Comparative Effects of Virtual and Jigsaw Learning Strategies on Secondary School Students' Chemistry Motivation

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ABSTRACT

The study compared the effects of virtual and jigsaw learning strategies on secondary school students' chemistry motivation in Taraba State. A quasi-experimental research design was adopted for the study. The population comprised 6683 secondary school two (SS 2) students and a sample size of 183 was obtained through purposive sampling where two intact classes were sampled. A total of 86 students were in the virtual learning group while 97 students were in the jigsaw learning group. Chemistry Motivation Questionnaire (CMQ) was used for data collection. The instrument was validated by two experts of Science Education and one expert in Measurement and Evaluation; all from Taraba State University, Jalingo. A pilot test was conducted and Cronbach alpha reliability coefficient of CMQ was found to be 0.93. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The study found a significant difference in the chemistry motivation of students in favour of virtual learning strategy ($p<0.05$). There was no significant gender difference and no significant strategies-gender interaction effects on chemistry motivation of the students ($p>0.05$). It was concluded that virtual learning strategy improves students' motivation in chemistry more than jigsaw learning strategy. It was recommended among others that chemistry teachers should utilise virtual learning strategies (such as PhET and Labster) in providing virtual chemistry lessons for students as a means of improving their chemistry motivation at the secondary school level.

Keywords: Virtual learning, jigsaw learning, motivation, gender, chemistry

INTRODUCTION

In many developing countries, including Nigeria, science education is considered a cornerstone for economic growth and sustainable development. Consequently, improving the quality of science teaching and learning at all levels of education remains a major priority. Within the domain of science education, chemistry occupies a central position alongside other science subjects due to its relevance to everyday life and its contribution to fields such as medicine, agriculture, engineering, and industry. Jack et al. (2025) posited that the teaching and learning of chemistry contributes to national development. Effective chemistry education requires learner's recognition of the importance of chemistry and the willingness to interact and participate in the learning process hence the need for motivation.

Motivation is often characterised as a psychological factor that determines learners' attendance, perseverance, and achievement in science subjects (Kamran & Akram, 2025). Students' motivation in learning chemistry refers to their interest, willingness, and drive to participate actively in learning activities and to persist in understanding complex concepts. Nnoli and Onyekpudoro (2026) asserted that motivation could be fuelled by intrinsic factors like passion and curiosity, or extrinsic factors such as rewards and recognition. High motivation has been linked to deeper understanding and improved achievement (Kamberi, 2025). Therefore, enhancing students' motivation has become a critical concern for educators and researchers. Studies (Akram et al., 2017; Nikolic & Nicholls, 2018; Steidtmann et al., 2023) have shown that students' motivation and interest in science, especially chemistry, has declined. Chemistry learning motivation could be enhanced if students enjoy the learning process and grasp a sense of importance accompanying studying chemistry. In other words, chemical concepts should be made relevant and relatable, enabling students to connect classroom lessons to real world problems. Abstract concepts, limited instructional resources and wrong teaching strategies are some factors that compound students' motivation in chemistry and consequently hampering effective learning.

Motivation in learning is not independent of instructional practices; rather, it is could be strongly influenced by the teaching strategies employed in the classroom. Conventional lecture-based methods, which are still prevalent in many Nigerian schools, often position students as passive recipients of knowledge, thereby limiting their engagement and intrinsic motivation. This necessitates the comparison of innovative, student-centred learning strategies in local contexts so as to furnish the chemistry teacher with empirical evidence of their effectiveness with regards to motivation. One such innovative approach is the virtual learning strategy, which utilizes digital tools and simulations to enhance teaching and learning. Herdhiana (2023) posited that virtual learning refers to methods of study that are enhanced by digital technology and includes blended learning which involves in-person classes as well as the use of online tools like webinars and virtual labs among others. Platforms such as Physics Education Technology (PhET) Interactive Simulations and Labster provide virtual experiences that allow students to visualize abstract chemical processes. These platforms were used in the present study to provide virtual learning experiences for students.

