Effects of Computer Supported Collaborative Learnings on Secondary School Students' Academic Achievement in Chemistry

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Abstract

The study looked at how Computer Supported Collaborative Learning (CSCL) affects secondary school students' academic performance in Chemistry. There were two research questions, and two hypotheses were examined at the 0.05 alpha level. The design used was quasi-experimental, specifically a pretest-posttest nonrandomized control group. The study population of the study was 3,441 SS2 chemistry students. Samples of 103 students were chosen using purposeful and random selection approaches. The data-gathering instruments were the Chemistry Achievement Test (CAT), which was validated by three specialists. The reliability of CAT was determined using the Kuder-Richardson Formula 20, which resulted in coefficients of internal consistency of.88.Mean and standard deviation were utilized to answer research questions while the hypotheses were tested using analysis of covariance. According to the study, students who received chemistry instruction using CSCL outperformed those who received instruction by DTI in terms of mean achievement scores. There was also a substantial difference in mean achievement scores between students taught Chemistry utilizing CSCL and Direct Teacher Instruction (DTI), with CSCL coming out on top. The study found no significant influence of gender. It was suggested that chemistry educators should provide a rich learning environment and experience for their students by utilizing instructional group studies, which may be accomplished with the help of computers and collaborative software tools.

Keywords: Computer, Achievement, Chemistry

1. Introduction

The collaborative learning and instruction strategy enables students to actively participate in the processing of new content by working in groups rather than relying exclusively on remembering techniques. Collaborative learning can occur in larger groups or between peers. Peer instruction, also referred to as peer learning, is one kind of cooperative learning in which students share ideas or solve problems in small groups or pairs (Igboanugo, 2021). According to educational experts, peer instruction allows students to teach one another by discussing and dispelling misconceptions, similar to the notion that three or two brains are superior to one.

According to research (Amir, 2023; Du-Plessis, 2023), learning takes place more thoroughly when educational experiences are student-owned, active, social, contextual, and engaging. However, the challenge for teachers when incorporating collaborative learning approaches into the learning process is determining how best to foster interaction among students as well as interaction with learning materials (Jeong, Hmelo-Silver & Jo, 2019,

Avwiri, 2020). There is also the issue of maintaining good contact among students inside groups, as well as between groups within and outside of school. However, educators urge for the use of computer technology to facilitate student connection. Computer Supported Collaborative Learning (CSCL) originated as a result of the use of computer technology to facilitate student interaction with learning materials.

Cooperative or collaborative learning (CL) laid the groundwork for and transformed computer-supported collaborative learning (CSCL), a learning strategy that employs computer technology to assist peer collaboration, exchanges discussion, and discussion, as well as student-teacher exchanges, in order to help achieve the goals of knowledge creation and sharing (Ergün, 2019). The premise of CSCL is that technology can effectively enable collaborative knowledge production and problem solving. As a result, the cornerstone of CSCL is based on how computers are used in business and industry to facilitate collaborative work environments. In these circumstances, computers are used to improve, redefine, and/or facilitate classmate interactions. In CSCL, computers are used to enable and redefine classroom interactions, both between students and teachers and between students and members of the greater, out-of-school community (Gijlers & deJong, 2013, Avwiri, 2016). These interactions are included into an educational learning environment. Thus, computer-supported collaborative learning (CSCL) is a teaching method in which students use computers to facilitate interactions with teachers and one another.

CSCL encompasses a wide range of technologies, including email, bulletin boards, the Internet/World Wide Web, collaborative groupware systems such as Computer-Supported Intentional Learning Environments (Integrated Writing Environments, or DIWE), and message boards. Zoom and Telegram-X was the computer programs used in this study. It has been discovered that CSCL technologies makes it easier to create collaborative learning communities, especially when classes are connected. to a larger relevant learning culture. Talan (2021) meta-analysis of CSCL discovered that CSCL, or computer-supported collaborative learning, enhanced academic achievement. Vega, Stanfield, & Mitra (2020) discovered that CSCL increased elementary students' reading comprehension with less teacher interaction than those who did not receive the therapy using internet-enabled computer collaboration. Recent research syntheses have identified CSCL's good effects while also highlighting its limitations (Gress, Fior, Hadwin, & Winne, 2010; Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2012). Despite these limitations, CSCL has the potential to increase students' academic performance in Chemistry.

