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NIGERIAN SENIOR SECONDARY SCHOOL (SSS) CHEMISTRY TEACHER'S KNOWLEDGE AND BELIEFS ABOUT APPLICATION OF MULTIPLE REPRESENTATIONS' (MR) IN CHEMISTRY PEDAGOGY

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Abstract

Multiple representations interpret for repeated substitutions of pedagogical activities of concepts with different types of representations. The challenges in learning chemistry have to do with beliefs, pedagogy and school curriculum. These challenges were also attributed to students' lack of interest, which led to the increase in chemistry attrition rates. The framework for this study was an intervention that involved the case study of five purposively selected chemistry teachers from low resourced SSS in Lagos. The descriptive and interpretive methodologies were used in the study. This article narrated a research process on chemistry teachers' knowledge and beliefs about applications of multiple representations in SSS chemistry pedagogy. Five case study teachers completed the only questionnaire in this study. They responded to items on their background data, and about teaching practices, beliefs and difficulties in teaching chemistry effectively. They were interviewed and their classroom lessons were observed, before the intervention. The intervention in the study consisted of two professional learning workshops. Participants were actively engaged on how to apply multiple representations during the pedagogical processes of three perceived "difficult" chemistry topics. The chemistry teachers' classroom activities were also observed, after the first and second multiple representations workshops. The process involved representational activities and challenges that were complemented with experiments and small group discussions. Findings showed that application of multiple representations (MR) impacted positively on the teachers' knowledge, beliefs and practices. The students were more actively engaged in learning chemistry. It was recommended that chemistry teachers should be resourceful, creative and develop skills that supports the application of multiple representations in classroom pedagogies.

Introduction

Chemistry was viewed by students as a difficult subject because it had many other concepts combined into its learning structure (Kausar, Ghazala and Anosha, 2022; Olaleye, 2013). Chemistry involved both abstract and high order thinking, and employed mathematical calculations in almost all the topics, because it is a branch of science that deals with composition of matter from substances, which included the interaction among substances in the formation of compounds, examined the properties and reactions of chemical compounds and involved the formation of new chemical substances (Braimoh, 2022). Chemistry further tracks into the physical and chemical properties of matters from reactions and investigates the shared

values and uses of independent and combined matters to societies. The focus in contemporary studies in chemistry education has been on how to make chemistry pedagogy interesting without the use of the conventional traditional lecture methodologies. Creativities and innovations in learning chemistry were addressed by researchers across different aspects of chemistry education (Ogunmade, Braimoh and Saibu, 2024; Saibu, 2023; Chukwu and Adolphus, 2022; Choi and Lee, 2021). The idea of investigating the knowledge and beliefs of chemistry teachers with application of multiple representations (MR) for chemistry pedagogy was to further the understanding of how MR would help chemistry teachers in becoming effective in chemistry pedagogy.

Multiple representations interpret for repeated representation of concepts with different types of representations. The challenges in learning chemistry have to do with beliefs, pedagogy and school curriculum (Ogunmade, Braimoh and Saibu, 2024). These challenges were also attributed to students' lack of interest, which led to the increase in chemistry attrition rates (Olaleye and Braimoh, 2018). Conceptual learning in chemistry would be best achieved when learners were able to express chemistry concepts with different representations. In such circumstance, concepts could be represented as concept maps, role-plays, mathematical or graphical representations, models, flow-charts, tables, particulates or verbal representations. Multiple representations in chemistry pedagogy would provide opportunities for conceptualising chemistry concepts with different representations Incikabi (2017). The focus in this research was to address how the senior secondary school (SSS) pedagogy of chemistry would improve, and about how teachers' knowledge and beliefs were often translated into their classroom pedagogical practices. Braimoh *et al.* (2023) reiterated this by mentioning that chemistry teachers' pedagogical practices and beliefs should be tailored towards developing creative skills, experimentation and inquiry. Upon those stances, chemistry teachers would live with beliefs in effective chemistry pedagogies and about how best to construct representations of chemistry concepts.

Research Questions

The following research questions were used in the research:

1) What difficulties do chemistry teachers encounter in effective chemistry pedagogy in Nigerian senior secondary schools (SSS)?
2) What are the current knowledge and beliefs of Nigerian SSS chemistry teachers regarding the use of multiple representations (MR) in chemistry pedagogy?
3) How do multiple representations influence Nigerian chemistry teachers' beliefs, knowledge, and pedagogical practices?

Sample/Sampling Techniques

Thirty chemistry teachers completed the only questionnaire for this study. Five chemistry teachers were purposively selected for this intervention study. The selected teachers participated in the two workshops that explored multiple representations. They planned lessons for three different topics, which were agreed upon by them to be perceived "difficult" SSS chemistry topics. The topics selected by the five teachers were:

1) Oxidation and reduction;
2) Reaction rates and collision theory; and

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3) Water and solutions.

Afterwards, the chemistry teachers' lessons were observed, and they were interviewed.