Concepts such as thermodynamics, chemical reaction, and hydrocarbon nomenclature among others can be visually presented and learned through virtual platforms. Abstractions in chemistry learning are greatly minimized with virtual learning. Generally, being learner-centred, technology-assisted learning usually appeals to the learners as it represents a drift from the conventional chalk and talk method they are accustomed to. Studies on the outcome of students' motivation after virtual or technology-based intervention have produced mixed results. For instance Ghorbani et al. (2020) observed that motivation among e-learning students is higher than that of conventional learning students. However, Aslan and Duruhan (2021) found that motivation of students taught with virtual learning environment did not significantly differ with those taught without virtual learning. In addition Bulic and Blazevic (2020) revealed that there is no statistically significant difference in motivation between students taught aided by online classes and those taught without online classes. The variations in virtual learning strategy's effectiveness with regards to motivation leave room for more studies to be conducted in this regards; especially a comparison between the strategy and other robust strategies such as jigsaw learning strategy.

Jigsaw learning strategy is a cooperative learning technique that promotes collaboration and peer teaching. In the jigsaw method, students are divided into groups, and each member is assigned a specific portion of the learning material. Students first become "experts" in their assigned topics and then teach their peers within their groups. Students first assemble into small groups to meet with members of other groups and then after mastering the material return to their own groups to teach the material to their team members (Taylor, 2023). With this strategy, every student of a team serves as a piece of the topic's puzzle and needs to work together as a whole to complete the jigsaw puzzle (Taylor, 2023). By fostering a sense of responsibility and teamwork, the jigsaw strategy helps students become more engaged and confident learners. Empirically, Alfaruqy (2021) and Blajvaz et al. (2022) both reported that learning through jigsaw strategy improves students' motivation. This strategy encourages active participation, accountability, and social interaction, all of which could enhance students' motivation even though there is need to further research on its motivation enhancement efficacy in comparison to virtual learning strategy.

In addition to instructional strategies, gender is an important variable that may influence students' motivation in chemistry. Research has shown that differences may exist between male and female students in terms of interest, confidence, and participation in science subjects. Alkan (2023) reported that gender has no significant effect on the dimensions of chemistry motivation, laboratory anxiety, and self-efficacy beliefs. Salsabila et al. (2023) found that gender significantly influences motivation. Similarly, Huda and Rohaeti (2023) also reported that gender influences motivation to learn chemistry with female students having higher incentive to learn chemistry than male although the correlation is not large. The differences in findings necessitate further research on this course. This study compared virtual and jigsaw learning strategies' effectiveness on students' chemistry motivation with gender moderating the exploration.

Research Questions

i. What is the difference in the mean motivation ratings of students taught chemistry using virtual and jigsaw learning strategies?

ii. What is the difference in the mean motivation ratings of male and female students taught chemistry with virtual and jigsaw learning strategies?

iii. What is the interaction effect of strategies and gender on students' motivation in chemistry?

Null Hypotheses

Ho1: There is no significant difference in the mean motivation rating of students taught chemistry using virtual and jigsaw learning strategies.

Ho2: There is no significant difference in the mean motivation rating of male and female students taught chemistry with virtual and jigsaw learning strategy.

Ho3: There is no significant interaction effect of strategies and gender on students' motivation in chemistry