Watts (2013) defines academic achievement as an individual's average final exam score. Gambari & Yusuf (2016) defined academic achievement as a student's ability to learn and retain information, as well as articulate that knowledge in writing or verbally, even under test settings. Thus, a student's grades or test scores reflect their academic achievement. Chemistry students' performance has fallen short of expectations, especially on external exams. The most common factor contributing to this lack of good academic accomplishment in chemistry is the manner in which chemistry teachers instruct the subject. Chemistry teachers frequently use traditional instructional methods such as lectures, discussions, and direct teacher instructions, which are often teacher-centered. Given the difficulty in implementing computer-supported collaborative learning among chemistry teachers, one wonders if the method can be useful in enhancing students' academic achievement in chemistry. As a result, it is necessary to undertake a study to investigate the potential effects of CSCL on students' academic progress in Chemistry.

Examining the impact of CSCL is necessary since male and female secondary school students continue to perform differently in chemistry. According to recent surveys conducted in the developed world, girls are surpassing males in almost every subject at all educational levels, indicating a reversal of the gender gap in academic performance (Wrigley-Asante,

Ackah, & Frimpong, 2023). According to Day, Corbett, and Boyle (2020), women make about one-third of chemistry researchers on average, however this varies significantly by sub-discipline. Over the past five years, women have also submitted fewer publications to science journals than men. According to Hsiu-Yi, John, Mark, & Mei-Hung (2024), this gender disparity was seen among industry respondents from both high and low Human Development Index (HDI) areas. On the other hand, gender differences by occupation were minimal.

Among secondary school students, gender disparities in chemistry academic achievement have also been noted (Konyefa, 2023). Male students who received chemistry instruction using an adaptive learning approach did better than female students, according to Izuegbunam's (2023) findings. On the other hand, Nnamani & Oyibe (2016) found that the mean achievement scores of female secondary school students were greater than those of male students. Nwankwo (2018) found a significant difference between male and female mean achievement scores, but Rafiee, Pazhakh, & Gorjian (2014) found no significant difference. Further study on the impact of gender on students' academic performance in chemistry is necessary, as evidenced by the gender gap in chemistry attainment.

The statement of the problem is: 1) Is there any difference between the mean achievement scores of students taught Chemistry using Computer Supported Collaborative Learning (CSCL) and those taught using direct teacher instruction (DTI)?
2) Do teaching strategies and gender impact students' academic achievement in chemistry?

2. Review of Related Literature

2.1 Effects of Computer-Supported Collaborative Learning (CSCL)

Gambari & Yusuf (2013) researched improving physics students' retention and attitude with a computer-supported team-assisted individualization technique. The study sought to investigate how cooperative learning using computer-supported Team Assisted Individualization (TAI) might be used as an instructional technique for teaching physics, and might affect students' achievement, retention, and attitude toward the subject. The Covariance and Scheffe tests revealed no significant difference in academic performance across the groups.

Gambari & Yusuf (2016) investigated the influence of the computer-assisted jigsaw II cooperative learning technique on physics achievement and retention. The study sought to explore the impact of a computer-assisted jigsaw II cooperative technique on physics achievement and retention. The data was analyzed using covariance analysis and Scheffe's test. Students who were taught physics via computer-assisted Jigsaw II fared better and kept the physics topics for longer time than those who were taught using individualized computer teaching. In addition, accomplishment levels had a major impact on their performance. Gambari & Yusuf's studies in 2013 and 2016 found that computer-supported collaborative instructional strategies have a significant favourable influence on student academic attainment.

