. However, the scale of cohesiveness proved to be negatively associated with achievement.

In Australia, Giles (2019) investigated, among students in the ninth year, the association between attitudes to mathematics and perceptions of CLE. Using correlation analysis, the findings revealed a positive association between CLE and students' attitudes toward mathematics. Moreover, according to the regression analysis, teacher support, involvement, and task orientation were the best predictors of mathematics attitudes. Looking at the research conducted by Fraser and Raaflaub (2013) in Canada regarding sex differences in the CLE, the students' perceptions of Mathematics and science CLE and attitudes were positively associated. However, in a study by Gupta and Sharma (2023) in India, the analysis revealed no significant association between academic achievement and CLE.

Yang (2015) conducted a study on how rural junior secondary school students in China perceive their CLE and how their perceptions are associated with their mathematics attitudes as well as achievement. A positive correlation between CLE and students' attitudes toward mathematics and academic success in the subject was identified. In addition, Zeidan (2010) investigated the relationship between the attitudes toward Biology and perceptions of the Biology CLE among grade 11 students in Tulkarm District, Palestine. The results of the correlation analysis revealed significant associations between attitudes toward Biology and the Biology CLE.

Moreover, in India, Aluri and Fraser (2019) measured students' perceptions of mathematics CLE and investigated their associations with students' achievement. The findings revealed a statistically significant correlation between CLE and students' achievement. Furthermore, in the United Arab Emirates (UAE), Khalil and Aldridge (2019) examined whether a relationship existed between the learning environment and students' attitudes toward science classes. The findings revealed a statistically significant and positive relationship between the five scales of learning environment and each attitudinal outcome.

2.5. Gender Differences in Perceptions of Learning Environment

Researchers have noted gender disparities in how learners perceive CLE. For instance, Fraser (2012) found that boys and girls perceive their CLE differently. Besides, Peer and Fraser (2015) looked into sex variations in students' perceptions of CLE. According to this study, male students generally had, to some extent, more positive perceptions of the CLE than female students. Scholars Fraser et al. (2010) conducted nationwide research on secondary science CLE in both Indonesia and Australia. They found that differences between sexes in the perception of the CLE existed among boy and girl students. In a recent study by Rogers and Fraser (2023), similar findings were reported: females held a more positive perception of CLE than their male peers.

Although in the above-reviewed studies, girls displayed more positive attitudes, whereas in other studies, males did, all concluded that the observed sex disparities are caused by the instructional strategies used by teachers. Hence, the effect of gender on students' perceptions of the learning environment remains inconclusive. It seems that most studies were conducted outside Rwanda. Therefore, there is a need for further research, expansion, and clarification to enrich this controversial situation, especially in developing countries like Rwanda.

From the reviewed literature, it is clear that students' perceptions of CLE are positively correlated with both academic achievement and attitudes towards different school subjects across time and educational contexts. Although much research has been conducted on the association between CLE and attitudes and achievement, only a few studies have been done on this association in Biology. Besides, most of the reviewed studies have been done in Western and other developed countries, and such studies are scarce in the Rwandan context. Thus, this work is exceptional for exploring the association among students' perceptions of CLE, attitude, and Biology academic achievement in Rwanda.

3. Methodology

3.1. Research Design

A correlation research design using a quantitative approach was adopted for the study. The population consisted of Biology students in 47 secondary schools in the Nyamagabe district, Rwanda. Seven secondary schools were purposively selected from the population. The data sample involved a collection of 449 students (225 males and 224 females). The data collection process involved 12 classes in selected coeducational government-aided secondary schools in the district. The school contexts are very similar in terms of students' achievement levels, instructional materials, teachers' qualifications, school learning environments, and parents' socio-economic status (Harerimana et al., 2017).

3.2. Instruments

The perceptions of students regarding the learning environment were measured using the Aldridge et al. (1999) validated form of the "What Is Happening In This Class (WIHIC)", comprising seven scales from the initial WIHIC, each with eight items. These include Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity. The WIHIC was selected since it has been the most widely utilized (Fraser, 2012). Besides, it has been employed

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in several states, let alone across the country's investigations, and in subjects such as Mathematics and Chemistry (Amponsah et al., 2018; Chipangura & Aldridge, 2017).