METHODOLOGY

The research design used for the study was a quasi-experimental design involving pre-test and post-test. The study was conducted in Jalingo Education Zone of Taraba State. The population of the study comprised 6683 secondary school two (SS 2) students taking chemistry in the Zone. The sample size of the study was 183 students. Purposive sampling technique was used for sampling where school with functional computer gadgets needed for virtual learning were considered. An additional consideration for purposive sampling was the qualification of the chemistry teachers as only schools where teachers with B.Sc. (Ed.) degree in chemistry and above were considered. Two intact classes were sampled eventually sampled. A total of 86 students were in the virtual learning group while 97 students were in the jigsaw learning group. This was the total number of students in the two purposively selected classes. A 20-item Chemistry Motivation Questionnaire (CMQ) was used for data collection. The questionnaire items were on a four-point scale of strongly agree, agree, disagree and strongly disagree (SA, A, D and SD). The instrument was validated by two experts of Science Education and one expert in Measurement and Evaluation all from Faculty of Education, Taraba State University, Jalingo. A pilot test was conducted in Zing Education Zone which is not part of the study area and the data obtained was used to determine the reliability of the instrument. Cronbach alpha reliability index of CMQ was found to be 0.93 implying CMQ is suitable for data collection in the study. The exercise lasted six weeks. Students were given pre-test in the first week, four weeks of teaching followed where students in the virtual and jigsaw learning groups were taught thermodynamics and hydrocarbons nomenclature. After teaching, post-test was administered. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Administration: Detailed Implementation Procedure

First, permission to conduct the study was obtained from the principals of the two sampled schools. In the first week, the researchers interfaced with the research assistants who were the regular chemistry teachers of the sampled schools. The research assistants were briefed on the implementation of the learning strategies: how to access the PhET and Labster Simulations as tools for virtual chemistry instructions, implement the jigsaw learning strategy in the classroom and they were provided with four lesson plans for virtual jigsaw learning strategy and four lesson plans for jigsaw learning strategy. Upon conclusion of the briefing, students were given pre-test with CMQ to establish initial groups' equivalence. Thereafter, the real teaching began and lasted for four weeks. Each session lasted 90 minutes. Students were taught four concepts for four weeks: Introduction to thermodynamics, Laws of thermodynamics, saturated hydrocarbons (Alkanes), unsaturated hydrocarbons (alkenes and alkynes).

In the virtual learning group, PhET simulation was utilised for instruction for the first two weeks, covering thermodynamics concepts while Labster simulation was used for instruction in the last two weeks. All the 86 students were provided with internet-enabled computers. For the first topic (introduction to thermodynamics), to access the simulation, students clicked on the address www.phet.colorado.edu/en/simulations/energy-forms-and-changes_all.html after which they clicked on 'Intro' and virtual environment displayed for them to manipulate and interact with under the guidance of the teacher, assisted with the lesson plan. The students' manipulation involved using the mouse (cursor) to virtually lift materials and objects, heat, observe temperature readings and heating process among others. Students were generally allowed to repeat the manipulation as often as they could in order to enable them develop better understanding of the environment and the process. The environment enabled them to infer cause-and-effect relationship as there were means of heating and cooling, pouring and discarding and utilising different materials in line with the concepts of heat, temperature and thermodynamics.

In the Jigsaw group, students also learned 'introduction to thermodynamics' in the first week. Students were divided into groups with five students (home groups). The home groups were labelled A to S. In each group, the students were numbered 1 to 5; consequently, group A had A1, A2, A3, A4 and A5; group B had B1, B2, B3, B4 and B5; this sequencing was maintained for all the groups. Students with label ending with 1 (A1, B1, C1 and so on) formed the first expert group and learned about heat as they were provided with charts, written notes and captions; students with label ending in 2 (A2, B2, C2 and so on) formed the second expert group and learned about temperature changes as they were provided with thermometer and materials with varying degrees of heat content, students with label ending in 3 (A3, B3, C3 and so on) formed the third expert group and learned about conduction as they were given a heat source (stove), diagrams and charts on heat conduction to study; students with label ending in 4 (A4, B4, C4 and so on) learned about convection as they were given a heat source (stove), water in kettle, diagrams and charts on heat convection to study, students with label ending in 5 (A5, B5, C5 and so on) learned about radiation as they were given a heat source (stove), water in kettle, diagrams and charts on heat radiation to study. After the expert groups were done studying, they returned to the home groups where each expert now shared what they learned with other members of the home groups. The teacher facilitated the process as the students were guided into synthesizing what they have learned from each other to form a whole. This procedure was repeated for the remaining three weeks of the teaching exercise.