Fakomogbon & Bolaji (2017) revealed similar findings when they investigated the influence of collaborative learning approaches on student performance in a ubiquitous collaborative mobile learning environment. The experiment consisted of six unique groups, five of which were collaborative and one of which was non-collaborative in their learning styles. The six groups are: think-pair-share (TPS), reciprocal teaching (RT), think-aloud pair problem solving (TAPPS), group grid (GG), collaborative writing assignment (GWA), and non-collaborative (NC).The study's data were analyzed using the mean, standard deviation, and multivariate analysis of variance (MANOVA). The results revealed that there were significant gains in the gap between students' pretest and posttest scores during the mobile learning experience, and the think-aloud-pair problem-solving strategy was the most successful collaborative learning style. Furthermore, all collaborative learning styles are more effective at learning in a mobile learning environment than non-collaborative learning styles.

2.2 Effects of Direct Teacher Instruction (DTI) on academic achievement

Olaosebikan & Chizoba (2012) investigated how direct and indirect instructional styles affected students' mathematical achievement. The collected data was examined using Mean (x), Standard Deviation (SD), and t-test analysis. The results of data analysis revealed that the direct teaching approach has a greater effect on student achievement in Mathematics than indirect instructional strategy; there was a significant difference between direct and indirect teaching on student's Mathematics achievement; and gender is a significant factor in determining the effect of direct and indirect instructional strategy on achievement of student in Mathematics, favoring males. Anidi, Obidike, & Anyachebelu (2021) reported similar findings in a study looking into the effect of direct instruction on primary school students' reading comprehension success in Anambra state Awka South Local Government Area. They reported that DI had higher reading achievement than the control group, with a significant difference in mean achievement. Female readers performed better on average than male readers in DI. There was no significant variation in reading comprehension based on gender.

Rubina, Pir, & Ali (2010) found that the direct instruction model had a substantial impact on intermediate class achievement and attitudes regarding English grammar. For three months, the experimental group received direct training, and the control group received traditional instruction. Chi-square and t-tests were used to assess the null hypotheses, 05 is the level of significance. The Direct Instruction Model routinely outperformed traditional instruction, both in terms of achievement and attitude. After six weeks, students taught through DI demonstrated improved retention.

2.3 Influence of Gender on Students' Academic Achievement

Nnamani & Oyibe (2016) conducted a study on the gender and academic achievement of secondary school students in social studies in Abakaliki, Ebonyi state. The study sought to investigate the gender's influence on secondary school students' academic ability in social studies. For all study topics, data were analyzed using mean and standard deviation, and the null hypotheses were tested using an analysis of covariance (ANCOVA). The study's findings showed that female secondary school students had higher mean accomplishment scores than male students. The study's findings also found that social studies were taught to both male and female secndary school students by male professors scored higher on average compared to female professors who taught social studies to both male and female students. The survey also found that there is a substantial difference in the average social studies performance of secondary school students by gender

These findings from Nnamani & Oyibe (2016) differ from those of Baran (2016), who investigated disparities in high school students' interest in physics by gender. Data were collected using a standardized interview form. The research data was examined using frequency, chi-square, and content analysis. The findings of the analysis revealed no discernible difference between male and female students' interests in physics. Furthermore, male students were shown to be more knowledgeable of advances in physics than female students.

Some of the conclusions on the field of chemistry matched with those of Baran (2016). Abungu, Okere, & Wachanga (2014), who investigated the effect of a teaching technique for science process skills on boys' and girls' chemistry achievement in Nyando district, found that boys scored higher on the CAT pre-test than girls, but there were no statistically significant differences in pre-test mean scores between boys and girls in the Experimental Group. The findings of Rafiee, Pazhakh, & Gorjian (2014), who conducted a study on the function of self-directed learning in building speaking skills among Iranian EFL learners at various competence levels, concurred further. The data collected from the instruments were analyzed using one-way analysis of variance (ANOVA) and the t-test to determine whether the differences between

