Practical Approaches and Students' Scientific Attitude in Chemistry in Uyo Local Government Area of Akwa Ibom State, Nigeria

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Abstract

The study investigated the effect of practical approaches and students' scientific attitude in Chemistry in Uyo Local Government Area of Akwa Ibom State, Nigeria. The design of the study was a quasi- experimental pretest posttest non-randomized design. The population of the study consisted of all the senior secondary two (SS2) Chemistry students in the thirteen (13) public co-educational secondary schools in Uyo Local Government Area with a sample of one hundred and twenty-nine (129) senior secondary two (SS2) Chemistry students in three intact classes from three (3) public co-educational secondary schools in the study area. The instrument for data collection was the Scientific Attitude Questionnaire (SAQ) with a reliability index of 0.76 using Cronbach alpha statistics. Data obtained were analysed using mean and standard deviation and Analysis of Covariance (ANCOVA). Findings showed that students taught using hands-on activity had positive scientific attitude while virtual laboratory and expository approach group had negative scientific attitude. There was a significant effect of practical approaches on students' scientific attitude but no significant difference and interaction effect based on gender and scientific attitude. It was recommended, among others, that the use of hands-on activity approach should be encouraged for teaching of students who will acquire positive scientific attitudes. Also, teachers of Chemistry in secondary schools should be trained on the use of hands-on activity as it will re-emphasize the need for teachers to always enrich the teaching and learning process with good practical approaches that will foster scientific attitude.

Key words: Practical approaches, Virtual laboratory, Hands-on activity, Scientific attitude, Expository

Introduction

The aim of learning science in secondary schools is to promote the understanding of the observable behaviour of the environment, with a view to applying the knowledge of such understanding in the real-life situation. According to the Federal Government of Nigeria (FGN, 2014), the objectives of science education at all levels of education in Nigeria encompass the following: the acquisition of knowledge, skills, inquiry, and a rational mind for the conduct of a good life; the production of scientists for national development; service studies in technology and the promotion of technological advancement; the comprehension of the physical world, its forms, and the conduct of life; the provision of knowledge and understanding of the intricacies of the physical world and the forms and conducts of life.

The significance placed upon the crucial role of science education in national development renders it imperative and practically necessary for the implementation of a well-structured and organized approach towards the teaching of science, encompassing activities for both educators and learners to achieve optimal outcomes (Ibrahim, 2014). There exist three distinct branches within the realm of science, namely; Chemistry, Physics, and Biology.

Chemistry plays a vital role in national development. As a foundational science, it is often a compulsory requirement for pursuing any science courses at the tertiary level of education. It is imperative to note, as emphasized by Kousa, Kavonius and Aksela (2018) and Wahyudiati and Rohaeti (2020), that promoting Chemistry education is crucial to prepare individuals to tackle future scientific challenges and contribute towards the collective development of society. It is however expected that instructional approaches used in teaching should be such that will encourage student participation in teaching and learning and will help students to build a positive attitude towards science and retain more knowledge of the concepts learned (Ajayi & Ogbeba, 2017; Udu, 2018).

Practical approaches as used in this study is one of the student centered learning approaches expected to boost students' conceptual understanding and lead to meaningful learning that involves critical reasoning and creative thinking. According to the constructivist leaning theory as postulated by John Dewey in 1938 that humans generate knowledge and meaning from their experiences (Dewey, 1938). Lev Vygotsky's cognitive development theory also postulates that

social interaction is fundamental to cognitive development. Hence, the students interact with one another in a practical class and generate their own knowledge. Some of these approaches include co-operative learning, collaborative learning, guided discovery, think-pair-share, use of analogy, inquiry-based learning, problem-based learning, concept mapping, virtual laboratory approaches, hands-on activity approaches, and so on. In this study, we shall consider the virtual laboratory and hands-on activity approaches, as the interest of the learners in the classroom is very paramount and should be sought after and encouraged. In this study virtual laboratory and hands-on activity approaches will be used to teach the concept of soap production and obtain data on students' scientific attitudes.

The virtual laboratory approach engages simulations. Simulation is a method of designing teaching and e-learning activities that is used in education (Campos, *et al.,* 2020). Computer simulations are programs that mimic features of realistic world situations, including mathematical models, and calculate the consequences of various inputs before selecting the appropriate conclusions. They augment genuine laboratory techniques and skills by providing quantitative and hands-on experience for each experiment (Diwakar, *et al.*, 2015). Eden *et al.*, (2023) reiterated that the virtual laboratory approach provides for problem-solving, inquiry, and exploration of phenomenon.

