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YouTube Video Technology in Chemistry Classroom: Its Impact on Pre-Service Teachers' Attitude and Academic Performance

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Abstract: The study investigated the impact of YouTube video assisted instructions (YVAI) on pre-service teachers'(PSTs) attitudes and academic performance in chemistry classroom. A quasi-experimental design was adopted for the study. One hundred and twenty (120) Pre-Service Teachers (PSTs) pursuing primary education programme constituted the participants of the study. Sixty (60) PSTs each were non-randomly assigned to the Experimental Group (EG) and Control Group (CG). Data on PSTs' attitude and performance were collected with PSTAS and GCPT respectively. The SPSS software version 20 was used to analyse the data to generate descriptive and inferential statistics. A non-parametric analysis was used in the inferential statistics. The attitude means rank (MR=78.62) of EG (U = 713.000, Z=-6.924, p <.001) was statistically higher than CG (MR=42.38) (U = 713.000, Z=-6.924, p <.001) after treatment. The EG after treatment recorded a mean rank (80.86) statistically higher than CG (40.14), U = 578.500, Z = -6.441, p <.001 after treatment. YVAI was proven as an effective instructional strategy that enhances learners' altitudinal changes and performance. The study recommended the use of YouTube technological-driven instructions to support classroom instructions.

Keywords: *Attitude, instructions, performance, technology, YouTube.*

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Introduction

Knowledge derived in chemistry plays an important role in the life of every individual globally. For instance, knowledge on expired products, polluted environment, concentrations of salt and sugar in meals, drugs dosages, fuel for transportation, global warming and the likes, play a major role in the survival of man (Akhter et al., 2022). In spite of benefits derived from chemistry concepts, students, particularly in Africa pay little attention to chemistry courses. Many students offer chemistry courses because they are compelled to but not at will (Tekane et al., 2020). Chemistry is branded by students at various levels of education in Ghana as a difficult and abstract course (Marifa et al., 2023; Yeboah & Siaw, 2020). The students' attitude might have resulted from the understanding of complex concepts in chemistry through the approaches to teaching (Adjei et al., 2023). *The pessimistic outlook held by students significantly hampers their academic achievement and undermines Ghana's ongoing educational reforms, which aim to enhance learning outcomes* (Ministry of Education, 2018; Ogembo et al., 2015).

Teacher education in Ghana is aimed at preparing future educators 'equipped with professional skills, attitudes and values as well as the spirit of inquiry, innovation and creativity' to conform to rapidly changing world (National Teaching Council [NTC], 2017). Thus, the seamless integration of technology in the Colleges of Education courses has become paramount to prepare the educators of tomorrow to embrace this transformative power. The use of YouTube video assisted instructions (YVAI) among other technological driven instructions enables learners to participate fully in the teaching and learning process (Sherer & Shea, 2011). It is worth noting that the nature of work and education is properly reformed by technology (Shaturaev, 2022).

Studies by Allgaier (2020), Orús et al. (2016) and Zhou et al. (2020) indicated that YouTube instructional video is a popular stimulating learning tool that introduces technology into the classrooms for educational purposes and it impact

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positively on students' learning outcomes. YouTube instructional video also offers opportunities to students to create and construct their own knowledge (Liu, 2010). The sounds, beautiful motion pictures of YouTube websites provide intuitive information that support learners in concepts acquisition (Abrar, 2022). Students have consistently demonstrated enthusiasm for watching, downloading and exchanging YouTube video clips with peers, both within and beyond the classroom setting (Habes et al., 2019). Thus, incorporating students' interest in YouTube videos into the chemistry classroom as an interactive tool will significantly enhance student engagement by promoting active participation during instructional sessions (Koto, 2020).

The integration of YouTube videos into education aligns with cognitive theory of multimedia learning (Mayer & Moreno, 2002). This theory supports the application of technology on knowledge and skills (Ezeudu et al., 2020). In a YouTube video learning approach, learners build proper mental structure with corresponding concepts (Mayer & Moreno, 2002). This is as a result of associated auditory and visual channels of YouTube videos for information processing (Ezeudu et al., 2020). The use of YouTube instructional videos in the teaching learning process captures learners' attention, make lessons more interesting and enhance understanding of concepts and ability to undertake cognitively demanding tasks (Ezeudu et al., 2020). The blend of online environment with social interaction connects human's social networks (Zhou et al., 2020).