the three groups were statistically significant. The t-test between gender-based means revealed no significant difference in male and female means. However, Nwankwo's (2018) findings were drastically different. Nwankwo (2018) examined the effect of activity-based education on students' accomplishment and acquisition of scientific process skills in basic science. The study sought to investigate the impact of activity-based education on students' accomplishment and development of science process skills in basic science. The data were examined using the mean to answer research questions, standard deviation to determine how near the students' scores are to the mean, and Analysis of Covariance (ANCOVA) to test the hypotheses at the 0.05 level of significance. The results revealed a substantial difference in the mean accomplishment scores of male and female students in the experimental group.

3. Research Questions

3.1 What are the mean achievement scores of students taught Chemistry using Computer Supported Collaborative Learning (CSCL) and those taught using direct teacher instruction (DTI)?

3.2 What is the interaction effect between instructional approaches and gender on students' academic achievement in Chemistry?

4. Research Objectives

To determine the effects of computer-supported Collaborative learning on academic achievement of secondary school students in chemistry in Warri South Local Government Area of Delta State. Specifically, the study determined the:

4.1 Mean achievement scores of students who were taught chemistry utilizing Computer Supported Collaborative Learning (CSCL) and those taught using direct teacher instruction (DTI);

4.2 Interaction effect of instructional methods and gender on students' academic achievement in Chemistry.

5. Hypotheses

5.1 There is no significant difference in mean achievement scores between students taught Chemistry utilizing Computer Supported Collaborative Learning (CSCL) and those taught using Direct Teacher Instruction (DTI).

5.2 There is no significant interaction between instructional approaches and gender on students' academic achievement in Chemistry.

6. Research Methodology

The study used a quasi-experimental research approach, namely a pretest-posttest, non-randomized control group design. Figure 1 shows the study's design.

$$\begin{array}{cccc} E & 0_1 & X_1 & 0_2 \\ \hline C & 0_1 & \sim X & 0_2 \end{array}$$

Figure 1: Design of the Experiment

Where,
E = Experimental group one on CSCL
C = Control group on DTI
0_1 = Pre-test
0_2 = Post-test
X_1 = Treatment using CSCL
∼X= No experimental treatment (Direct Teacher Instruction, DTI)
…… = Non-randomized groups

The study focused on the Warri South Local Government Area in Delta State. The study's population consisted of 3,441 (2,382 males, 1,059 females) senior secondary year two (SS2) Chemistry students from Warri South Local Government Area in Delta. The sample size for the study is 103 SS2 students drawn via a multi-stage sampling technique. The data was collected using the Chemistry Achievement Test (CAT). The CAT consisted of a 50-item multiple-choice objective test with five response possibilities lettered A to E covering the principles of basic molecules, their structures, and nuclear chemistry. The CAT questions were based from the standardized West African Examination Council (WAEC) former question exams from 2015 to 2023. A table of specifications was used to map out the content coverage for each notion. Each correct answer on each item of the CAT received two marks.

Three specialists from the Science Education Department and the Department of Educational Foundations (Measurement and Evaluation) at Nnamdi Azikiwe University in Awka checked the Chemistry Achievement Test. The reliability of CAT was determined using the Kuder-Richardson Formula 20 (KR-20), and the reliability coefficient achieved was 0.88. The experiment was conducted in two phases. The initial part involves briefing the research assistants. The briefing lasted one week and consisted of three contacts, each lasting an hour. The second phase involved teaching the students. The experimental group was taught using computer-supported collaborative learning, whereas the control group was taught using direct instructor teaching. Before the treatment, the instruments (CAT) were used as a pretest with no feedback. In the same week that they completed the pretest, students received a quick orientation on how to surf the internet while participating in the collaboration forum built by the teacher using Telegram X and Zoom. Students were taught how to use the computer collaboration tool to find information, copy and paste it, and create simulations, text, images, videos, audio, wikis, digital textbook pages, and blogs related to the learning subject. They were also taught how to answer inquiries, delete communications, and alter previously sent messages or responses. Following the orientation, students were divided into groups of five, and each group was assigned a laptop computer from the school's computer lab, with which they collaborated throughout the study. Kids in their group utilized the laptops both inside and outside of school, and kids in the same groups lived close to one another. Each computer was also outfitted with a sim-enabled modem that included internet subscriptions so that students could browse and use their computer collaboration apps online. Apart from the laptop, kids, with their parent's permission, used mobile phones and tablets to connect to the platforms for larger and easier collaboration.