A virtual laboratory is also very helpful when conducting studies that could involve dangerous substances and potentially dangerous apparatus. In the system intended to replace real machines with virtual machines on a single host server, virtual laboratory is also utilized (Ranjan, 2017). According to Yusuf and Widyaningsih (2020), adopting e-learning-based virtual laboratories can improve the learning quality and students' metacognitive skills in Chemistry experiment courses through lesson study activities, where the students mostly arrive at reasonable and perfect levels. Yehya *et al.* (2019) reiterated that the use of well-designed virtual laboratory has the potential to increase learners' positive attitudes toward science. In the study of Bogusevschi *et al.,* (2020), it was confirmed that virtual lab provides students with a great learning experience.

Hands-on activity approach allows for careful integration of direct instruction, keeping students engaged in working with materials, building increasingly complex problem-solving activities, and assessing understanding to guide and direct learning. According to Eden, *et al.,* (2023) hands-on activity approach involves physical manipulation of materials to facilitate

learning. In science education it has been shown to be effective in developing practical, manipulative skills related to handling equipment. According to the research conducted by Fuad Deb *et al.,* (2018), hands-on activity approach encourages lifelong learning and motivate learners to explore and discover new facts. Alkan (2016) and Pirttimaa *et al.,* (2015) have also highlighted that learners who are fully engaged with activities are likely to appreciate and learn what they are being taught. As such, the hands-on activity approach can promote authentic learning, scientific attitude, and enable learners to become better scientists who will positively impact the nation.

Scientific attitude can be described as open-mindedness, a desire for accurate knowledge, showing of confidence in scientific activities and with results. Crawley and Koballa (2014) stated that scientific attitude is a general positive or negative feeling about science; whether a person likes or dislikes science. To be scientific entails possessing attitudes such as curiosity, rationality, and willingness to suspend judgment, open-mindedness, critical-mindedness, objectivity, honesty, and humility. Scientific attitude refers to the beliefs and open mind-set students have about themselves and what they are to learn and do in science. Scientific attitudes are a combination of individual values, feelings, and beliefs towards science (Montes, *et al.,* 2018). Scientific attitude as a concept arises from an effort to explain regularities in individual behaviours toward science (Oluwatelure & Oloruntegbe, 2020). It has been observed that scientific attitude account for 25% of the variability in students' performance scores (Adesoji, 2018).

Research examining scientific attitude have stressed several dimensions of scientific attitude, among which are curiosity, rationality, open mindedness, critical mindedness, aversion to superstitions, objectivity of intellectual beliefs, suspended judgments, humility and honesty (Supardi *et al.,* 2019). Nisha and Prema, (2022) in a study on the levels of scientific attitude among school students showed that there is no significant difference between the levels of scientific attitude of different age groups.

Olasehinde and Olatoye (2014) who examined scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria found that there is a significant positive relationship between scientific attitude and science achievement was positive. Sakariyau *et al.,* (2017) in a study on attitudes of secondary school students towards science in Odeda Local Government Area of Ogun State, Nigeria showed that a higher proportion of the students display positive attitude towards science.

The changes in scientific attitude are predominantly influenced by various factors such as fear of failure, teacher scientific attitudes, teaching methods, students' cognitive style, parents' influence, gender, age, career interest, and social view of Chemistry. These factors have been extensively studied by scholars such as Coulter (2019), Olatunji (2015), Perloff (2016) and Arniezca and Ikhsan (2020). When the learning conditions are unfavorable, students tend to lose interest and develop a negative scientific attitude towards the subject, as pointed out by Akanwa *et al.,* (2018). Some of the factors contributing to this negative attitude are the inability of teachers to conduct practical activities of good quality, inadequate knowledge of scientific concepts, and the perceived difficulty of science, including Chemistry. Majid and Rohaeti (2018) found that a positive scientific attitude towards learning can improve and motivate students' learning outcomes. Similarly, Kahu and Nelson (2018) concluded that student scientific attitude is a critical factor that determines student performance. Yunus and Ali (2014) stated that doing practical work in the laboratory can make students show positive scientific attitudes and enhance performance.