The validated WIHIC was modified to guarantee the scale's appropriateness in the study. To begin with, it was determined whether the WIHIC measures could be used to evaluate the perceptions of the learning environment in lower secondary school classes. Thus, teacher support, student cohesiveness, task orientation, equity, and cooperation were measured using the WIHIC's six-item subscales. The scale of "Investigation" was therefore excluded as it was not pertinent to its use in lower secondary school Biology classrooms.

Moreover, to ensure the approaches would work smoothly in Rwanda, the language and wording of each WIHIC scale were also examined. For instance, one item on the "Teacher support" scale was revised from "Teacher takes a personal interest in me" to "The teacher is interested in me" to clarify that there is no misinterpretation of the statement's intent. It is important to note that, since its creation, numerous variants of the WIHIC have been used in a variety of international investigations and have significantly increased the number of academicians in the field of education (Chipangura & Aldridge, 2017). There was a total of 48 Likert-type items that asked students to respond on a five-point scale (1= almost never, rarely, 2= rarely, 3= sometimes, 4= often, and 5= almost always) on which students rate how frequently the statement occurred.

The Biology Attitude Questionnaire (BAQ) was another study instrument. This work used it to evaluate students' attitudes towards Biology. Based on the scales developed by Prokop et al. (2007) and Zeidan (2010), I adapted them after getting permission from those scholars to use and modify their scale items. As a result, thirty BAQ scales in total were distributed among the four constructs as follows: 9 scales on interest, six scales on career, five scales on importance, and 10 scales on enjoyment. Students indicated their agreement or disagreement using a five-point response scale (5=strongly agree to 1=strongly disagree).

Students' academic Achievement was measured by students' marks from the second trimester of the 2023 school year. According to scholars (Ahmad et al., 2022; Cohn & Fraser, 2016; Yang, 2015), students' marks in Biology serve as indicators of their entire achievement in this subject, and they have been extensively utilized in earlier research to assess the achievements of students.

3.3. Validation of the Instruments

Even though the WIHIC and BAQ were validated in numerous nations with a variety of linguistic and educational systems: Aldridge et al.(1999) in Taiwan, and Australia, Amponsah et al.(2018) in South Africa, Khine et al.(2020) in the UAE, Alzubaidi et al.(2014) in Jordan, and others, the WIHIC and BAQ were presented to experts in science education from the University of Rwanda, College of Education, for face and content validation. As a result, it was possible to determine whether the language was suitable and easily understood by lower secondary school student respondents. It also made it possible to clarify ambiguous things and verify that the items measured what they claimed to measure by rewording them and double-checking them.

3.4. Data Collection Procedures

The study involved 449 lower secondary school students from 4 schools, distributed in 12 classes, from which data were gathered. The Biology teachers in these schools gave a hand in this study, serving as study assistants. The Biology classroom teachers administered both instruments at the beginning of the third trimester in 2023. Students were given 1.5 hours to complete each instrument. The study was conducted based on the participants' voluntary participation. They were made aware of the study's scope. Participants' private information and rights were also safeguarded.

3.5. Data Analysis

Data obtained on the WIHIC and BAQ scales were subjected to the mean and standard deviation. The Pearson correlation coefficient (r) was used to examine the bivariate relationships among the WIHIC and BAQ scales and academic achievement (Subiyakto et al., 2020). Cohen's criteria were used to interpret the strength of the observed correlations, where r=0.10-0.29 was considered to be a small correlation, r=0.30-0.49 a moderate correlation, and r ≥0.5 a strong correlation (Cohen, 1988). Multiple regression (*R*) was used to examine the association between the BAQ and WIHIC scales. The standardized computation of the regression coefficient (β) was done and examined to find out the WIHIC scales that exclusively and significantly contributed to the change in attitudes. In regression analysis, the effect size of the predictor variables is given by the beta loadings. In interpreting the effect size, Cohen et al.(2018) indicate the following guidance: 0-0.1= weak effect, 0.1-0.3= modest effect, 0.3-0.5= moderate effect, and > 0.5= strong effect. Furthermore, the Independent t-test was employed to assess gender differences in the learning environment. The data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 21.0. To determine significance, an alpha level of 0.05 was used for all inferential statistical analyses.

4. Results

4.1. Reliability and Validity of the WIHIC

In the statistical analyses, internal consistency (Cronbach's alpha), discriminant validity (mean correlations of a scale with the other six scales of the instrument), and an ANOVA to determine the WIHIC's ability to distinguish between classrooms were used. The results are reported in Table 1.