Each week, the students connected to the internet via modem on each computer and launched the collaboration program on the desktop page following brief classroom lessons or on the Zoom application. Students spend the second half of the lesson in the computer lab, discussing the topic, answering each other's questions, searching the internet for answers, and assisting others in learning through the videos, text, and pictures they post on the collaboration page and to one another, first within their group and then with those of other groups. The teacher assessed the students' learning by participating in the forum collaborative activities as a facilitator. The teacher also asked students questions on the topic given to help them with their collaboration activities and to identify students who are not participating or who do not attend online collaboration activities. Performance test questions were initially administered online as group assessments on collaborative platforms, followed by individual achievement test evaluations in the classroom.

The control group was taught with direct instructor instruction. There was no usage of computers, and students were not exposed to any type of computer-supported cooperation. The teacher directed and encouraged classroom interaction. The students, on the other hand, were free to ask questions and seek clarification on the unit sections or solutions that they were unsure about. At the end of the lesson, the students were given the CAT as a post-test. Their

results, together with those from the pretest, were aggregated, cleaned, and used for data analysis. The study questions were answered using mean and standard deviation, and the hypotheses were assessed at the 0.05 level of significance using Analysis of Covariance (ANCOVA). ANCOVA was performed to reduce initial group disparities among the students.

The decision rule was to reject the null hypothesis if the probability value (p-value) was less than or equal to a significant value of 0.05 ($P \leq 0.05$), and accept the null hypothesis if the P-value was greater than 0.05 ($P > 0.05$).

7. Research Results

Research Question 1: What are the mean achievement scores of students taught Chemistry using Computer Supported Collaborative learnings (CSCL) and those taught using direct teacher instruction (DTI)?

Table 1: Mean Achievement Scores of Students taught Chemistry using CSCL and those taught using DTI

Source of Variation	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
CSCL	49	21.24	8.31	72.20	13.57	50.96
DTI	54	35.06	6.62	67.37	13.86	32.31

Table 1 shows that students taught Chemistry using CSCL had a pretest mean achievement score of 21.24 and a posttest mean achievement score of 72.20, with a gained mean achievement score of 50.96, whereas those taught Chemistry using DTI had a pretest mean achievement score of 35.06 and a posttest mean score of 67.37, with a gained mean of 32.31. Students taught Chemistry using DTI had a homogenous pretest score (6.62), followed by those taught CSCL (8.31), but students taught DTI had a more heterogeneous posttest score (13.86) than students taught CSCL (13.57).

Hypothesis 1: There is no significant difference in mean achievement scores between students taught Chemistry utilizing Computer Supported Collaborative Learning (CSCL) and Direct Teacher Instruction (DTI).

Research Question 2: What is the interaction effect between instructional approaches and gender on students' academic achievement in Chemistry?

Table 2: ANCOVA on Difference between the Mean Achievement Scores of Students taught Chemistry using MII, CAI, and DTI

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	7983.658[a]	4	1995.914	16.814	.000	
Intercept	22857.304	1	22857.304	192.555	.000	
Pretest	553.975	1	553.975	4.667	.033	
Method	1881.280	1	1881.280	15.848	.000	Sig.
Gender	191.181	1	191.181	1.611	.207	No Sig.
Method * Gender	6251.799	1	6251.799	52.667	.000	Sig.
Error	11633.119	98	118.705			
Total	519568.000	103				
Corrected Total	19616.777	102				

Table 2 demonstrates a significant main effect of the treatment on students' Chemistry achievement, F (2, 98) = 15.848, P < 0.05. As a result, the null hypothesis was rejected, indicating that students taught Chemistry using Computer Supported Collaborative Learning (CSCL) outperformed those taught using direct teacher instruction (DTI).