Recently, the use of YouTube video technology is speedily gaining roots in the instructional classrooms. Several studies have investigated into the YouTube video technology in the instructional classrooms. Ezeudu et al. (2020) conducted a study on the effect of YouTube instructional package videos on male and female secondary school students' achievement and retention in economics. A study conducted by Sunday et al. (2023) investigated into YouTube online device on undergraduate students' performance in mathematics education. Taufik et al. (2022) researched on the application of YouTube-based virtual blended learning as a learning media for fundamental movement skills in elementary schools. Abrar (2022) conducted a study on the use of YouTube tutorial videos to improve students 'speaking skill at the second-grade students. Despite the numerous studies examining instructional strategies on YouTube, none have specifically explored the impact of YouTube video instruction on students' attitudes. Yet, research indicates that students' attitudes significantly affect their academic performance (Hacieminoglu et al., 2016). It is therefore imperative to carry out a study to investigate into the influence of Youtube video assisted instructions (YVAI) on students' attitude to general chemistry and academic performance. This study was therefore aimed at investigating into the effect YVAI on pre-service teachers' (PSTs) attitude and performance in learning general chemistry.

Attitude is a package of human feelings, behaviors or thoughts toward a person, product, process, condition or an event (Assem et al., 2023). The attitude of learners changes directly or indirectly based on their experience, observation or learning environment (Musengimana et al., 2021). Factors such as conditions of the classroom, influence of friends, gender, parents, society, teacher's attitude and students' aspirations contribute immensely to the change of learners' attitude in class (Ogembo et al., 2015). Researchers have explored relationship between attitude and performance in Chemistry (Ogembo et al., 2015; Olakanmi, 2017; Nennig et al., 2020; Vishnumolakala et al., 2017). Students' negative attitude to chemistry is of great concern to many chemistry facilitators and other stakeholders in Ghana. This is because chemistry is a pivotal tool for technological development and its concepts are useful in the interpretation of biological, chemical and physical phenomena (Ndukwe, 2021). In spite of numerous interventions adopted by chemistry instructors to better learning outcome in chemistry, students persistently show undesirable attitude to chemistry which significantly affect their performance (Musengimana et al., 2021). Thus, learners' attitudes and beliefs have an influence to impede or facilitate learning (Ogembo et al., 2015).

Performance in general is an individuals' ability to carry out a task. However, in an academic setting, students' ability to accomplished assigned tasks or studies constitutes to their performance (Muhammad-Jamiu, 2023).

Statement of the Problem

Students' poor performance in chemistry and other science related courses has been a greater concern to educational stakeholders and the government in general, since development of every country is dependent on science, technology, engineering and mathematics (STEM) education (Freeman et al., 2019). Notwithstanding, learners' poor performance affects their transition into careers in science and technology (Ogembo et al., 2015). Several varied instructional strategies have been explored by educationist and other researchers to whip up students' interest and facilitate the teaching and learning process. However, students persistently show reluctant attitude towards to chemistry courses, in spite of the instructors' effort to assist them to acquire professional knowledge, professional values and attitudes and professional practice for rapidly changing job market (NTC, 2017).

Year one (1) students perusing primary education at Atebubu College of Education still hold the notion that chemistry concepts are abstract and difficult to learn. This concern can best be addressed by tapping learners' interest in watching videos through YouTube websites before, during and after classroom instructions (Insorio & Macandog, 2022). YouTube visual and auditory channel facilitate knowledge transfer and assist immensely in the teaching and learning process (Abu-Taieh et al., 2022). The use of YouTube as a learning tool will also provide divergent ideas on chemistry concepts to PSTs and offer them the opportunity to playback videos to remind them of the concepts learnt (Sunday et al., 2023).

Therefore, embarking on YouTube video assisted instructions (YVAI) will contribute significantly to the reversal of PSTs attitude to general chemistry and enhance their performance.

Research Questions

The following research questions were raised to guide the study:

1. How would YVAI enhance PSTs' attitude to general chemistry?
2. What effect would YVAI have on PSTs' performance?

Methodology

Research Design

A quasi-experimental research was conducted to investigate into the effect of YVAI on PSTs' attitude and performance in general chemistry at the Atebubu College of Education. The study employed non-equivalent control group design with pre-test/post-test measurement (Cohen et al., 2017). This research was used because it is very difficult to randomized participants in the Atebubu College of Education due to the classroom organization (Adjei et al., 2023).