Chemistry teaching and learning challenges

Data were obtained from chemistry classroom observations and interviews. The chemistry teachers revealed that there were difficulties in teaching chemistry. The challenges mentioned included time constraints, inadequate laboratory facilities and equipment, inadequate instructional materials, teachers' low morale and attitude, teachers' inability to complete the syllabus as scheduled, poor students' attitudes towards chemistry, very large chemistry classes, non-professionalism, poor learning environment and inadequate support from parents. From the pre-intervention interview, the chemistry teachers also explained that they use the conventional traditional methodology for chemistry teaching. One of the teachers expressed a belief in the use demonstration method as the best pedagogical process for learning SSS chemistry. Further investigation showed that the teachers were unable to effectively and frequently use demonstration method with the limited chemistry resources in schools. Teachers explained that students' assessment and evaluation of chemistry lessons were carried out with oral questions and quiz.

Classroom practices observations

Two chemistry lessons were observed with the five teachers. The procedure was to have one single period and one double period. Prior to the intervention, a single period and a double period of chemistry lessons were observed with each of the five sampled chemistry teachers. These lessons were observed to identify the teachers' current practice and the extent of students' engagement in their lessons. Classroom observations were made after the first and second intervention workshops on multiple representations. The observations focused on the pedagogical practices of chemistry teachers.

The activities in this study included the:

1) Observations of sampled chemistry teachers' classroom practices were made prior to the first workshop (i.e. the first workshop conducted on multiple representations);
2) First workshop was conducted on multiple representations;
3) Post-first workshop interaction with sampled chemistry teachers was conducted;
4) Second workshop was conducted on multiple representations;
5) Post-second workshop interaction with sampled chemistry teachers was conducted;
6) Further observations of sampled chemistry teachers' classroom practices were made after the post-second workshop interaction with sampled chemistry teachers (i.e. the first workshop conducted on multiple representations);
7) Interviews with sampled chemistry teachers after intervention;
8) Data generation on chemistry teachers' knowledge and beliefs on the pedagogy of chemistry;
9) Data generated were reported in the following section.

It would be important to be reminded that the pre-intervention interview revealed the chemistry teachers prior beliefs in the use of conventional traditional methodologies for chemistry. In such circumstance, the teacher acted as repository of knowledge, and demonstrated very few experiments.

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Lesson observations

The lesson taught by the chemistry teachers during the pre-intervention observation was "oxidation and reduction reactions." Teachers B, C, and E lessons were basically teacher-centered. The classes were developed and completed with explanations of ideas with little opportunities for interaction with students. Teachers dominated majority of the classrooms talks. They believed that they were authorities that knew what would be useful or the successful ideas that the students should learn from lessons. Out of 80 minutes of each lesson, the average calculated for the five teachers was 54 minutes used for teachers' explanations, while the average time for teacher-student interaction was 7.8 minutes. Teachers A and D introduced their lessons. The lessons taught by teacher A and D appeared to be organized with procedures of step-by-step approach, but were also teacher-centered. At the point of evaluating lessons taught, most students were unable to explain the re-arrangement of atoms and molecules in oxidation, reduction and redox reactions.