Hypothesis 2: There is no significant interaction between instructional approaches and gender on students' academic achievement in Chemistry.

Table 3 demonstrates a significant interaction impact of instructional modalities and gender on student achievement, F (1, 98) = 52.667, P < 0.05. As a result, the null hypothesis was rejected, indicating that instructional approaches and gender had a substantial interaction effect on students' academic performance in Chemistry. The nature of the interaction is seen in Figure 2.

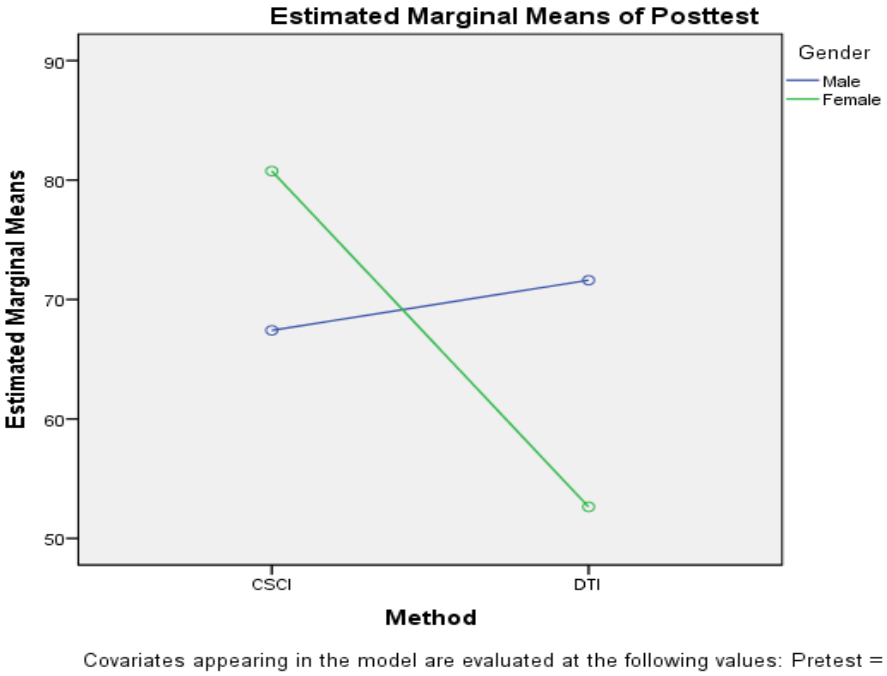

Figure 2: Plot of interaction between instructional methods and gender on students' achievement in Chemistry

Figure 2 depicts a significant and biordinal interaction between teaching modalities and gender on Chemistry achievement. This means that the educational approaches are gender sensitive, and their results vary according to gender.

Table 3: Mean Achievement Scores of Male and Female Students taught Chemistry using CSCL and DTI

Method	Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
CSCL	Male	23	19.74	8.40	64.65	11.04	45.91
	Female	26	22.58	8.16	78.88	12.14	56.30
DTI	Male	36	35.14	7.06	73.72	10.45	38.58
	Female	18	34.89	5.81	54.67	10.83	19.78

Table 3 shows that male students taught Chemistry using CSCL had a mean achievement score of 45.91, while female students had a mean score of 56.30, with females having a higher mean gain achievement score and a more varied posttest score (12.14) than males (11.04). Male students who taught Chemistry using DTI had a mean achievement score of 38.58, but female students had a mean score of 19.78, with males having a higher mean gain achievement score and a more homogeneous posttest score (10.45) and females (10.83).