Table 1. Scale Internal Consistency (Cronbach Alpha Reliability), Discriminant Validity (Mean Correlation with other Scales), and Ability to Differentiate between Classrooms (ANOVA results) for the WIHIC.

Scale	Alpha Reliability	Discriminant Validity	ANOVA Eta^2
SC	0.73	0.44	0.12*
TS	0.74	0.39	0.15*
INV	0.76	0.27	0.13*
TO	0.75	0.30	0.14*
CO	0.77	0.26	0.33*
EQ	0.76	0.33	0.10*

*p<0.05 n=449 students in 12 classes

In Table 1, the reliability coefficients for the WIHIC scales ranged from 0.73 to 0.77. The highest alpha reliability (0.77) was obtained for Cooperation, and the lowest (0.73) for the scale of Student Cohesiveness. The other internal consistency reliability coefficients lie between these values. The results being consistently equal or above 0.70 suggest that the WIHIC can be considered to be a reliable tool for Rwandan students. Additionally, the discriminant validity indices ranged from 0.27 to 0.44. They are small enough to suggest that each scale of the WHICH has adequate discriminant validity, even though some of them assess slightly overlapping aspects of the classroom environment. In keeping with traditional learning environment research, the eta^2 statistic was calculated to indicate the degree to which each scale could differentiate between the perceptions of students in different classes. The eta^2 statistic ranged from 0.10 to 0.33 and was statistically significant for each scale. This indicates that each scale of the WIHIC is capable of differentiating significantly between classes (p<0.05). Overall, the reliability, discriminant validity, and ANOVA results confirmed that the WIHIC could be used with confidence for further research.

4.2. Students' Perceptions of CLE and Attitudes Towards Biology

To assess the way students perceive their learning environment in Biology classrooms and their attitudes towards it, the standard deviation (SD) and item mean score were calculated for each WIHIC and BAQ scale (Table 2).

Table 2. Mean and Standard Deviation for Each WIHIC Scale, BAQ Scale, and Academic Achievement

Subscales	Mean	SD	Skewness	Kurtosis
SC	3.94	0.82	0.01	-1.35
TS	3.86	0.85	0.19	-1.48
INV	3.97	0.92	-0.10	-1.50
TO	4.02	0.89	-0.13	-1.57
CO	3.85	0.95	-0.24	-1.04
EQ	3.95	0.94	-0.12	-1.45
Interest	2.93	0.95	0.73	0.04
Career	3.00	1.01	0.78	-0.47
Importance	2.99	0.98	0.84	-0.23
Enjoyment	2.95	0.94	0.81	-0.20

As shown in Table 2, the student participants in this study did not perceive their Biology CLE favorably. This is because the range of WIHIC scales in terms of mean score was 2.93 to 4.02, suggesting that students perceive their Biology CLE as no more than "often". The scale with the higher mean score was TO (M=4.02, SD=0.89), suggesting that students received frequent orientation on the learning tasks.

Results in Table 2 also show that interest has a mean score of 2.93 (*SD*= 0.95); career has a mean of 3.00 (*SD*= 1.01); importance has a mean of 2.99 (*SD*= 0.98); and enjoyment has a mean of 2.95 (*SD*= 0.94). The total mean score of the BAQ was 2.97 (*SD*=0.94). The average item mean score for the attitudes towards Biology ranged from 2.93 to 3.00. This means that the students' attitudes towards Biology were a bit positive.

4.3. Relationship between Classroom Learning Environment and Attitudes towards Biology

The study examined whether students' perceptions of CLE were related to their attitudes towards Biology. Table 3 shows the results. Table 3 indicates that the associations between the WIHIC scales (SC, TS, INV, TO, CO, EQ) and the BAQ scales (interest, career, importance, and enjoyment) were positive and statistically significant (p< 0.01), taking into account all scales. In addition, the multiple correlation (R) between each BAQ scale and the WIHIC scale was significant (p< 0.01). Considering these findings, the way students perceived CLE, accounted for roughly 43% of the difference in students' interest, 47% of the difference in students' future careers in Biology, 43% of the difference in the students' importance of Biology, and 41% of the variance in students' enjoyment of Biology lessons.