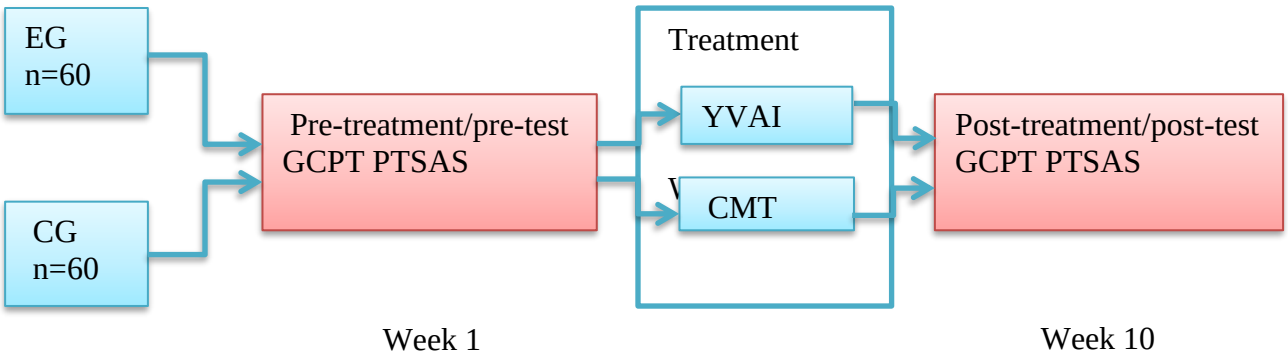

Figure 1. Symbolic Representation of the Research Design

The non-randomized sample size contributed to having same sample size with almost equal variation (Christopoulos et al., 2022). The cross-sectional representation of the research design as used in Adjei et al. (2023) is shown in Figure 1.

Participants

PSTs pursuing primary education programme at Atebubu College of Education constituted the participants of the study. A total of 120 PSTs (aged from 19 to 25) from two intact classes participated in the study willingly (Table 1). Prior to the treatment, the PSTs were non-randomly assigned into EG (60) and CG (60). Demographic characteristics of PST employed in the study were age and gender (Table 1). The EG was constituted by 29 (48.3 %) males and 31 (51.7 %) females whereas the CG counterpart consisted of 32 (53.3 %) males and 28 (46.7) females (Table 1).

Research Instruments

The students' attitude to general chemistry was evaluated on pre-service teachers' attitude scale (PSTAS). PSTAS is a 10 item Likert-type scale. Likert scale was adopted in the construct of PSTAS because it produces the highest reliability when several formats are tested (Cheung, 2009). PSTAS was constructed on four-dimension conceptual framework and consisted of five point-Likert scales-strongly disagree (SD), disagree (D), undecided (U), agree (A) and strongly agree (SA) corresponding to one, two, three, four and five points respectively for all positive statements (Table 2). The benchmark value (3) was set out for the study, which was obtained by finding the average of five points (1, 2, 3, 4 and 5) of the rating scale (Adjei et al., 2023). The benchmark value (3) set for the study indicate an average of PSTs' attitude towards general chemistry. A 10-item PSTAS was categorized into four sub-scales (Table 2). PSTs attitudinal responses in the four sub-scales were geared towards affective, cognitive and behavioural domains (Cheung, 2009). The first and second sub-scale focused on the affective domains which emphasis on the feelings of the participant on chemistry lessons and practical activities (Cheung, 2009).

Table 1. Demographic Characteristics

Variable	Experimental Group (EG)		Control Group (CG)	
	N	%	N	%
Gender				
Male	29	48.3	32	53.3
Female	31	51.7	28	46.7
Age				
20	2	3.3	3	5.0
21	5	8.3	4	6.7
22	11	18.3	8	13.3
23	16	26.7	15	25.0
24	14	23.3	17	28.3
25	12	20.1	13	21.7
Total	60	100	60	100

The third sub-scale stressed on cognitive domain where the participant responses were geared towards the beliefs and knowledge on the importance of chemistry to human life (Cheung, 2009). The fourth and the last subscale emphasized on the behavioural aspect of participant attitude (Cheung, 2009). General chemistry performance test (GCPT) was used to measure the level of PSTs performance in general chemistry in the pre-test and post-test, before and after treatment respectively. GCPT consisted of 40 multiple-choice questions, matching and fill in blank spaces questions and scored 40 marks. The validity of the questions (GCPT) was assessed in two ways 'content validity' and 'face validity' (Cohen et al., 2017). The content validity was achieved by adopting some chemistry past questions from the mentoring university (University of Cape Coast) and other textbooks to ensure depth coverage of the chemistry concepts. On the face validity of the test items, two expect chemistry teachers in the science department were tasked to assess fairness in the coverage, clarity and accuracy of the questions (Bohloko et al., 2019). In accordance with studies conducted by Martínez-Borreguero et al. (2022), a concordance test was undertaken on GCPT by the two expert chemistry teachers, who were given ten assessment criteria to assess the degree of agreement or disagreement.