In the second week, students in the virtual group learned the laws of thermodynamics. They accessed the virtual simulation environment through www.phet.colorado.edu/en/simulations/energy-forms-and-changes_all.html where students selected 'systems' and were presented with a learning environment different from the first one that enabled them manipulate and learn about the first, second, third and zeroth law of thermodynamics and applications. In the jigsaw group, the arrangement of students into 19 home groups (A to S) and five expert groups was retained. The first experts were given charts, ball, toy car so they would learn about the first law; the second expert group was given ice, hot metal, normal water and charts with caption which enable the students study the second law, the third expert group learned about the third law of thermodynamics aided by diagrams, thermometer, materials of different temperature and a table fridge; the fourth group learned the zeroth law of thermodynamics after being provided with thermometers, water in different temperature. The fifth expert group learned about the applications of the laws in real life. The students then went back to their home groups where they discussed what they have learnt with their peers and the teacher guided the synthesis of the fragmented learning.

For virtual students, in the last two weeks, Labster was accessed through www.labster.com were students' were given the password that enabled them access the organic chemistry simulation and learned how alkanes, alkenes and alkynes are structured and named. For students in the jigsaw group, in the last two weeks, the same home and expert groups arrangement were maintained; in the third week, the five expert groups learned about introduction, properties, IUPAC rules, nomenclature of normal and branched and alkanes. In the fourth week, the five expert groups learned about introduction, properties, IUPAC rules, nomenclature of normal and branched and alkenes and alkynes.

RESULTS

The results have been presented in the order of the research questions and null hypotheses.

Research Question 1: What is the difference in the mean motivation ratings of students taught chemistry using virtual and jigsaw learning strategies?

Table 1: Mean and Standard Deviation of Motivation Ratings of Students taught Chemistry using Virtual Learning Strategy and those taught using Jigsaw Learning Strategy

Strategies		**preCMQ**	**postCMQ**	**mean gain**
VLS	Mean	2.19	3.63	1.44
	N	86	86	
	Std. Deviation	0. 31	0.23	
JLS	Mean	2.19	3.34	1.15
	N	97	97	
	Std. Deviation	0.41	0.30	
Mean difference				**0.29**

Table 1 shows the mean motivation ratings of students taught chemistry through virtual learning strategy (VLS) and those taught with jigsaw learning strategy (JLS). At pre-test, students in the VLS group had a mean rating of 2.19 which at post-test, increased to 3.63 representing a mean motivation rating gain of 1.44. Students in the JLS group had a mean motivation rating of 2.19 at pre-test; at post-test, the students' mean motivation rating increased to 3.34. This represents a gain of 1.15. The difference between the gains of the two groups is 0.29. This means that students in the VLS group showed slightly higher motivation ratings than students in the JLS group. This implies that when two groups of students are taught chemistry with VLS and JLS, both groups of students will develop increased motivation to study chemistry; however, student taught with VLS will show slightly higher motivation (intrinsic commitment) to learn chemistry.

Research Question 2: What is the difference in the mean motivation ratings of male and female students taught chemistry with virtual and jigsaw learning strategies?

Table 2: Mean and Standard Deviation of Motivation Rating of Male and Female Students Taught Chemistry Using Virtual Learning Strategy

Gender VLS		**preCMQ**	**postCMQ**	**mean gain**
Male	Mean	2.22	3.68	1.46
	N	42	42	
	Std. Deviation	0.32	0.22	
Female	Mean	2.15	3.59	1.44
	N	44	48	
	Std. Deviation	0.30	0.24	
Mean difference				**0.02**

Table 3: Mean and Standard Deviation of Motivation Rating of Male and Female Students Taught Chemistry Using Jigsaw Learning Strategy

Gender JLS		**preCMQ**	**postCMQ**	**mean gain**
Male	Mean	2.08	3.33	1.25
	N	42	42	
	Std. Deviation	0.43	0.32	
Female	Mean	2.27	3.34	1.07
	N	55	55	
	Std. Deviation	0.37	0.29	0.18
Mean difference				