Furthermore, regression coefficients (β) indicated that different WIHIC scales were predictors of attitudes. For the interest in Biology, regression coefficients indicated that all six WIHIC scales (SC, TS, INV, TO, CO, EQ) were positive, independent, and statistically significant ($p< 0.01$) predictors. For career in Biology, five of the six WIHIC scales (SC, TS, TO, CO, EQ) were statistically significant ($p< 0.01$) predictors of career when the other scales were mutually controlled.

Table 3. Simple Correlation and Multiple Regression analyses for Associations between Learning Environment and Attitude Scales

Attitude-Learning Environment Associations								
Scale	Interest		Career		Importance		Enjoyment	
	r	*β*	*R*	*β*	*r*	*B*	*r*	*B*
SC	0.25**	0.16**	0.58**	0.29**	0.20**	0.06	0.22**	0.23**
TS	0.22**	0.24**	0.55**	0.25**	0.27**	0.06	0.20**	0.06
INV	0.17**	0.17**	0.45*	0.050	0.10	0.02	0.17**	0.16**
TO	0.13**	0.33**	0.38**	0.27**	0.16**	0.11**	0.12**	0.10**
CO	0.37**	0.24**	0.52**	0.23**	0.20**	0.27**	0.35**	0.21**
EQ	0.35**	0.21**	0.43**	0.29**	0.12*	0.16**	0.36**	0.24**
Multiple Regression (R)		0.43**		0.47**		0.43**		0.41**
R^2		0.185		0.221		0.185		0.168

*p < 0:05; **p < 0:01; N = 449

For the importance of Biology, regression coefficients indicated that three of the six WIHIC scales (TO, CO, and EQ) were statistically significant ($p< 0.01$) predictors of importance of Biology. For enjoyment, regression coefficients (*β*) indicated that five of the six WIHIC scales (SC, INV, TO, CO, and EQ) were statistically significant ($p< 0.01$) predictors of enjoyment of Biology lessons. These regression coefficients were positive, suggesting that students hold more positive attitudes in Biology lessons when they notice the CLE is more focussed on tasks, when students cooperate, and when teachers treat students equitably.

4.4. Associations of Students' Perceptions of Learning Environment with Academic Achievement in Biology

The associations between students' perceptions of CLE and academic achievement in Biology were examined using simple and multiple correlation coefficients, as well as the standardized regression Coefficient (*β*). Table 4 shows the results.

Table 4. Associations between the WIHIC and BAQ Scales and Academic Achievement in terms of Simple Correlation (*r*), Multiple Correlation (*R*), and Standardized Regression Coefficient (*β*)

WIHIC Scales	Academic Achievement	
	R	*β*
SC	0.423**	0.140**
TS	0.432**	0.209**
INV	0.321**	-0.048
TO	0.404**	0.172**
CO	0.325**	0.082
EQ	0.309**	0.096
Multiple Correlation *R* = 0.51*		

*Significant at $p < 0.01$, N = 449

In Table 4, the simple correlations presented indicate that the relationships between students' perceptions of the six WIHIC scales (SC, TS, INV, TO, CO, and EQ) and academic achievement were positively and statistically significant ($p < 0.01$) across all scales. According to the outcome sizes (r-values), the results show a modest but positive relationship between the CLE and students' academic achievement. These results indicate that in Biology classrooms where students cooperate in studying, have teacher support, and are involved, task-oriented, and treated equally, students' academic achievement in Biology increases.

Besides, the multiple relationship (*R*) between each WIHIC scale and academic achievement was statistically significant ($p < 0.01$). Considering this result, the way students perceive CLE accounted for approximately 51% of the change in students' academic achievement in Biology. The coefficients in regression (*β*) showed that different scales of the WIHIC, like SC, TS, and TO, were statistically significant ($p < 0.01$). This coefficient was positive, implying that when students perceive their Biology CLE to have good relationships with students, support from teachers, and a clear orientation on what they are supposed to do, their achievement in Biology is likely to be better.

4.5. Associations of Students' Attitude with Academic Achievement in Biology

The associations between students' perceptions of CLE and academic achievement in Biology were examined using simple and multiple correlation coefficients, as well as the standardized regression Coefficient (*β*). Table 5 shows the results.