Table 2. Pre-Service Teachers Attitude to Chemistry

Sub-scale	Item
1. Liking for chemistry lessons	I attend chemistry lectures always.
	I enjoy doing group work during chemistry lessons.
	Chemistry lessons are very interesting to me.
2. Liking for chemistry laboratory activities	I enjoy mixing chemicals.
	I enjoy interacting with laboratory equipment and apparatus.
	I prioritize laboratory activities over other activities on campus.
3.Use of knowledge acquired in chemistry	I believe chemistry is useful subject in the life of every individual
	I can use knowledge acquired in chemistry to solve confronted problems.
4. Behaviour tendency to learn chemistry	I like reading chemistry books
	I assist my colleagues to solve chemistry questions

The degree of agreement, $\circ\, a$ was calculated as follows; $\circ\, a = \frac{a}{a+d}$ (1)

Where a = the total number of agreements selected and d= the total is the number of disagreements selected. After, evaluating 18 agreement ticked criteria against 2 disagreement selected, the degree of agreement was found to be 0.9 which was classifiable as very good (Martínez-Borreguero et al., 2022). In addition, two psychometric tests, difficulty index and discrimination index were undertaken in line with the methodology employed by Martínez-Borreguero et al. (2022) to assess the validity of the GCPT.

Table 3. Psychometric Analysis of GCPT

Coefficient	N	Minimum	Maximum	Mean	SD
Difficulty index (p)	40	.37	.38	.37	.004
Discrimination index (D)	40	.27	.33	.31	.015

Note; N=number of test items, SD= Standard deviation

The mean difficulty index, p (M = .37, SD = .004) in Table shows that the degree of conceptual difficulty of GCPT was adequate for the study (Johari et al., 2011; Martínez-Borreguero et al., 2022). Similarly, the mean discrimination index, D (M = .31; SD = .015) in Table 3 was adequate and corresponds well with the recommendations reported by Martínez-Borreguero et al. (2022).

Table 4. Chemistry Module for the Semester

Module	Topic
1	The structure of the atom
2	Formation of ionic and covalent compounds
3	The mole concept
4	Chemical formula and equation
5	Pure & impure substances and mixtures
6	Acids, bases and salts
7	Chemistry of carbon compounds

Instructional Procedure

The EG and CG were taught by the same instructor (researcher) with 22 years of teaching experience. The EG was treated with YouTube video assisted instructions (YVAI) whilst the CG group counterpart was treated using conventional method of teaching (CMT). The study period lasted for 10 weeks within the second semester (2021/2022 academic year). Both groups were made to go through the same modules for the semester (Table 4). Each module consisted of two lecture periods per week, for two contact hours each and one laboratory session every Friday of the treatment period. The treatment session was categorized into 3 stages; pre-treatment stage, treatment stage and post-treatment stage as used in Adjei et al. (2023).

Stage 1: Pre-Treatment (week 1)

At the pre-treatment stage, permission to embark on the study was sought from the authorities and participants used, in the first week of the study. The course outline, course materials including course books were given to the PSTs in the first week of engagement. The tasks for the semester were also discussed with the students. The students' attitude to general chemistry was assessed with PSTAS which was issued to students via Google forms. The EG and CG were thereafter pre-tested with GCPT to ascertain groups' equivalence.

Stage 2: Treatment (week 2 to 9)

In the second week of the semester, the treatment commenced. The EG was treated with YouTube video assisted instructions (YVAI). YouTube video instructions' link on every topic was posted to EG's WhatsApp platform, a day before classroom instruction. The video watched on the lesson to be learnt was discussed 10 minutes before the start of every lesson. The discussion on video instruction was made in groups, where each member of the group was made to contribute to the group discussion. The instructional activities on the new concepts were thereafter carried out with corresponding assessment. The new concept was always built on the PSTs' prior conception (video watched). The students' attitude to instructional activities was also observed during the instructional period. The CG on the other hand, received a form of treatment (CMT) different from that of the EG on the weekly modules. CG's instructional activities were guided by the activities in their course book and their attitude to instructional activities was also assessed in each instructional period. The groups, EG and CG undertook a three hour practical activities on each topic separately, every Friday of the week.