Gender is one of the factors that may influence students' scientific attitude. Gender refers to the differentiated roles and responsibilities of men and women in a particular society. Studies have shown varying findings on students' scientific attitude (Nisha & Prema, 2022; Jack and Zubairu, 2022). Sakariyau *et al.,* (2017) in a study which investigated the attitudes of secondary school students towards science in Odeda Local Government Area of Ogun State, Nigeria found that there was no significant difference between the attitude of male and female students towards science. Nisha & Prema (2022) who conducted a study on the levels of scientific attitude among school students found that there is no significant difference between boys and girls in their level of scientific attitude. Olasehinde and Olatoye (2014) also found that there is no significant difference between male and female students in scientific attitude. Jack and Zubairu (2022) investigated the influence of gender on secondary school students' achievement, retention and attitude in Chemistry using 4MAT teaching model in Jalingo Education Zone of Taraba State revealed an insignificant effect of gender, insignificant effect of attitude, and insignificant interaction effect of gender and treatments on students' achievement in Chemistry using 4MAT.

On the other hand, Amiezca and Ikhsan (2020); Eden and Mkub (2019) found that female students outperformed their male counterparts in Chemistry. They attributed this difference to a positive attitude towards Chemistry possessed by female students which was an added advantage.

Based on this variations it is therefore necessary to delve further into gender differences in students' scientific attitude dispositions in Chemistry in order to develop possible intervention approaches.

"Scientists should challenge religious beliefs with scientific explanations" (Rationality); "conclusion based on insufficient evidences should not be accepted" (Aversion to superstitions); and "scientists should be curious to find out the occurrences of undesired events in nature" (curiosity). Do chemistry student possess any of these scientific attributes? Will the use of practical approaches such as virtual laboratory and hands-on activities help to effectively drive in conceptual knowledge and build positive scientific attitudes? In terms of practical based subjects like Chemistry, students need curiosity, rationality, open-mindedness, intellectuality, suspended judgement, humility, honesty and critical mindedness. Without these attributes, learners often have problem in accurately accessing and retaining information on the needed scientific concepts like soap production. Thus, the absence of these attributes of scientific attitude can impede the student's ability to apply scientific principles that are essential in real life scenarios. It is from this backdrop that this study is conducted to investigate the effect of practical approaches on students' scientific attitude in Chemistry in Uyo Local Government Area of Akwa Ibom State, Nigeria.

Purpose of the Study

The purpose of this study is to investigate the effect of practical approaches on students' scientific attitude in Chemistry in Uyo Local Government Area of Akwa Ibom State, Nigeria. Specifically the study seek to;

i. determine the effect of practical approaches on students' scientific attitude?
ii. estimate the difference in male and female students' scientific attitude mean scores?
iii. determine the interaction effect of practical approaches and gender on scientific attitude in soap production?

Research Questions

i. What is the effect of practical approaches on students' scientific attitude?
ii. What is the difference in male and female students' scientific attitude mean scores?
iii. What is the interaction effect of practical approaches and gender on scientific attitude in soap

production?

Research Hypotheses

i. There is no significant effect of practical approaches on students' scientific attitude

ii. There is no significant difference in male and female students' scientific attitude mean scores

iii. There is no significant interaction effect of practical approaches and gender on scientific attitude in soap production

Methodology

The design adopted for the study was a quasi- experimental, pre-test, post-test, non-randomized design. Quasi-experimental design was considered appropriate for the study because intact classes were used to avoid disruption of normal class lessons. The population of the study comprised all public co-educational Senior Secondary School two (SS2) students offering Chemistry in the thirteen (13) public coeducational secondary schools in Uyo Local Area of Akwa Ibom State, Nigeria; with a total enrolment of two thousand eight hundred and ninety (2890) students. (Source: Akwa Ibom State Secondary Education Board, 2023/2024 academic session). A sample of one hundred and twenty-nine (129) Senior Secondary two (SS2) Chemistry students were selected from three co-educational schools in the sample area. Simple random sampling technique was used to sample three secondary schools in Uyo Local Government Area of Akwa Ibom State.