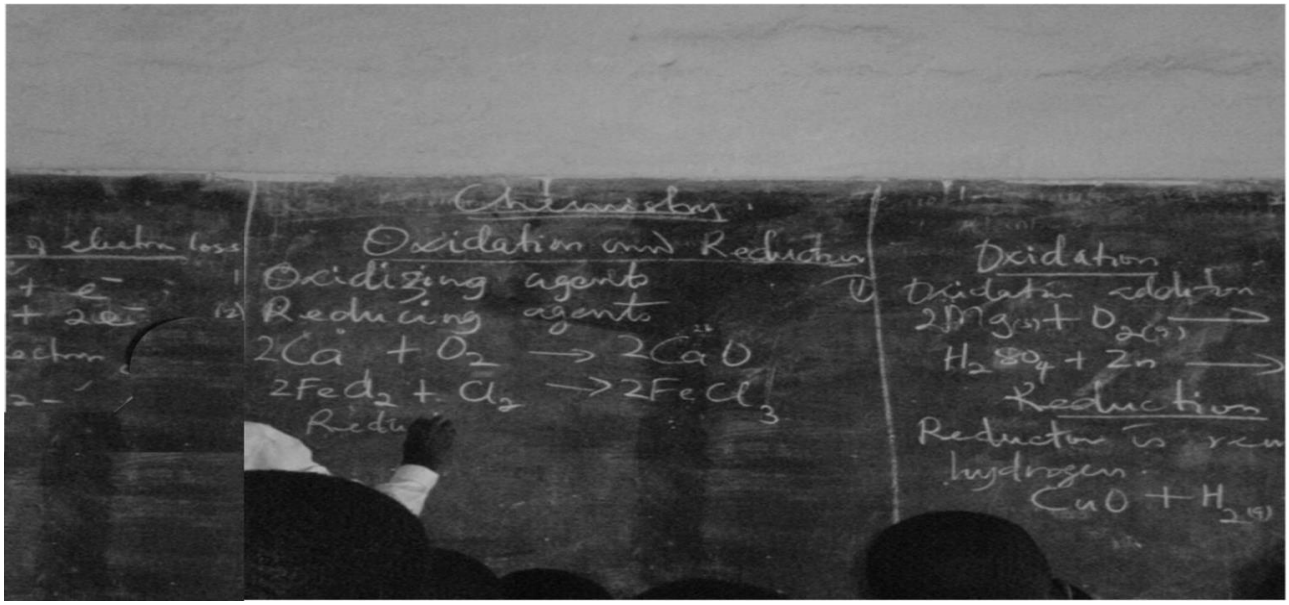

Figure 1a: Teacher D's blackboard notes

Teachers were conspicuously occupied with the teaching activities and did not allow students to respond to their presentation of contents. Researchers also observed that many students struggled to write down few things in their notebooks because blackboard contents were frequently rubbed off, as teachers aimed towards completing lessons within the limited time. Time was not enough.

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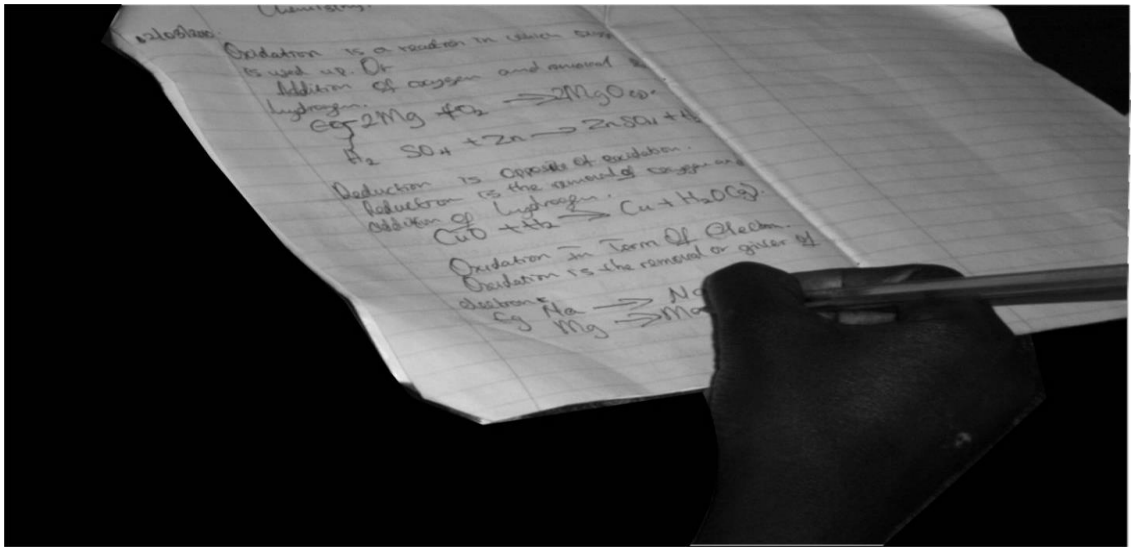

Figure 1b: Notes written by a student in Teacher D's lesson

Researchers realized that the participating chemistry teachers engaged in explanations and calculations throughout periods of lessons. Students did not get all information in the lesson.

Table 1, summarized the observations in the pre-intervention classroom teaching practices of the case study chemistry teachers. In this circumstance, a double period lesson was observed for each of the five teachers.

Table 1: Pre-intervention lesson observations for five case study chemistry teachers: Lesson topic: Oxidation-reduction

S/N	Pedagogical Strategies	TIME (Minutes) Tr. A	Tr. B	Tr. C	Tr. D	Tr. E	Ave.
		(%)	(%)	(%)	(%)	(%)	(%)
1.	The teacher is speaking and writing on the board as the students hardly write notes.	56 (70)	52 (65)	51 (63.75)	57 (71.25)	54 (67.5)	54 (67.5)
2.	The teacher and students participate in a question-and-answer session during chemistry lesson.	8 (10)	10 (12.5)	9 (11.25)	5 (6.25)	7 (8.75)	7.8 (9.75)
3.	Students converse as coteries during the lesson.	-	-	-	-	-	-
4.	Chemistry teacher and students participate in various pedagogical activities, thereby students were encouraged to create learning representations such as graphical illustrations, role-plays, models, diagrams, concept maps and flowcharts.	-	-	-	-	-	-

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5.	Students jot down notes and assignments as chemistry teacher put them on the blackboard.	6 (7.5)	8 (10)	12 (15)	10 (12.5)	9 (11.25)	9 (11.25)
6.	Teacher's assessment of chemistry learning.	10 (12.5)	10 (12.5)	8 (10)	8 (10)	10 (12.5)	9.2 (11.5)
7.	Duration of chemistry lesson (in minutes).	80	80	80	80	80	80

Note: Tr. = Teacher; Ave. = Average; % = Per cent.