Stage 3: Post-Treatment (week 10)

After the treatment, the EG and CG attitude to chemistry was assessed by administering PSTAS via Google form. A post-test was also conducted for both the EG and CG with the same GCPT as used in the pretest but different order of arrangement.

Data Collection

Demographic characteristics (age and gender) and students' attitude to chemistry before and after treatment were obtained by administering PSTAS. Pre-test/post-test scores were derived by conducting GCPT on pre-service teachers before and after treatment. Prior to administering the test items, a pilot testing was conducted on students' pursuing early childhood education who did not take part in the study to assess the validity and reliability of GCPT and PSTAS. Cronbach's alpha value computed on PSTAS reliability was 0.71. PSTs attitude to general chemistry was evaluated with PSTAS before the commencement of the treatment. Pre-test was also conducted to assess the equivalency in the groups (EG and CG) abilities using GCPT before the start of the treatment.

Data Analysis

PSTs responses in the PSTAS and scores obtained in the pre-test and post-test constituted the data of the study. The descriptive and inferential statistical analysis was made with SPSS statistical program (version 20). Prior to the analysis of PSTAS and pre-test/post-test data, a normality test was conducted with Kolmogorov-Smirnov test to assess the uniformity in the data distribution. The study employed Kolmogorov-Smirnov test because the sample size of the study

was above 50 (Adjei et al., 2023). After noticing that the data of the study's data did not follow a normal distribution, a non-parametric analysis was conducted using the Mann Whitney U test and the Wilcoxon Signed Rank test to compare the means EG and CG.

Results

Results of Kolmogorov-Smirnov test in table 5 showed that both the EG and CG attitude to chemistry recorded a lower level of significance than the alpha level (0.05) before and after treatment. This result indicated that data obtained by both the EG and CG were not normally distributed. Similarly, both the EG and CG pre-test/post-test scores recorded a lower level of significance than the alpha level (0.05) in the Kolmogorov-Smirnov test. Hence data obtained in the pre-test/post-test were not normally distributed (Table 6).

Table 5. Normality Test on Pre-Service Teachers' Attitude to Chemistry

Groups		Statistics	df	Sig.
Pre-treatment	Experimental group	0.150	60	.002
	Control Group	0.130	60	.013
Post-treatment	Experimental group	0.131	60	.012
	Control Group	0.128	60	.016

Table 6. Normality Test for Pre-Test and Post-Test Scores

Groups		Statistics	df	Sig.
Pre-test	Experimental group	0.131	60	.012
	Control Group	0.134	60	.009
Post-test	Experimental group	0.347	60	< .001
	Control Group	0.501	60	< .001

Research question 1: How would YVAI enhance PSTs' attitude to general chemistry?

In answering the research question 1, PSTs' attitude to general chemistry before and after treatment was assessed by soliciting participants' views via Google forms. The data obtained was computed and the summary of the sub-scales recorded (Tables 6). The bench mark value of three (3) set out for the study was obtained by finding the average of five points (1, 2, 3, 4 and 5) of the rating scale (Adjei et al., 2023).

Results in Table 7 suggest that PSTs used in this study did not enjoy general chemistry lessons before treatment. The attitude means scores of each sub-scale in both groups (EG and CG) were below the bench mark value (3) (Table 7). However, after treatment EG recorded a higher attitude mean score in each sub-scale than the bench mark value (3) set for the study (Table 8). The CG counterpart recorded an attitude mean score lower than bench mark value (3) in all the sub-scales (Table 8).

Table 7. Pre-Service Teachers Attitude before Treatment

Sub-scale	Experimental group (EG)		Control group (CG)	
	Mean	SD	Mean	SD
Liking for chemistry lessons	2.27	0.58	2.28	0.52
Liking for chemistry laboratory activities	2.12	0.59	2.17	0.59
Use of knowledge acquired in chemistry	2.45	0. 59	2.42	0.59
Behaviour tendency to learn chemistry	2.48	0.70	2.38	0.64

Table 8. Pre-Service Teachers Attitude After Treatment

Sub-scale	Experimental group (EG)		Control group (CG)	
	Mean	SD	Mean	SD
Liking for chemistry lessons	3.50	0.68	2.85	0.63
Liking for chemistry laboratory activities	3.47	0.60	2.73	0.63
Use of knowledge acquired in chemistry	3.48	0.89	2.85	0.73
Behaviour tendency to learn chemistry	3.55	0.91	2.93	0.58

The overall PSTs' attitude means scores in Table 9 for both the EG (M=2.47, SD=0.50) and CG (M=2.40, SD=0.49) before treatment were below the benchmark value (3). However, there is no significant difference in the attitude mean rank of EG (62.50) and CG (58.50) before treatment, U= 1680.000, Z = -.734, p = .63 (Table 9). On the contrary, the overall attitude mean score (M=3.63, SD=0.55) of the EG after treatment was above the benchmark value (3) whereas the CG counterpart had a mean score (M=2.97, SD=0.26) lower than the benchmark value (Table 9). The attitude mean rank (78.62) of EG

(*U* = 713.000, Z=-6.924, *p* <.001) was however, statistically higher than CG (42.38) (*U* = 713.000, Z=-6.924, *p* <.001) after treatment (Table 9).