The scientific attitude questionnaire (SAQ) was a researcher developed instrument which comprised of two sections: A and B. Section A is students Bio-data such as School name, Gender and Class. Section B consist of items on components of scientific attitude. It consists of 70-items on scientific attitude which include; curiosity, open mindedness, perseverance, sensitivity to the surrounding environment, humility and critical mindedness. The instruments SAQ was face and content validated by three validators; an experienced Chemistry teacher, lecturer and an expert in Test, Measurement and Evaluation in the Department of Science Education. The validators scrutinized the instrument in terms of: Clarity of instrument to the subject, proper wording of items, appropriateness and adequacy of the items for the study. The recommendations by the validators were used to modify the items in the instrument. In ascertaining the reliability index of the

instrument, copies of the instruments were administered to a trial test group of thirty (30) SS2 Chemistry students in a school not selected in the main study but found to be equivalent in all respects to the study groups. The result obtained after administration was subjected to Cronbach alpha statistics and found to be 0.73 hence, the instrument was adjourned reliable to be used to collect data for the study. The SAQ was scored using a modified 4-point Likert scale: Strongly Agree (SA) - 4, Agree (A) - 3, Disagree (D) – 2, Strongly Disagree (SD) -1. In the analysis of different parts put together, the highest limit of scientific attitude is 280.0 and the lowest limit is 70.0. Below 70.0 the attitude will be negative, at 70.00 neutral from 70.60 to 200.50 slightly positive, 200.60 to 220.50 moderately positive and from 220.6 to 280.00 taken highly positive.

The researcher obtained permission from the principals of the selected schools to carry out the research in their schools. The experimental procedure was done with the help of the Chemistry teachers as research assistants. The teachers were trained for one week on the use of the lesson packages and how to present lessons effectively using the virtual laboratory, hands-on activity and expository approaches. To ensure uniformity, the Chemistry teachers were taught how to use the lesson packages designed and prepared by the researcher to be used in the selected schools. A training module which consists of sample lesson packages to be followed when teaching the chosen Senior Secondary Two (SS2) Chemistry students was used. To ensure uniformity, the researcher designed, prepared and discussed with the Chemistry teachers the sample lesson packages to be used by the selected schools. Before the experimental activities, the pretest SAQ was used to record student's base line attribute of student's scientific attitude in the three groups. Thereafter, students in the Experimental group 1, 2 and control group were taught the concept of soap production using virtual laboratory, hands-on activity and expository approaches respectively. The teaching lasted for 3 weeks under the following headings: Nature and chemical composition of soaps and Laboratory preparation of soaps, production of local soaps and cleansing action of soap, hard water and soap, detergents (soapless), Soap versus soapless detergents. After the teaching, the post on SAQ was administered. The data obtained was analysed using Mean and standard deviation in answering the research questions, while Analysis of Covariance (ANCOVA) was used in testing the hypotheses at 0.05 level of significance.

Results

Research Question One: What is the effect of practical approaches on students' scientific attitude?

Table 1: Mean and standard deviation of students' pre-test and post-test on students' scientific attitude score in soap production based on practical approaches

		Pre-test		Post-test			
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**MD**	**Level**
Virtual Lab	37	87.11	15.44	153.65	10.70	66.54	N
Hands-on Activity	44	84.57	13.31	213.16	43.53	128.59	SP
Expository	48	89.73	19.88	153.94	12.02	64.21	N

N= Negative, SP= Slightly positive

Result in Table 1 shows the mean difference (post-test and pre-test) students scientific attitude to be 66.54, 128.59 and 64.21 respectively. This result indicates that students taught soap production using Hands-on activity approach had positive scientific attitude while those taught using the virtual laboratory and Expository approaches had negative scientific attitude.

Research Question Two: What is the difference in male and female students' scientific attitude mean scores?

Table 2: Mean and standard deviation of male and female students' pre-test and post-test scientific attitude mean scores

		Pre-test		Post-test			
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean gain**	**Level**
Male	55	87.40	16.78	168.51	35.01	81.03	SP
Female	74	87.08	16.63	174.18	41.45	87.10	SP

SP= slightly positive

Result in Table 2 shows the mean difference (post-test and pre-test scores) for male and female students to be 81.03 and 87.10, respectively. This result indicates that both male and female students had positive scientific attitude.

Research Question Three: What is the interaction effect of practical approaches and gender on students' scientific attitude in soap production?