From the data in Table 1, it was observed that all the participating chemistry teachers adopted teacher-centered methodology. 70% of the entire period of lesson was used by Teacher A on talking and writing on blackboard. Teacher D used 71.25%, and the per cent of the average time used by the sampled teachers on talking and writing on blackboard was calculated as 67.5%. The teachers spent little time on interacting with their students during the 80 minutes double period of lesson. It was recorded that Teacher B had 12.5% of her time for interacting with her students, while Teacher C had 11.25% of his time for same. The per cent of the average time recorded for Teacher-Students interaction for all the teachers was 9.75%. None of the teachers had recorded time for small group discussion during their lessons. Further, it was also recorded that none of the sampled chemistry teachers engaged their students with classroom activities. The time provided by Teacher A for jotting notes and assignments was 7.5% and Teacher B used 10% for same. The average per cent of time used by the sampled chemistry teachers for evaluating learning during the period of lesson was 11.5%.

Key findings 1
The observed pedagogical approach used by the sampled chemistry teachers was predominantly lecture-based, leaving-out little opportunity for active student engagement. Students largely remained passive, with minimal time allocated for teacher-student interactions. Additionally, there was no provision for small group discussions and hands-on class activities.

Chemistry teachers' participation in the first workshop conducted on multiple representations

Table 2, as presented below summarized the challenges and problems of SSS chemistry pedagogy, as mentioned by sampled chemistry teachers.

Table 2: Challenges of teaching and learning in SSS chemistry.

The obstacles of effective teaching and learning in SSS	*Recommended solutions*
Large chemistry class sizes with high student-to-teacher ratio.	Addressing the challenges of large chemistry classes and students' engagement through group discussions, the adoption of the applied scholastics method, and soliciting collaborative support from private organizations.

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Absence of chemistry laboratories and insufficient laboratory equipment and materials.	Overcoming the challenges of absence of chemistry laboratories with use of improvisation should be further stimulated.
Students are not showing interest towards learning chemistry.	Teacher should possess brilliant and strong mastery of subject matter. Teacher should link chemistry concepts with students' real-world experiences/activities. The use of models, diagrams and flow-charts in chemistry pedagogy should be encouraged
Chemistry teachers possessed insufficient qualifications.	The challenges of unqualified chemistry teachers could be addressed by engaging qualified and professionally trained chemistry educators.
Students' limited exposure to the foundational knowledge of chemistry concepts.	By developing Junior Secondary School (JSS) basic science curriculums, which have foundational topics of Senior Secondary School (SSS) chemistry concepts.
Frequently changing curriculum materials.	SSS chemistry teachers should be encouraged to organize and regularly attend professional development activities, like conferences, workshops, seminars and curriculum development meetings.
Insufficient teachers' salaries.	Chemistry teachers should be adequately remunerated.
Teachers' limited knowledge in use of contemporary strategies for teaching abstract chemistry concepts.	Chemistry teachers should be encouraged to update their content knowledge with use of technology. Artificial Intelligence is readily available for providing new knowledge and developments in chemistry pedagogy.

Teaching and learning following the first workshop

The teachers were observed for another 80 minutes of double lessons after the first workshop, in order to identify the impacts of the learning on use of multiple representation programme on their classroom practices. After the lesson observation, the teachers were interviewed. Classroom settings included the teacher having discussions with the whole class, small group and individual student work respectively.

Lesson observation

After attending the workshop, the five chemistry teachers' lessons were observed. The teachers were more of using multiple representations strategies. Students actively participated in experiments and in writing of equations for reactions (See Figures 2 & 3).