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Table 2 and 3 compares the mean motivation ratings of male and female students taught chemistry with virtual and jigsaw learning strategies. In the virtual learning strategy group, as shown in table 2, male students had mean motivation rating of 2.22 at pre-test and 3.68 at post-test, a mean gain of 1.46. Female students had a mean rating of 2.15 at pre-test and 3.59 at post-test showing a mean gain of 1.44. The difference in gain is 0.02 in favour of male students. Table 3 shows that in the JLS group, male students had mean motivation rating of 2.08 at pre-test and 3.33 at post-test, representing a mean gain of 1.25. The female students had a mean motivation rating of 2.27 at pre-test and 3.34 at post-test representing a mean gain of 1.07. This represents a gain difference of 0.18 in favour of male students. By comparison, male students gained more motivation than their female counterparts in both VLS and JLS groups. However, this difference is more observable in the JLS group.

Research Question 3: What is the interaction effect of strategies and gender on students' motivation in chemistry?

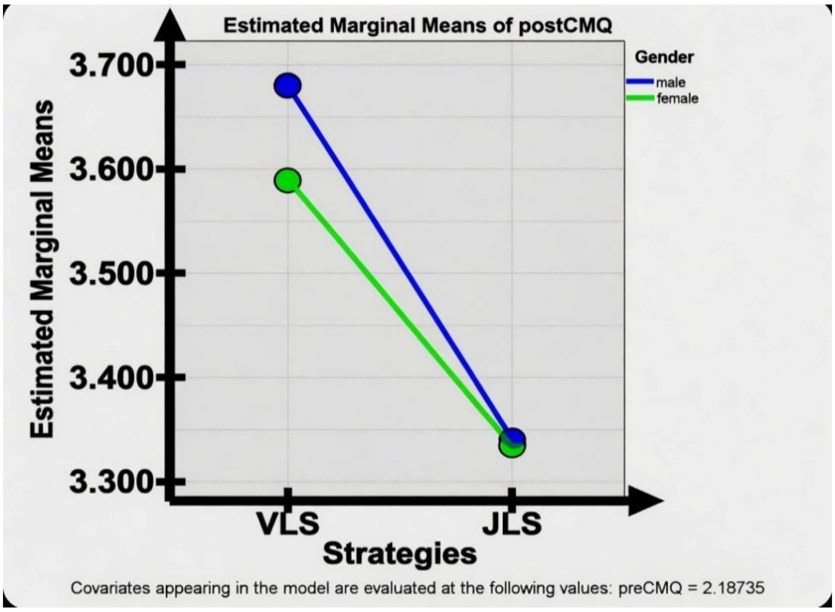

Figure 1: Plot of Interaction Effect of Strategies and Gender on Students' Motivation Ratings

Figure 1 shows the plot of interaction effect of strategies and gender on students' mean motivation ratings. An interaction effect is shown by intersection of the two lines representing male and female motivation ratings. The figure indicates that the two lines meet towards the JLS axis. This means that there is an interaction effect of the strategies and gender on students' motivation ratings.

Null Hypotheses

Ho1: There is no significant difference in the mean motivation rating of students taught chemistry using virtual and jigsaw learning strategies.

Table 4: One-Way ANCOVA of Motivation Rating of Students taught Chemistry using Virtual Learning Strategy and Jigsaw Learning Strategy

Dependent Variable: postCMQ

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	4.141a	2	2.070	28.234	.000	.239
Intercept	54.603	1	54.603	744.668	.000	.805
preCMQ	.111	1	.111	1.511	.221	.008
Strategies	**4.033**	**1**	**4.033**	**55.004**	**.000**	**.234**
Error	13.199	180	.073			
Total	2228.395	183				
Corrected Total	17.339	182				

Table 4 shows the ANCOVA result of the difference in students' motivation ratings between students taught with VLS and JLS. The table shows that F(1, 180) = 55.004 and significance value is = 0.000. Since the significant value is lower than the benchmark 0.05, the result infers that there is a significant difference in the motivation ratings of students taught chemistry with VLS and JLS in favour of VLS since students in VLS had higher mean motivation gain from Table 1. Therefore, null hypothesis 1 is rejected. The partial eta squared value is 0.234. This means 23.4% of the differences in students' mean motivation rating is accounted for by the learning strategy used.