Table 3: Interaction effect of practical approaches and gender on scientific attitude in soap production

		Pre-test		Post-test			
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**	**Level**
Virtual Laboratory							
Male	18	88.78	16.78	152.78	10.05	64.00	N
Female	19	85.53	14.35	154.47	11.50	68.94	N
Hands-on Activity							
Male	16	82.88	13.37	206.25	44.45	123.37	SP
Female	28	85.54	13.43	217.11	43.32	131.57	SP
Expository							
Male	21	89.05	19.46	155.43	12.40	66.38	N
Female	27	90.26	20.56	152.78	11.82	62.52.	N

N= Negative, SP= slightly positive

Result on Table 3 shows the pre-test and post-test mean score of the interaction effect of gender and practical approaches on students' scientific attitude score in soap production. The result shows that the female students exposed to virtual laboratory approach had higher mean increase in scientific attitude of 68.94 as compared to the male students who had 64.00 which indicates that virtual laboratory proved to be more effective in increasing students' scientific attitude score of female students in soap production more than their male counterparts, but the scientific attitude was negative for both male and female. In like manner, female students exposed to hands-on activity approach had a higher mean gain of 131.57 as against 123.37 for the male students. This means that hands-on activity approach proved to be more effective in increasing students' scientific attitude score which was positive for both male and female students. Furthermore, the result shows that male students under expository approach had a higher mean difference of 66.38 when compared to their female counterparts with a mean gain of 62.52, but the scientific attitude was negative for both male and female.

Testing of Hypotheses

Hypothesis One: There is no significant effect of practical approaches on students' scientific attitude score

Table 4: Analysis of Covariance (ANCOVA) of students' post-test on scientific attitude score classified by practical approaches (virtual laboratory, hands-on activities and expository) with pre-test as covariate

Source of Variance	Sum of squares	df	Mean	F	Sig
Corrected model	103645.38 [a]	6	17274.23	23.19	0.00
Pre-test (Covariate)	284.84	1	284.84	0.38	0.54
Main effect:					
Practical Approaches	89491.30	2	44745.65	60.07*	0.00
Error	90883.23	122	744.95		
Corrected total	194528.62	128			

*significant at p<.05

The result on Table 4 shows the analysis of Variance (ANCOVA) of the effect of practical approaches (virtual laboratory, hands-on activity and expository) on students' scientific attitude. The results show that there is a significant effect of practical approaches on students' scientific attitude (F=60.07; 0= 0.00). Hence the null hypothesis that there is no significant effect of practical approaches on students' scientific attitude score is rejected at the 0.05 level of significance.

To show which of the practical approaches was better in producing students' scientific attitude, a Post Hoc using LSD was performed as reported in Table 5

Table 5: Summary of LSD Post Hoc pair wise comparison of students' post- test performance classified by practical approaches

Treatment groups (I)	(J)	Mean Diff (I-J)	Std. Error	Level of sig.
Virtual Laboratory	Hands-activity	-57.79*	6.215	0.000
	Expository	-0.47	6.005	1.000
Hands-activity	Virtual Laboratory	57.79*	6.215	0.000
	Expository	57.79*	5.892	0.000
Expository	Virtual Laboratory	-0.47	6.005	1.000
	Hands-activity	-57.79*	5.892	0.000

R Squared = .740 (Adjusted R Squared = .726) *significant at p<0.05

Table 5 shows the Post-Hoc result of the significant effect of practical approaches on students' scientific attitude. Results show that virtual laboratory and hands-on activity differ significantly, but virtual laboratory and expository approach do not differ, hands-on activity and expository differ with hands-on activity showing more promise in enhancing students' scientific attitude.

Hypothesis Two: There is no significant difference in male and female students' scientific attitude

mean scores

Table 6: Analysis of Covariance (ANCOVA) of male and female students' post-test scientific attitude mean score with pre-test as covariate

Source of Variance	Sum of squares	df	Mean	F	Sig
Corrected model	103645.38 [a]	6	17274.23	23.19	0.00
Pre-test (Covariate)	284.84	1	284.84	0.38	0.54
Main effect:					
Practical Approaches	89491.30	2	44745.65	60.07*	0.00
Gender	649.83	1	649.83	.87	0.35
Error	90883.23	122	744.95		
Corrected total	194528.62	128			

*significant at p<.05

The result on Table 6 shows the Analysis of Variance (ANCOVA) of the difference in male and female students' scientific attitude. The result showed that there is a no significant difference in male and female students' scientific attitude (F=0.87; P=0.35). Since the associated probability value of 0.35 obtained is greater than 0.05 level of significance set for decision making, the null hypothesis which states that there is no significant difference in male and female students' scientific attitude mean scores was rejected.