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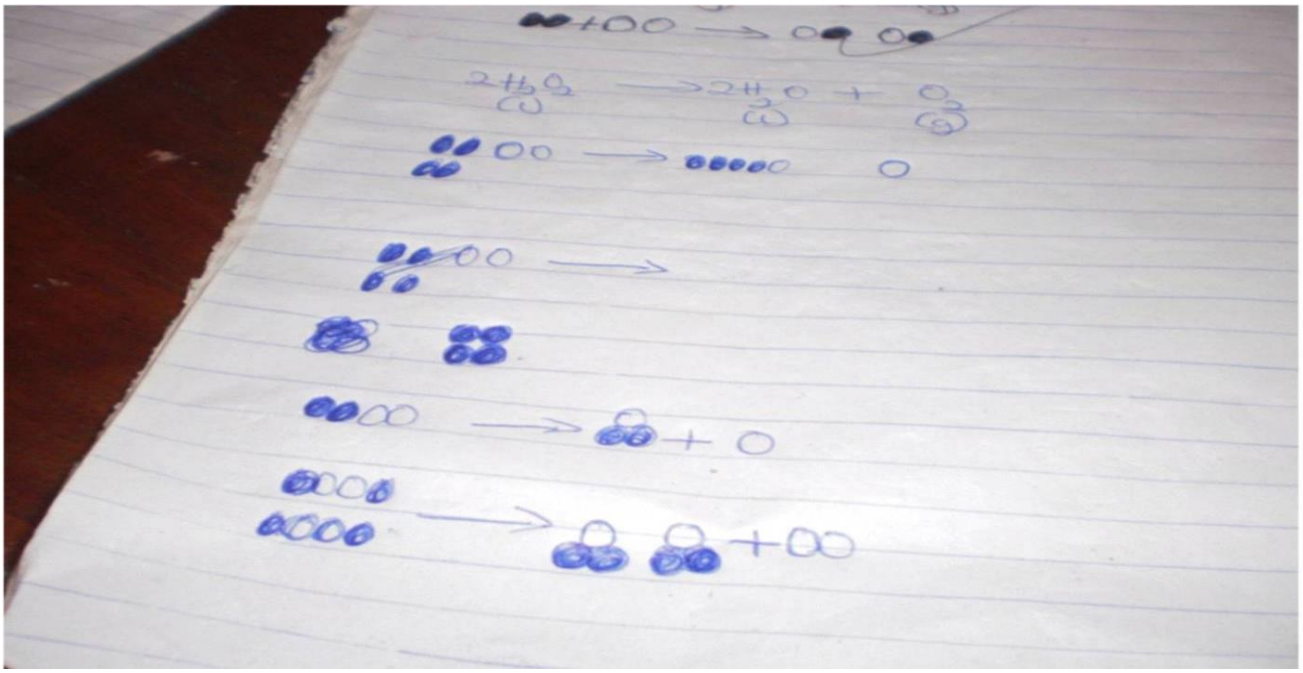

Figure 2: Example of equation for representation of thermal decomposition of hydrogen peroxide as designed by a student.

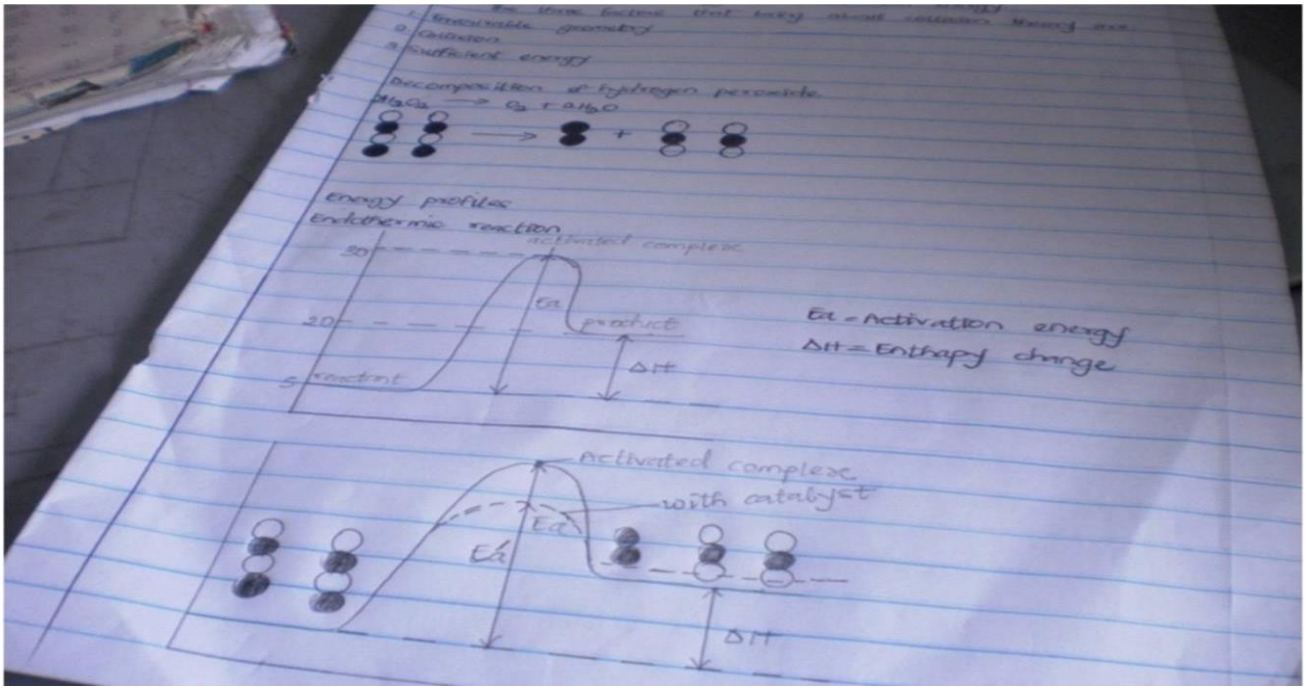

Figure 3: Example of graphical representations of thermal decomposition of hydrogen peroxide as prepared by a student.