Ho2: There is no significant difference in the mean motivation rating of male and female students taught chemistry with virtual and jigsaw learning strategy.

Table 5: One-Way ANCOVA of Motivation Ratings of Male and Female Students Taught Chemistry with Virtual Learning Strategy

Dependent Variable: VpostCMQ

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	.200a	2	.100	1.907	.155	.044
Intercept	21.394	1	21.394	408.835	.000	.831
VpreCMQ	.010	1	.010	.187	.667	.002
Vgender	**.178**	**1**	**.178**	**3.407**	**.068**	**.039**
Error	4.343	83	.052			
Total	1139.977	86				
Corrected Total	4.543	85				

Table 6: One-Way ANCOVA of Motivation Ratings of Male and Female Students Taught Chemistry with Jigsaw Learning Strategy

Dependent Variable: JpostCMQ

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	.096a	2	.048	.523	.594	.011
Intercept	30.396	1	30.396	329.556	.000	.778
JpreCMQ	.096	1	.096	1.042	.310	.011
Jgender	**.003**	**1**	**.003**	**.034**	**.855**	**.000**
Error	8.670	94	.092			
Total	1088.418	97				
Corrected Total	8.767	96				

Table 5 and 6 presents the ANCOVA result of gender difference in students' motivation ratings in the two groups. Table 5 shows that F (1, 83)= 3.407, significance = 0.068. The significance value is above the benchmark 0.05.This means that there is no significant difference in male and female students' motivation ratings when they are taught with VLS. The partial eta squared value of 0.039 was obtained. This means that about 3.9% of students' difference in motivation is accounted for by gender difference.

On the other hand, Table 6 shows that F (1, 94) = 0.034; significance = 0.855. The significance value is above the benchmark 0.05.This means that there is no significant difference in male and female students' motivation ratings when they are taught with JLS. The partial eta squared value of 0.000 indicates that 0% of the students' variation in motivation ratings is as a result of gender. The significance values in both table 5 and 6 show that hypothesis 2 is accepted as there is no observed significant difference in the motivation ratings of male and female students taught chemistry using VLS and JLS.

Ho3: There is no significant interaction effect of strategies and gender on students’ motivation in chemistry.

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Table 7: Two-Way ANCOVA of Interaction Effect of Strategies and Gender on Students Motivation Ratings

Dependent Variable: postCMQ

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.315a	4	1.079	14.742	.000	.249
Intercept	52.945	1	52.945	723.575	.000	.803
preCMQ	.095	1	.095	1.294	.257	.007
Strategies	4.009	1	4.009	54.788	.000	.235
Gender	.108	1	.108	1.477	.226	.008
Strategies * Gender	**.072**	**1**	**.072**	**.981**	**.323**	**.005**
Error	13.024	178	.073			
Total	2228.395	183				
Corrected Total	17.339	182				

Table 7 shows that that F (1, 178) = 0.981; sig = 0.323. Since the significance is above 0.05, it means there is no significant interaction effect of strategies and gender on students' chemistry motivation ratings. Consequently, null hypothesis 3 is accepted. The partial eta squared value is 0.005. This means that only about 0.5% of the variation in students' motivation ratings is attributable to the interaction between the two strategies and gender.

DISCUSSION OF FINDINGS

The study found that students who were taught chemistry using virtual learning strategy (VLS) showed higher motivation than students taught same concepts with jigsaw learning strategy. Students taught with virtual platforms like PhET and Labster may have experienced higher motivation because these tools provide interactive, visually rich, and immediate feedback, which can make abstract concepts more engaging and easier to understand. This observation demonstrates the effectiveness of VLS and aligns with previous related research studies that have established the effective of the strategy. The finding corroborates Ghorbani et al. (2020) who observed that the mean of motivation ratings among the e-learning students is higher than the conventional learning students. However, it disagrees with Aslan and Duruhan (2021) who found that motivation of students taught with virtual learning environment design didn’t significantly differ with those taught without virtual learning. It further disagrees with Bulic and Blazevic (2020) who revealed that there is no statistically significant difference in motivation between the tested sub-samples of experimental (taught aided by online classes) and control groups (taught without online classes). The autonomy and control students have when exploring simulations at their own pace may also have played a crucial role in enhancing intrinsic motivation. In contrast, jigsaw learning relies heavily on peer collaboration, which may be less motivating for students who feel unprepared, anxious, or dependent on others’ contributions.