Table 5. Associations between the BAQ Scales and Academic Achievement in terms of Simple Correlation (*r*), Multiple Correlation (*R*), and Standardized Regression Coefficient (*β*)

BAQ Scales	Academic Achievement	
	r	*B*
Interest	0.288**	0.275**
Career	0.538**	0.514**
Importance	0.293**	0.089
Enjoyment	0.263**	0.328**
Multiple Correlation R = 0.544*		

*Significant at $p < 0.01$, N = 449

In Table 5, the simple correlations indicate that the relationships between students' reactions on the BAQ scales (Interest, career, importance, and enjoyment) and academic achievement were positively and statistically significant ($p< 0.01$) for all scales. Furthermore, the multiple correlation (R) between each BAQ scale and academic achievement was statistically significant ($p < 0.01$). According to this result, students' attitudes towards Biology accounted for 54.4% of the variation in academic achievement. Furthermore, the regression coefficient (β) indicated that the different scales of the BAQ, such as interest, career, and enjoyment, were positively associated and statistically significant ($p< 0.01$). The coefficients mentioned were positive, implying that students' positive attitudes towards Biology help improve academic achievement in the subject.

4.6. Differences in Gender Perceptions of the Learning Environment

The means and SD scores for each of the male and female students' perceptions on CLE scales were computed, followed by an independent sample t-test (Table 6).

Table 6. (SD) Represents the Mean, Standard Deviation, and T Stands for *T*-Test Value, and Effect Size, as for (d) it implies (*d*) for Differences in Gender for Every WIHIC Scale.

	Mean		*SD*		Differences	
Scale	Male	Female	Male	Female	*t*	*d*
SC	4.00	4.19	0.80	0.80	2.47*	0.24
TS	4.29	4.07	0.94	0.92	2.48*	0.24
INV	4.20	4.02	0.90	0.93	2.78*	0.20
TO	4.20	4.38	0.85	0.79	2.34*	0.22
CO	3.74	3.96	0.93	0.96	2.51*	0.23
EQ	3.82	4.10	0.87	0.90	3.41**	0.32

Males: N = 225; Females: N = 224

* $p < 0.05$; ** $p< 0.01$;

As shown in Table 6, there were statistically significant gender differences for all WIHIC scales, with females scoring a higher mean than males. The effect size range for these scales was 0.22 to 0.32, which is considered moderate. This implies that female students hold more positive perceptions of CLE than male students.

5. Discussion

The main aim of this study was to investigate the lower secondary school students' perceptions of their Biology CLE in Nyamagabe district, Rwanda, and its association with their attitudes towards Biology and academic achievement. The study first assessed the students' perceptions of their CLE. The findings revealed that students perceived their Biology CLE as unfavorable. Except for the TO scale, the mean item scores for the other WIHIC scales were below 4, indicating that students perceived the activities in those scales less often. These low item mean scores were also found in other previous studies (Shadreck, 2012; Rogers & Fraser, 2022; Yang, 2015).

It was also found that students perceived their Biology CLE as sometimes or rarely given opportunities to discuss and share their thoughts or answers in their Biology classes. The lack of students' opportunity to discuss and explain their ideas, as perceived by students, reflects that teachers highly dominate the Biology teaching and learning process. Scholars (Byukusenge et al., 2022; Ndayambaje et al., 2021; Nkundabakura et al., 2023; Ntawuhiganayo & Nsanganwimana, 2022) confirmed that in Rwanda, teacher-centered approaches dominated Biology classes. Similar findings were also reported in other countries, such as China (Yang, 2015) and Nigeria (Precious & Feyisetan, 2020), to mention a few.

The possible explanation of such a teacher-centered teaching approach is an examination culture where the teachers' purpose is to help students master knowledge that they replicate during exams (Byukusenge et al., 2022; Yang, 2015). Another explanation is the large class sizes in most Rwandan secondary schools, coupled with limited pedagogical resources such as textbooks and laboratory materials (Nizeyimana et al., 2021; Nsengimana, 2021; Kwok, 2024). Consequently, owing to large classes and stress to cover all syllabus contents, most Biology teachers tend to employ traditional expository methods such as lecturing, as it allows teachers to cover large amounts of content in a short time to complete the required teaching tasks. In this CLE, students are limited to having the chance to freely exchange their ideas with their fellow educators, air out their views, and have the opportunity for cooperation.