Figure 3 summarised the classroom activities of case study chemistry teachers during the double period lessons supervised on use of multiple representations.

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Table 3: Observation of chemistry teachers' lessons after first workshop on multiple representations:

S/N	*Pedagogical Strategies*	TIME (Minutes) Tr. A (%)	Tr. B (%)	Tr. C (%)	Tr. D (%)	Tr. E (%)	Ave. (%)
1.	The teacher is speaking and writing on the board as the students hardly write notes.	2 (2.5)	4 (5)	5 (6.25)	4 (5)	3 (3.75)	3.6 (4.5)
2.	The teacher and students participate in a question-and-answer session during chemistry lesson.	8 (12.5)	12 (15)	9 (11.25)	5 (6.25)	7 (8.75)	8.2 (10.25)
3.	Students converse as coteries during the lesson.	10 (12.5)	15 (18.75)	12 (15)	10 (12.5)	14 (17.5)	12.2 (15.25)
4.	Chemistry teacher and students participate in various pedagogical activities, thereby students were encouraged to create learning representations such as graphical illustrations, role-plays, models, diagrams, concept maps and flowcharts.	40 (50)	37 (46.25)	35 (43.75)	44 (55)	38 (47.5)	38.8 (48.5)
5.	Students jot down notes and assignments as chemistry teacher put them on the blackboard.	12 (15)	8 (10)	10 (12.5)	8 (10)	9 (11.25)	11.2 (14)
6.	Teacher's assessment of chemistry learning.	8 (12.5)	4 (5)	9 (11.25)	9 (11.25)	9 (11.25)	7.8 (9.75)
7.	Duration of chemistry lesson (in minutes).	80	80	80	80	80	80

Note: Tr. = Teacher; Ave. = Average; % = Per cent.

The classroom observations of sampled chemistry teachers' as made by the researchers after the first workshop on multiple representations showed that Teacher A used 2.5% of the 80 minutes double period lesson for talking and writing. For that same activity, time used (in per cent) by Teachers B, C, D and E were respectively 5, 6.25, 5 and 3. The average per cent recorded for talking and writing on the board was 4.5%. In the same In that same agreement, the average per cent calculated for question and answer session was 10.25%. There were tremendous improvements in teachers' practice of organising students into small discussion groups during lessons. Teachers' A, B and E spent 12.5%, 18.75% and 15.25% of the 80 minutes lessons on the pedagogical strategy of organising students into small discussion groups. The first workshop on multiple representations provided new ways for sampled teachers in presenting chemistry classroom learning. The average per cent of the time used by the chemistry teachers during the 80 minutes lessens, on challenging and engaging students with pedagogical activities was 48.5%, while the per cent of time spent by students on copying notes and assignments, as were written on the blackboards was 14%. All the participating teachers expended between 4 and 10 minutes out the double period of 80 minutes for evaluating chemistry lessons taught.

From the interview on chemistry teachers' pedagogical experiences with application of multiple representations, it was revealed that majority of the teachers (80%) of them engaged their classes. It was

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mentioned that chemical reagents, laboratory materials and equipment were not readily available for practical and demonstration of reactions mechanisms. The teachers also revealed that students were unable to perform experiments individually, due to limited number of laboratories and chemistry facilities.

The teachers were enthusiastic in their participation and use of multiple representations in chemistry pedagogy. The teachers reported that they were particularly interested in the learning intervention. They explained that these pedagogical processes required fewer efforts.

Key findings 3
With application of multiple representation, the students were actively involved, and their participation in learning chemistry was evident. The teachers made a positive impact on teaching what were traditionally seen as "difficult" chemistry topics. Additionally, the teachers shared that their experience with multiple representation expanded their understanding of chemistry teaching strategies and shifted their perspectives on these challenging topics.

The second workshop on multiple representations was held. The topic in these chemistry classroom practices is "water and solutions." Classroom activities of the chemistry teachers were observed. The classroom settings were scheduled on the observation template. The experiences were different from what was observed before the first MR workshop, where the teachers talked for almost the entire double period lessons of 80 minutes. It was observed during the second workshop that students were actively engaged in various pedagogical activities and they used representational modes to develop solutions to problems (see Figure 4).