The study found that although male students showed slightly higher motivation gain, there was no significant difference in the motivation rating of male and female students taught chemistry with VLS and JLS. This means that both strategies are gender friendly. This also infers that the strategies likely provided equal opportunities for both male and female students to enhance their motivation. The observation that VLS is gender friendly agrees with Anari et al. (2025) who found no significant gender difference in students' motivation. It also is consistent with Hagos and Andargie (2022) who found that when technology is integrated into classroom learning, gender has no effect on students' motivation. However, it is not in uniformity with Roy and Sarkar (2025) who found male students to have exhibited higher academic motivation compared to female students. Gender indifference in students' motivation in JLS is consistent with the findings of Josiah (2024) and Keter et al. (2016) who observed that jigsaw and cooperative strategies improves students' motivation with no significant gender differences. It also aligns with the result obtained by Mohammad (2024) which revealed that male and female science students did not differ in science motivation. The absence of a significant difference suggests that both male and female students responded similarly to the instructional strategies, indicating that motivation gains may be more influenced by the teaching strategies as and not by gender. Virtual learning and jigsaw strategies are designed to foster collaboration, engagement, and active participation, which benefit learners regardless of gender.

The study found no significant interaction effect of strategies (VLS and JLS) and gender on students' motivation rating. This is in agreement with Anari et al. (2025) who also reported no significant interaction effect of strategies and gender on students' motivation. It also agrees with Hagos and Andargie (2022) who found no significant interaction impact of strategies and gender on students' motivation. This confirms that the effectiveness of the two strategies on students’ motivation in chemistry does not depend on the gender of the students receiving instruction; emphasising that both male and female students will achieve at same levels should they be taught with these strategies.

CONCLUSION

Based on the findings of the study, it could be concluded that virtual learning strategy improves students’ motivation in chemistry more than jigsaw learning strategy. Similarly, utilisation of both virtual learning strategy and jigsaw learning strategy will neither make female students better than male students nor make male students better than female students with regards to their motivation in chemistry learning.

RECOMMENDATIONS

The following recommendations have been proffered.

1. Chemistry teachers should utilise Physics Education Technology (PhET) and Labster in providing virtual chemistry lessons for students as a means of improving their motivation towards chemistry.
2. Male and female students should be allowed to access virtual learning platforms as the study has shown that both genders would gain from the strategy.
3. Jigsaw learning strategy could be used by chemistry teachers in remediating gender disparity in students' chemistry motivation.

LIMITATIONS

It is important to highlight the limitations of the study which were beyond the researchers’ control:

1. The study purposively sampled two schools in Jalingo Education Zone of Taraba State. This may limit the generalizability of the findings to other Zones in the State.
2. The absence of adequate and functional computers in most of the schools and the need to make the study more manageable and more precise led to the selection of two intact classes.
3. The study utilised no control group, as such, it will not be able to provide the effectiveness of each of the two strategies in comparison to the conventional learning strategy in the Zone.
4. A total of 97 students were in the jigsaw learning group, 19 expert groups of 5 students each were assembled which leaves two students without a group. These students were merged into the S home group which made the S-group have 7 students as against 5 students in each of the 18 other groups. The two remaining students maintained the label S5 which meant three students in the group were labelled S5.

Ethical Consideration

Permission was sought and obtained from the Principals of the two selected schools that participated in the study. Upon obtaining permission, the study was conducted in intact class and the schools’ regular activities were not disrupted.

Conflict of Interest

The Authors have no conflict of interest.

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