In addition, this study found a positive relationship between students' perceptions of the CLE and their attitudes toward Biology. This finding is in line with previous research in the area of education carried out in Biology (Zeidan, 2010), and concerning a wide range of subjects (Afari et al., 2013; Karpudewan & Meng, 2017; Peer & Fraser, 2015; Rogers & Fraser, 2022; Shadreck, 2012; Yang, 2015). The findings suggest that the more students perceive the CLE favorably, the more likely they are to develop a positive learning attitude. Specifically, this study found that all six WIHIC scales were positive, independent, and statistically significant predictors of interest, five WIHIC scales were positive, independent, and statistically significant predictors of career, and three WIHIC scales were positive, independent, and statistically significant predictors of enjoyment of Biology lessons.

These findings replicate the positive relationship between the learning environment and interest, career, importance, and enjoyment in Biology in previous studies of science subjects (Karpudewan & Meng, 2017; Shadreck, 2012) and other subjects such as Mathematics (Khalil & Aldridge, 2019; Robinson & Aldridge, 2022; Su, 2023) and arts (Radovan & Makovec, 2015). The findings imply that in classroom situations where strong task orientation and cooperation are implemented, and where there is equality in students' treatment by teachers, students have a tendency to have more affirmative attitudes toward Biology.

In addition, this study found a positive and significant association between CLE and students' achievement in Biology. This means that the better students perceive the Biology CLE, the higher their academic achievement in the subject. Specifically, the WIHIC scales, such as the SC, TS, and TO, were positive and statistically significant independent predictors of students' achievement. The positive relationship found in this study between CLE and students' achievement is consistent with previous research on students studying Mathematics (Malik & Rizvi, 2018; Yang, 2015; Su, 2023). The findings suggest that when the CLE is cohesive, student and teacher relationships are harmonious, students receive strong support from teachers and have strong task orientation, and students' achievement is relatively good.

Furthermore, the findings revealed a positive and significant association between attitudes and students' academic achievement in Biology. This suggests that the more positive a student's attitude towards Biology learning, the higher their academic achievement in the subject. Specifically, the study found that all BAQ scales were positive, statistically significant, and correlated with achievement. The findings are in line with those of Chi et al. (2017), Hacieminoglu (2016), Su (2023), and Zheng et al.(2019). However, the findings contradict those of Brooks (2011) and Salmi et al. (2016), who found no significant relationship between students' attitudes and achievement.

Finally, the findings revealed that females had more favorable perceptions of the Biology learning environment than males. Similar findings were also reported by (2010) in the Biology classroom, Shadreck (2012) in the science classroom, and Deieso and Fraser (2019), Taylor and Fraser (2013), and Liu and Fraser (2013) in Mathematics and English classrooms, respectively. The authors explained that females usually develop closer relationships with their teachers, representing a kind of friendship, mutual respect, and appreciation, which, in turn, may positively affect their perceptions of the learning environment.

6. Conclusion

This study examined whether students' perceptions of the classroom learning environment and attitudes towards Biology were interrelated, and whether these perceptions and attitudes could predict academic achievement in Biology. The results of the correlation and regression analyses indicated a positive and significant association among the learning environment, attitudes, and academic achievement in Biology. This suggests that CLE has a considerable positive impact on students' attitudes towards and achievement in Biology. This supports the notion that the nature of CLE strongly influences students' attitudes toward the subject, which in turn can enhance academic achievement. Therefore, the more students perceive the CLE favorably, the more likely they are to develop positive attitudes and achieve academically well, and vice versa. Additionally, the study found that females perceive the CLE more positively than males do.

The findings of this study indicate a significant association between CLE and attitudes, and both CLE and attitudes have a significant positive influence on academic achievement in Biology. Therefore, these findings can help Biology teachers improve students' academic achievement in Biology by creating a conducive CLE and promoting positive attitudes towards the subject, irrespective of gender.

7. Suggestions

Based on the findings of this study, it was recommended that school authorities evaluate the need for professional development to assist teachers in improving the Biology classroom learning environment and other science subjects. Additionally, the Ministry of Education should consider improving the learning environment, particularly regarding the CLE in schools. In addition, Biology teachers should use learner-centered teaching strategies to enhance students' active participation in the learning process. This may improve the learning environment and foster positive attitudes towards Biology among learners, which in turn can enhance academic achievement in the subject.

Declarations

Author Contributions. BE: Conceptualization, literature review, methodology investigation (data collection and analysis), writing the original draft. TGJ: Conceptualization, methodology, review, and improvement of the original draft. SB: Conceptualization, literature review, methodology, investigation (data collection and analysis), writing, and reviewing the original draft. All authors have read and approved the published version of the article.

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