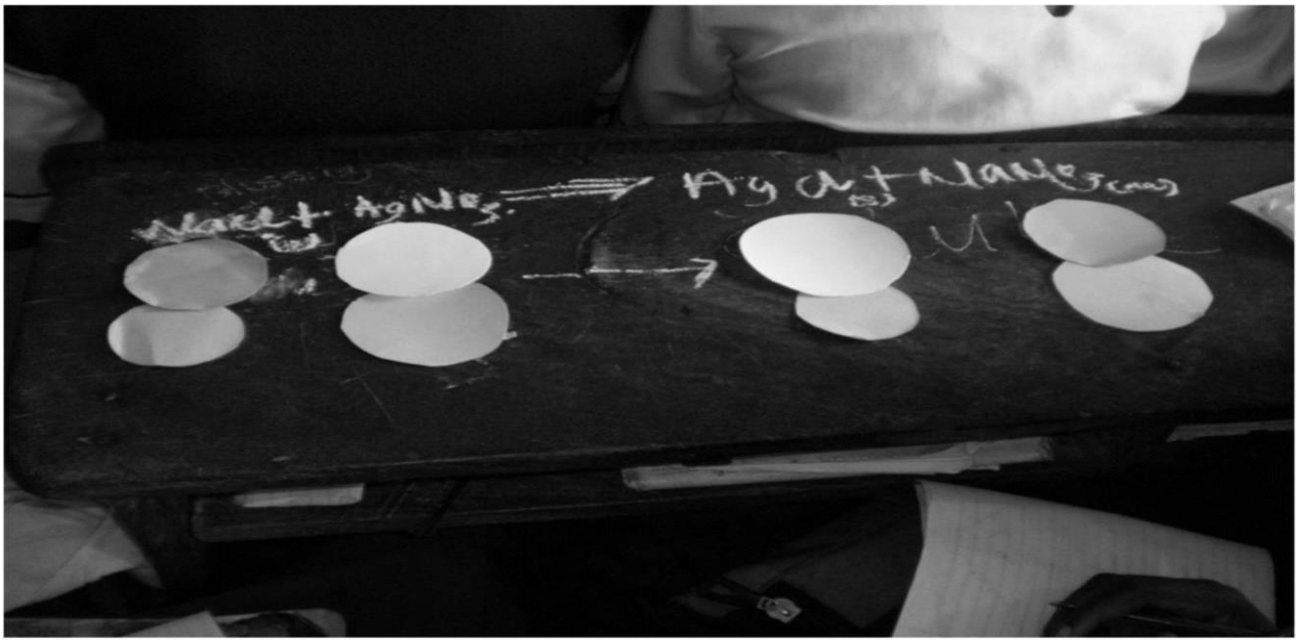

Figure 4: The drawing made by a group of students during the second workshop

The pedagogical processes in MR involved critical thinking and students would be required to make use of higher thinking about using particles to represent the reacting molecules, so the lesson becomes real and

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accessible. The students were actively engaged during the lesson and this made the participation to be lively and involved. Table 4 summarized the observed lesson.

Table 4: Observation of chemistry teachers' lessons after second workshop on multiple representations:

S/N	*Pedagogical Strategies*	TIME (Minutes) Tr. A	Tr. B	Tr. C	Tr. D	Tr. E	Ave.
		(%)	(%)	(%)	(%)	(%)	(%)
1.	The teacher is speaking and writing on the board as the students hardly write notes.	1 (2.5)	1 (5)	1 (6.25)	1 (5)	1 (3.75)	1 (1.25)
2.	The teacher and students participate in a question and answer session during chemistry lesson.	10 (12.5)	12 (15)	8 (10)	8 (10)	10 (12.5)	9.6 (12)
3.	Students converse as coteries during the lesson.	12 (15)	14 (17.5)	16 (20)	15 (18.75)	14 (17.5)	14.2 (17.75)
4.	Chemistry teacher and students participate in various pedagogical activities, thereby students were encouraged to create learning representations such as graphical illustrations, role-plays, models, diagrams, concept maps and flowcharts.	54 (67.5)	52 (65)	50 (62.5)	55 (68.75)	48 (71.25)	51.8 (64.75)
5.	Students jot down notes and assignments as chemistry teacher put them on the blackboard.	3 (3.75)	1 (1.25)	3 (3.75)	1 (1.25)	4 (5)	12 (15)
6.	Teacher's assessment of chemistry learning.	-	-	2 (2.5)	-	3 (3.75)	5 (6.25)
7.	Duration of chemistry lesson (in minutes).	80	80	80	80	80	80

Note: Tr. = Teacher; Ave. = Average; % = Per cent.

After the second workshop, all five chemistry teachers had one minute of introduction for their lessons. The per cent of the average time used for learning was 64.75%, and that was the time spent for experiments. The students spent an average time of 15 minutes in working together and another 12 minutes for recording. The teachers were full of appreciation and were satisfied with the learning outcomes. Importantly, the teachers' believed that the pedagogical processes MR relieved them from the long period of time spent on in the traditional approach.

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Key findings 4
The intervention instituted that chemistry classroom pedagogical learning with multiple representations provided active learning. Students collaborated, shared ideas and constructed knowledge on their own. The teachers were satisfied with students' learning outcomes.

Further, the teachers were enthusiastic about the experiences in multiple representations (MR) pedagogical practices. The teachers believed in effective chemistry pedagogy and resourceful outcomes offered by MR. Their responses and recommendations were summarized as Key-finding 5.