Hypothesis Three: There is no significant interaction effect of practical approaches and gender on scientific attitude in soap production

Table 7: Analysis of Covariance (ANCOVA) of male and female students' post-test scientific attitude mean score with pre-test as covariate

Source of Variance	Sum of squares	df	Mean	F	Sig.
Corrected model	103645.38 [a]	6	17274.23	23.19*	0.00
Pre-test (Covariate)	284.84	1	284.84	0.38	0.54
Main effect:					
Practical Approaches	89491.30	2	44745.65	60.07*	0.00
Gender	649.83	1	649.83	0.87	0.35
Error	90883.23	122	744.95		
Corrected total	194528.62	128			

*significant at p<.05

The result on Table 7 shows the Analysis of Variance (ANCOVA) of the difference in male and female students' scientific attitude. The result showed that there is no significant difference in male

and female students' scientific attitude (F=0.87; P=0.35). Since the associated probability value of 0.35 obtained is greater than 0.05 level of significance set for decision making, the null hypothesis which states that there is no significant interaction effect of practical approaches and gender on scientific attitude in soap production was retained.

Discussion of Findings

Findings on the effect of practical approaches on students' scientific attitude showed that students taught soap production using hands-on activity approach increased in scientific attitude better than those taught using the virtual laboratory, followed by those taught using Expository approach. This could be attributed to the fact that hands-on activity approach increased learners' understanding of scientific concepts through manipulating objects and made then appreciate the science experiments and this increased their scientific attitude disposition. They had a slightly positive attitude to science which showed their behaviour towards science. This agrees with Oluwatelure and Oloruntegbe (2020) who stated that scientific attitude as a concept arises from an effort to explain regularities in individual behaviours toward science.

The findings of this study showed that there is a significant effect of practical approaches on students' scientific attitude. The post hoc analysis also showed that virtual laboratory and hands-on activity differ significantly, but virtual laboratory and expository approach do not differ, hands-on activity and expository differ with hands-on activity showing more promise in enhancing students' scientific attitude. The findings of this study is in line with that of Olasehinde and Olatoye (2014) who examined scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria.. Findings showed that there is a significant positive relationship between scientific attitudes. The findings of this study is also in line with that of Sakariyau, Taiwo and Ajagbe (2017) which investigated the attitudes of secondary school students towards science in Odeda Local Government Area of Ogun State, Nigeria. Findings showed that a higher proportion of the students display positive attitude towards science. The findings of this study is in contrast with that of Nisha and Prema, (2022) was conducted a study on the levels of scientific attitude among school students. Results showed that there is no significant difference between the levels of scientific attitude of different age groups.

Results of this study show that when students are exposed to the use of practical activities they then change their perspective of science. Adesoji (2018) observed that scientific attitude account for 25% of the variability in students' performance scores. The findings of this study therefore indicates that the use of hands-on activity approach raised the scientific attitude of students when taught soap production.

Findings on the difference in male and female students' scientific attitude mean scores showed that both male and female students had positive scientific attitude. This could be due to the fact that female students strive competitively in any given science class. This agrees with

Amiezca and Ikhsan (2020); Eden and Mbuk (2019) that females exhibit a more favourable attitude towards Chemistry than their male counterparts. According to Adesoji (2018) several factors are related to students' attitude toward science such as: teacher attitudes, teaching method, students' cognitive style, parents' influence, gender, age, career interest, and social view of science. However, this difference was not statistically significant.

The non- significant difference in male and female students' scientific attitude is in line with Olasehinde and Olatoye (2014) who examined scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria. Results showed that there is no significant difference between male and female students in scientific attitude. The findings of this study are also in line with Nisha & Prema (2022) who conducted a study on the levels of scientific attitude among school students. The results showed that there is no significant difference between boys and girls in their level of scientific attitude. This findings also collaborates that of Sakariyau, Taiwo and Ajagbe (2017) in a study which investigated the attitudes of secondary school students towards science in Odeda Local Government Area of Ogun State, Nigeria. Findings showed that there was no significant difference between the attitude of male and female students towards science. Therefore, it was concluded that there is no difference in male and female students' scientific attitude as both gender are comparatively competitive in a Chemistry class on soap production.