8. Discussion

According to the study's findings, students who were taught chemistry using CSCL performed significantly better academically than those who were taught with DTI. The study's findings can be explained by how the computer-supported collaborative learning (CSCL) system creates a collaborative environment that actively participates in monitoring and controlling collaboration, hence dynamically boosting learning. CSCL might thus be utilized to address concept learning, problem-solving, and design, depending on the type of collaborative work required. In the learning sciences, there has also been an increased emphasis on encouraging students to learn in small groups. Nonetheless, there is still an issue with effectively combining computer assistance with collaborative learning, or technology and education, to increase learning; this is what CSCL addresses.

On the other hand, a full reworking of the concept of learning was required, resulting in significant changes to education, teaching, and the student experience. To prevent students from responding solely to submitted content, CSCL emphasizes group collaboration. Student interactions have an important role in the learning process. Students acquire knowledge by asking questions, sharing their findings, mentoring one another, and witnessing how others learn. To promote and maintain positive student interaction, curriculum, pedagogy, and technology must be carefully planned, coordinated, and executed. Using CSCL simplified the process of organizing fruitful student collaboration. This is in line with the findings of Gambari & Yusuf (2016) that Students who were taught physics via computer-assisted Jigsaw II fared better and kept the physics topics for longer time than those who were taught using individualized computer teaching. The study which investigated the influence of the computer-assisted jigsaw II cooperative learning technique on physics achievement and retention also reported that accomplishment levels had a major impact on their performance.

The findings of the study also suggest that by interacting with the materials and collaborating, students appropriately understood the chemistry principles being taught. Fakomogbon & Bolaji (2017) revealed similar findings when they investigated the influence of collaborative learning styles on student performance in a ubiquitous collaborative mobile learning environment. The results of the study revealed that there were significant gains in the gap between students' pretest and posttest scores during the mobile learning experience, and the think-aloud-pair problem-solving strategy was the most successful collaborative learning

style. Furthermore, all collaborative learning styles are more effective at learning in a mobile learning environment than non-collaborative learning styles.

The relevant learning that is inherent in collaborative learning resulted in a proper grasp of chemistry, which helped students improve their academic performance. The study's findings are consistent with those of Talan (2021) and Vega, Stanfield & Mitra (2020), which found that CSCL greatly increased students' academic achievement. The rich learning experiences encountered in computer supported collaborative learning is not easily achieved with direct teacher instruction. Although direct teacher instruction may provide students with important information to improve learning more than conventional methods. Rubina, Pir & Ali (2010), Olaosebikan & Chizoba (2012), and Anidi, Obidike, & Anyachebelu (2021) reported similar findings that direct teacher instruction significantly improve achievement more than conventional instruction.

The study further revealed that there was a significant gender interaction with the instructional strategies on achievement. The ordinal nature of this interaction can be explained from the fact that computer related interaction may be more appealing to the female students that it is for the male students. Female students chat a lot online and therefore collaboration over academic matters that are over the internet may provide them with richer learning experience that may not commonly appeal to the male students. The female students' higher academic achievement over the male students in the CSCL group can be explained from this fact. The findings of the study are in line with the findings of Nnamani & Oyibe (2016) that female secondary school students had higher mean accomplishment scores than male students.

The result of the study also supports the finding of Nwankwo (2018) that a substantial difference in the mean accomplishment scores of male and female students in the experimental group.

9. Conclusion

The study's findings revealed that students who were taught Chemistry using CSCL performed much better than those who were taught via DTI. The study shows that CSCL is an excellent instructional strategy for improving students' academic learning experiences in chemistry while also encouraging meaningful learning. The method enables students to develop the social skills required for teamwork and a collaborative problem-solving approach to challenging chemistry ideas.

10. Recommendations

10.1 Secondary school chemistry teachers should use Computer Collaborated Instructions to increase student participation with learning resources.

10.2 Chemistry educators can enhance the learning experience for students by implementing group studies using computers and collaborative tools.

10.3 Install internet-enabled computer gadgets and handheld computers in secondary schools to enhance learning and collaboration among students and teachers alike.

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