Key findings 5
After implementing various interventions and classroom practices in MR, the chemistry teachers subsequently believed that effective chemistry pedagogy should involve the applications of some elements of MR, such as demonstrations, active student engagements, group interactions, resources and clear explanations. These strategies helped in motivating students to participate fully in the pedagogical processes and enhanced their understanding of chemistry concepts, which were often perceived as challenging.

Discussion

Research Question 1: What difficulties do chemistry teachers encounter in effective chemistry pedagogy in Nigerian senior secondary schools (SSS)?

Data from this study showed how majority of the chemistry teachers explained the lack of pedagogical resources in Nigerian SSS. The challenges in high students-teacher ratio, insufficient time and overcrowded syllabus were also reported as some of the difficulties that chemistry teachers encounter in effective SSS chemistry pedagogy. Data obtained from teachers' questionnaire further revealed that Nigerian senior secondary school (SSS) students had inadequate junior secondary school (JSS) experiences in their foundation of science practical and experiments. The SSS chemistry teachers' pedagogical styles were predominately teacher-centered. These assertions were earlier reported in Braimoh, Fasinro and Saibu (2023). Further, Saibu, Braimoh, Ogunmade and Olude (2023) revealed that teacher-centred approaches would not help in the dynamics of improving students' performances in science, rather hands-on and expository pedagogical strategies should be adopted by chemistry teachers towards enhancing students' learning.

Research Question 2: What are the current knowledge and beliefs of Nigerian SSS chemistry teachers regarding the use of multiple representations (MR) in chemistry pedagogy?

The foundational building blocks in this study revealed that Nigerian chemistry teachers were not familiar with application of MR in chemistry pedagogy (Olaleye, 2013). The teachers did not belief in engaging students during pedagogical processes, and they have not been exploiting the use of locally available resources in developing pedagogical models. The chemistry teachers reiterated repeatedly during the pre-intervention interviews that their classroom practices were predominately teacher-centered. Ehujuo, Adiaha and Obih (2023) emphasized on the need for chemistry teachers to involve pedagogical practices

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that would enhance high level of students' engagements and learning in chemistry classrooms. The results obtained from the interview was evidenced in Table 1, and further corroborated with key findings in KF 1 & KF 3, which gave further insights into the foundational beliefs and knowledge of the chemistry teachers in traditional teaching methodologies. The dynamics in appropriate chemistry teachers' practices was provided in the KF 4.

Research Question 3: How do multiple representations influence Nigerian chemistry teachers' beliefs, knowledge, and pedagogical practices?

At the commencement of this study, the researchers advised the case study chemistry teachers to indicate any three chemistry topics that they perceived to be "difficult" to teach. All the teachers met and agreed on the following three topics:

a. Oxidation and reduction;
b. Reaction rate and collision theory; and
c. Water and solutions.

The topics selected by the teachers involved the use of word equations and symbolic representations of chemical reactions. Basically, the activities involved in the selected topics had limited the chemistry teachers' ability to effectively oversee the progress made by students during pedagogical process, thereby limiting their assessment strategies, when they were using the conventional traditional methodologies. Kwon and Capraro (2021) in a publication on MR within students' real-world interest corroborated the Key finding 5 (KF 5), as was established that active students' engagements with multiple representations (MR), interactions among groups and effective use of resources were significant features in achieving effective chemistry pedagogy (Olaleye and Braimoh, 2018). These methodologies would encourage students to actively engage and successfully grasp challenging chemistry concepts.

Conclusion

The conventional traditional styles and practices is prevalent to Nigerian SSS chemistry teachers. The contemporary best practices in chemistry pedagogy require teachers to attend regular professional development programmes and activities, such as in-house meetings, workshops, seminars and conferences. Such meetings were organised for refreshing teachers' knowledge and beliefs about the pedagogy of chemistry concepts, and helpful to teachers for discussing new chemistry pedagogies and strategies for achieving best classroom practices. Multiple representations is a pedagogical strategy, which required careful planning and activities with higher-order thinking. The focus in MR was constantly towards actively engaging students during teaching and learning processes. If effectively implemented, the multiple representations strategy as used in this study would positively influence chemistry teachers' knowledge and beliefs about chemistry pedagogy. According to Braimoh *et al.* (2023), chemistry teachers need to wake up to the challenges in the use of contemporary pedagogical styles, and must switch from use of didactic methodologies to new ways, which placed students' learning outcomes above all other objectives of lessons.

Effective pedagogical practices in chemistry classrooms required carefully planned lessons in order to achieve meaningful learning outcomes. In this study, MR was found to be resourceful to chemistry

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pedagogy and helpful to learning SSS chemistry. The research proved that the pedagogical activities in multiple representations had facilitated chemistry learning in Nigerian SSS, therefore it would be imperative on chemistry teachers to more resourceful, creative, and skilled in applying innovative pedagogical strategies to enhance classroom learning. Chemistry pedagogy would be more engaging if teachers were supported with curriculum resources that integrate the multiple representations strategy.

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