Table 9. Descriptive & Inferential Statistics of Pre-Service Teachers' Attitude to Chemistry

Test	Groups	N	Mean	SD	Mean rank	Mann Whitney U	Z	Sig.
Pre-Treat.	EG	60	2.47	.50	62.50	1680.000	-.734	.463
	CG	60	2.40	.49	58.50			
Post-Treat.	EG	60	3.63	.55	78.62	713.000	-6.924	<.001
	CG.	60	2.97	.26	42.38			

Note: Pre-Treat=Pre-Treatment, Post-Treatment, EG = Experimental group, CG= Control group, Z= Standardized Test Statistic, Sig: Asymptotic Significance. (2-sided test).

Table 10. Descriptive Statistics of EG and CG in the Pre-test and Post-test

Group	Test	N	Mean	SD	Min.	Max.	Mean achievement gain
EG	Pre-Test	60	16.95	3.798	10	24	14.53
	Post test	60	31.48	2	27	36	
CG	Pre-Test	60	16.88	3.669	10	25	10.85
	Post test	60	27.73	2.755	24	34	

Research question two: What effect would YVAI have on PSTs' performance?

In answering the research question two, the descriptive and inferential statistics of the pre-test/post-test scores of both EG and CG were computed and the summary of the results was recorded. As shown in table 10 the mean achievement gains of the EG (14.53) was higher than the CG (10.85) counterpart after treatment (Table 10). However, the means of both EG and CG appreciated significantly after treatment (Table 11).

Table 11. Related-Samples Wilcoxon Signed Rank Test of EG and CG

		N	Mean Rank	Sum of Ranks	Z	Sig.
EG	Negative Ranks	0[a]	.00	.00	-6.740[b]	<.001
	Positive Ranks	60[b]	30.5	1830.00		
	Ties	0[c]				
	Total	60				
CG	Negative Ranks	0[a]	.00	.00	-6.740[b]	<.001
	Positive Ranks	60[b]	30.5	1830.00		
	Ties	0[c]				
	Total	60				

The mean rank of the EG (MR=60.32) treated with YVAI was not statistically different from CG treated with CMT (MR=60.68) in the pre-test result, *U* = 1789.000, *Z*=-.058, *p* =.954. However, the EG after treatment recorded a mean rank (MR=80.86) significantly higher than CG counterpart (MR=40.14) in the post-test, *U* = 578.500, *Z* = -6.441, *p* <.001 (Figure 3; Table 12).

Table 12. Descriptive & Inferential Statistics of Pre-Test and Post-Test Scores

Test	Groups	N	Mean	SD	Mean rank	Median	Mann Whitney U	Z	Sig.
Pre-Test	Exp.	60	16.95	3.88	60.32	16.50	1789.000	-.058	.954
	Cont.	60	16.88	3.70	60.68	17.00			
Post -Test	Exp.	60	31.48	2.51	80.86	32.00	578.500	-6.441	<.001
	Cont.	60	27.73	2.76	40.14	27.50			

Note: EG = Experimental group, CG = Control group, Z= Standardized Test Statistic, Sig: Asymptotic Significance. (2-sided test)