Findings on the interaction effect of practical approaches and gender on scientific attitude in soap production showed that the female students exposed to virtual laboratory and hands-on activity approaches had higher mean increase in scientific attitude as compared to the male students. This could be due to the fact that virtual laboratory and hands-on activity approaches captivated the students and furnished more interest in them thereby building more positive scientific attitude. As Crawley and Koballa (2014) puts it, scientific attitude is a general positive or negative feeling about science; whether a person likes or dislikes science. This agrees with Yehya *et al.* (2019) that the use of well-designed virtual laboratory has the potential to increase learners' positive attitudes toward science. However, there was no interaction effect of practical approaches and gender on scientific attitude in soap production.

The non-significant interaction effect of practical approaches and gender on scientific attitude in soap production is in line with Olasehinde and Olatoye (2014) who examined scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria. Result showed that there is no significant difference between male and female students in scientific attitude, attitude to science and science achievement. The findings of this study is also in line with that of Jack and Zubairu (2022) who investigated the influence of gender on secondary school students' achievement, retention and attitude in Chemistry using 4MAT teaching model in Jalingo Education Zone of Taraba State. The study revealed an insignificant effect of gender, insignificant effect of attitude, and insignificant interaction effect of gender and treatments on students' achievement in Chemistry using 4MAT.

Conclusion

The result of this study highlighted the effect of practical approaches in fostering positive scientific attitudes of Chemistry students in soap production. The hands-on activity approach helped the students to overcome the difficulties inherent in learning the concept of soap production which is a practical based concept and is difficult to understand theoretically by both students and teachers. Based on the findings of this study, it was concluded that hands-on activity was most effective in producing students' positive scientific attitude. There was no significant effect of gender across treatment groups.

Recommendations

Based on the findings, it is recommended that;

i. The use of hands-on activity approach should be encouraged for teaching students who will acquire positive scientific attitudes
ii. Teachers of Chemistry in secondary schools should be trained on the use of hands-on activity as it will re-emphasize the need for teachers to always enrich the teaching and learning process with good practical approaches that will foster scientific attitude.
iii. Professional bodies and other Education stakeholders should organize conferences, seminars and workshops for Chemistry teachers to acquaint them with the use of practical approaches to improve the process and product of learning.

References

Adesoji, F. A. (2018). Managing students' attitude towards Science through Problem-Solving Instructional Strategy. *Anthropologist,* 10 (1), 21-24.

Ajayi, O. V. & Ogbeba, J. (2017). Effect of gender on senior secondary Chemistry Students' Performance in Stoichiometry Using Hands-on activity. *American Journal of Educational Research*, 5 (8), 839-842

Akanwa, U. N., Ndirika, M. C. & Udoh, N. M. (2018). Effect of jigsaw and debriefing teaching techniques on Biology students' performance on water holding capacity of Soil in Uyo Municipal. Akwa Ibom State, Nigeria. M.Ed Thesis Submitted to the Department of Science Education

Alkan, F. (2016). Experiential learning: Its effects on performance and scientific process skills. *Journal of Turkish Science Education*, 13(2), 15-26.

Arniezca, E. Y. & Ikhsan, J. (2020). Students' attitudes towards chemistry: on the gender and grades perspective. *Advances in Social Science, Education and Humanities Research,* 54(1), 309 - 314

Bogusevschi, D., Muntean, C., & Muntean, G. M. (2020). Teaching and learning physics using 3D virtual learning environment: A case study of combined virtual reality and virtual laboratory in secondary school. *Journal of Computers in Mathematics and Science Teaching, 39*(1), 5-18.

Campos, N., Nogal, M., Caliz, C., & Juan, A. A. (2020). Simulation-based education involving online and on-campus models in different European universities. *International Journal of Educational Technology in Higher Education,* 17(1), 1-15.

Coulter, B. (2019). Science through modelling and simulation connect. Available at http://www.iiste.org. Retrieved on 20th January, 2023.

Crawley, F.E. & Koballa, T.R. (2014). Attitude research in science education: Contemporary model and methods. *Science Education,* 78, 35-55.

Dewey, J. (1938). Experience and Education.Toronto: Collier-McMillan Canada ltd.

Diwakar, S., Kumar, D., Radhamani, R., Nizar, N., Nair, B., Sasidharakurup, H., & Achuthan, K. (2015). Role of ICT-enabled virtual laboratories in biotechnology education: Case studies on blended and remote learning. In *International Conference on Interactive Collaborative Learning (ICL),* (pp. 915-921).

Eden, M. I. & Mbuk, W. (2019). Students' attitude towards Chemistry and their academic performance in selected concepts in Chemistry among secondary school students in Ibiono Ibom Local Government Area, Nigeria. *International Journal of Innovative Research and Advanced Studies*, 6 (12), 19-26.