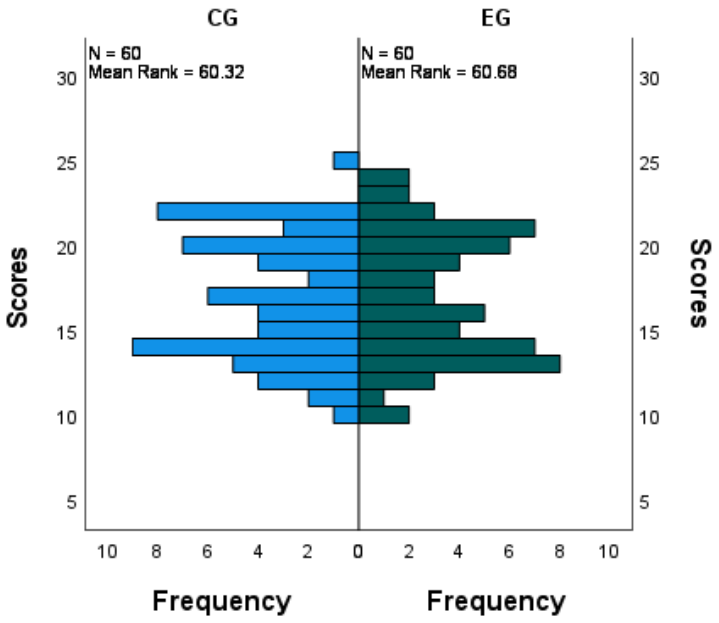

Figure 2. Independent Samples Mann Whitney U Test of Pre-Test Scores

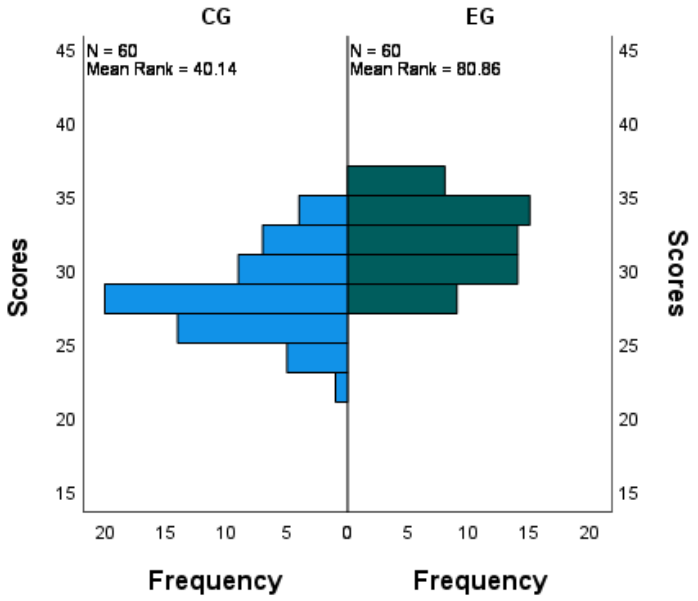

Figure 3. Independent Samples Mann Whitney U Test of Post-Test Scores

Table 13. Related-Samples Wilcoxon Signed Rank Test of EG and CG

		N	Mean Rank	Sum of Ranks	Z	Sig.
Pre-Test	Negatives Ranks	22[a]	20.45	450.00	-.851	.395
	Positive Ranks	17[b]	19.41	330.00		
	Ties	21[c]				
	Total	60				
Post-Test	Negatives Ranks	41[a]	21.00	861.00	-5.590	<.001
	Positive Ranks	0[b]	.00	.00		
	Ties	19[c]				
	Total	60				

Results in Table 13 shows that there was no significant difference between medians of EG (16.50) and CG (17.00) in the pre-test score, Z=-.851, p=.395. However, EG (32.00) recorded median significantly higher than the CG (27.50), Z=-5.590, p<.001(Table 10; Table 11).

Discussion

The findings of the study have shown that the EG's attitude to chemistry in each sub-scale after treatment was higher than the benchmark value (3). The elevated attitude of liking for chemistry lessons and liking for chemistry laboratory activities might have resulted from the enhanced PSTs' affections for chemistry subject after administering intervention strategy. Attitude is dependent on learners' interest and affections. When instructional activities are tailored in the interest and relevance of modern world to learners, they show strong affection for the course and display positive attitude to it (Cheung, 2011). Learners inherently possess eagerness to view, download, and share YouTube videos with their peers, both within and beyond the classroom setting (Habes et al., 2019). Hence, incorporating in chemistry lessons revitalize their interest and captures their attention during chemistry instruction. An increase in EG's attitude to use knowledge acquired in chemistry was as result of an enhanced self-belief and confidence after treatment (Cheung, 2011). PSTs' attitude to general chemistry lessons is tied to the evaluative belief learners have about the relevance of chemistry in solving confronted problems (Cheung, 2011). Additionally, self-belief and confidence are important factors that influence students learning (Mazana et al., 2019). The rise in EG's behavioural tendency to learn chemistry was due to elevation of learners' interest. PSTs with higher positive attitude to learn chemistry participate fully in the instructional activities, thereby improving their learning behaviour (Subban & Mahlo, 2017).