Eden, M. I., Akpan, I. F. & Umanah, F. I. (2023). Virtual laboratory and hands-on activity approaches on students' academic performance in soap production in Akwa Ibom State. *International Journal of Education Framework,* 3(1), 135-150

Fuad, M., Deb, D., Etim, J. and Gloster, C. (2018). Mobile response system: A novel approach to interactive and hands-on activity in the classroom. *Educational Technology Research and Development*, 66 (2), 493–514.

İbrahim, H. Ö. (2014). Curriculum reform and teacher autonomy in Turkey: The case of history teaching. *International Journal of Instruction,* 4 (2), 13-25.

Jack. G. U. and Zubairu, H. A. (2022). Influence of gender on secondary school student's achievement, retention and attitude in Chemistry using 4MAT teaching model *Journal of Education in Developing Area,* 29 (2), 1-10

Kahu, E. R. & Nelson K. (2018). Student engagement in the educational interface: understanding the mechanisms of student success. *Higher Education Research & Development,* 37 (1), 58-71.

Kousa, P. Kavonius, R. & Aksela, M. (2018). Low-achieving students' attitudes towards learning Chemistry and its teaching methods. *Chemistry Education Research and Practice,* 19 (2), 1-16

Mahdi, G. J. (2014). Students' attitudes towards chemistry: an examination of choices and preferences. *American Journal of Educational Research*, 2(6), 351–356.

Majid, A. N. & Rohaeti, E. (2018). The effect of context-based chemistry learning on student performance and attitude. *American Journal of Educational Research*, 6(6), 836-839

Montes, L. H., Ferreira, R. A. & Rodríguez, C. (2018). Explaining secondary school students' attitudes towards Chemistry in Chile. *Chemistry Education Research and Practice*, 19(2), 1-17

Nisha, K. & Prema, N. (2022). Levels of scientific attitude among school students: A brief survey. *Journal of Positive School Psychology,* 6 (4), 11583 – 11586

Olasehinde K. J, Olatoye R. A. (2014). Scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State Nigeria. *Journal Education Social Research,* 4(1), 445-452.

Olatunji, F. (2015). Readability of Basic Science and Technology for primary school. *Research Journal in Organizational Psychology and Educational Studies,* 1 (1), 23-36.

Oluwatelure, T. A. & Oloruntegbe, K. O. (2020). Effect of parental involvement on students' attitude and performance in Science, *African Journal of Microbiology Research,* 4 (1), 1 – 9.

Perloff, R. M. (2016). The dynamics of persuasion: communication and attitudes in the twenty-first century. Routledge

Ranjan, A. (2017). Effect of virtual laboratory on development of concepts and skills in physics. *International Journal of Technical Research & Science, 2*(1), 15-21.

Sarabando, C., Cravino, J. P. & Soares, A. A. (2016). Improving student understanding of the concepts of weight and mass with a computer simulation. *Journal of Baltic Science Education,* 15(1), 109-126

Supardi, R., Istiyono, E. & Setialaksana, W. (2019). Developing scientific attitudes instrument of students in chemistry. *Proceedings from the International Seminar on Science Education. 012025*.

Udu, D. A. (2018). Utilization of learning activity package in the classroom: Impact on senior secondary school students' academic performance in organic Chemistry. *African Journal of Chemical Education,* 8(2), 49-71.

Vygolsky, L. (1973). Constructivist Theory Applied to Collaborative Learning. Available at http://www.Simplyphyschology.Org.

Wahyudiati, D. & Rohaeti, E. (2020). Attitudes toward Chemistry, self-efficacy, and learning experiences of pre-service Chemistry teachers: Grade level and gender differences. *International Journal of Instruction,* 13, 235–254.

Yehya, F., Barbar, A. & Abou-Rjelil, S. (2019). Learning with simulations: Influence of a computer simulation with hand-on activities on students' learning of the physics capacitors' concepts. *Research in Social Sciences and Technology,* 4(1), 1-29.

Yunus, F. W. & Ali, Z. M. (2014). Urban students' attitude towards learning Chemistry, *Procedia Social and Behavioural Science,* 68, 295–304.

Yusuf, I. & Widyaningsih, S. W. (2020). Implementing e-learning-based virtual laboratory media to students' metacognitive skills. *International Journal of Emerging Technologies in Learning,* 15(5), 63-73.