The findings from the study revealed additionally that the overall attitude mean score of the EG was higher than that of CG counterpart. Thus, the PSTs treated with YVAI performed significantly better than those treated with conventional method. This finding corresponds favourably with Fasasi (2017), Osokoya (2007) and Rahmawati and Anwar (2022). This result is evident that teaching method is a significant factor on PSTs' attitudinal changes to general chemistry (Hongsuchon et al., 2022; Osokoya, 2007). The significant difference might have resulted from the arousal and sustenance of learners' interest by YVAI. The enhanced attitude of learners might have resulted from the opportunity of playing back the video after instructions (Sunday et al., 2023). Also, the positive attitudinal changes might have stemmed on the enhancement of behavioural tendency to learn general chemistry concepts. YVAI eradicates PSTs perceived remoteness of chemistry concepts and build their confidence (Fasasi, 2017). YouTube videos in chemistry classroom illustrate chemistry concepts in a concrete manner, which would have been taught in abstract in a traditional classroom. Adoption of YVAI in chemistry classroom also helps PSTs to do away with psychological barriers that impede their performance (Iji et al., 2017). Learners' positive attitude to learning is dependent on sufficient and appropriate instructional technique in order to break learning barriers. Thus, YVAI enhances PSTs wiliness and confidence to learn which in turn improve their learning performance (Pratama et al., 2018).

The study also found out that both EG and CG appreciated in their means after treatment. The EG treated with YVAI, however performed significantly better in the post-test than the CG counterpart treated with CMT (Table 9). This was expected since YVAI in chemistry classroom captures and sustains PSTs' attention, making learning more interesting and promoting the entire learning process. The technologically enhanced instructions used also deepen understanding and spark up curiosity, making learning an exciting adventure. YVAI improved learning performance by providing opportunities to learners to apply learning outcomes to the real life situations (Pratama et al., 2018). Additionally, YVAI provides visual and auditory channel that facilitate proper knowledge transfer (Abu-Taieh et al., 2022). The use of YouTube as a learning tool also gives divergent ideas on chemistry concepts to students and offer them the opportunity to playback videos to remind them of the concepts learnt (Sunday et al., 2023). Engaging leaner in YVAI enhances learners' motivation to learn and improve their understanding of concepts (Briones, 2018). YVAI promotes learners' knowledge through proper understanding of concepts. The findings of the study are consistent with the findings reported in Ezeudu et al. (2020) and Taufik et al. (2022).

Conclusion

YouTube video assisted instructions (YVAI) in chemistry classroom has proven to be an impactful teaching strategy on PSTs' attitude and performance. The study results indicated that the experimental group treated with YVAI had an elevated attitude and performance than the control group counterpart. The outcome of this study spelt out the significance of integrating YouTube technology in the instructional classroom. Technological driven instructions spark up learners' interest and curiosity in classroom interaction and deepen their understanding of concepts. YouTube technology in the instructional classroom provides opportunities for collaboration and communication that transcends beyond traditional classroom boundaries. YouTube playback videos remind learners the concepts learnt and promote consistent practice. Integration of YouTube videos in the classroom interactions empowers future educators with the necessary skills to leverage technology effectively in the classroom and build their confidence in solving confronted problems with the acquired knowledge and skills. Findings in this study is evidently clear that adopting YVAI in the teaching and learning of general chemistry will contribute significantly to the reversal of learners' negative attitude towards chemistry course and other science related courses and enhance students' performance.

Recommendation

This study therefore recommends the integration of YVAI or a technology driven instructions into the traditional classrooms to serves as a catalyst for active engagement, deeper understanding and mastery of concepts. A similar study

should be made in the senior high school integrated science course in Ghana where students perform poorly in their masses.

Limitation

Even though the intervention strategy adopted yielded positive results in addressing attitudinal and performance challenges, the study encountered some levels of limitation. The first limitation boarders on network and data systems. The network at the area of study was not stable. In addition, some PSTs complain of data usage, hence they did not open and watched all YouTube instructional videos forwarded to them which affected the results. Some students did not have smart phones to view, download and watched the instructional videos prior to chemistry lessons.

Ethics Statements

The study was guided by ethical policy governing research activities involving human and non-human participants in the Atebubu College of Education.

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Conflict of Interest

Authors declare that there is conflict of interest.

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Authorship Contribution Statement

All authors contributed sufficiently to the study. Adjei Yeboah: corresponding author, concept and design, drafting of manuscript and critical revision of manuscript. Duku Prince: Data collection and data analysis. Donkor Job: Data analysis and revision of manuscript. Boachie Solomon: drafting manuscript and revision of manuscript.

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