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Chemistry Lesson Plan Design and Teaching: A Case Study of Senior Secondary Schools in the Urban Regions of the Gambia

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This study aimed to understand chemistry lesson plan design and teaching at secondary schools with 14 teachers and 282 students, grade 11, through Randomized Post-test Control Group Design, placed in each experimental and control group. The experimental group was taught using multifunctional approaches, social constructivism, and laboratory experimentations. The control group was taught using traditional methods and laboratory experimentations, focusing on concepts of acids, bases, and salts. Indicators such as lesson topic, objectives, activities, evaluations, and conclusions were thematically reviewed, while teaching categories such as lesson organisation, activities teaching, pedagogical approaches, collaborative learning, teacher-student interaction, instructional resources, and students' academic performance were quantitatively analysed. Descriptive statistics were used to obtain frequency per cent (%), weighted mean, and standard deviation. The finding shows that teachers were knowledgeable about designing a chemistry lesson even though they followed the same trajectory and were inadequately prepared. In addition, only pedagogical approaches and instructional resources were moderately utilised among the teaching categories. Further, students in the experimental group performed better academically, as measured by their mean difference (12.121), significant ($t = 6.142$, $p = .000$), which may be attributed to paradigm-shifting from teacher-centred to the students-centred, instructional resources, students' ability, and motivation. Therefore, the current lesson plan design as a case study in the chemistry classroom implies that effective lesson plans and teaching can lead to better learning of core competencies in the Gambian context if they were to be monitored and improved extensively. However, a further study may be needed by comparing the difference between pre-test and post-test scores, as this will indicate a better measure .

***Keywords*:** lesson plan design, chemistry teaching and learning, secondary school

In chemistry classrooms, students are limited to developing core transferable competencies such as critical thinking (Harvey, 2016), comprehension, and skills (Chun & Jordan, 2010). Lapcharoen (2021) attributes it to teachers' inadequate understanding of the importance of core competencies and pedagogy (Blonder & Mamlok-Naama, 2019),

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including high-level learning requirements (Joof, 2014). Further, Burama (2019) also connected it to the nature of the chemistry curriculum structure in The Gambia, which he described as academic with little inclusion of inclusive education. This gap may be filled if nations redesign both skills-based, including critical thinking (Qing et al., 2010) and academic curricula, to orient teachers from academic to creative approaches (Marchak et al., 2021). However, need assessment is imperative to guide the alignment (World Bank [WB], 2017), inlcuding the relationship between the current situation and competencies.

Although curriculum alignment may theoretically inform the need for core competencies, the appropriate practice can be informed through lesson plan study and Teaching (Margarita & Rodriguez, 2007; Roxana, 2018). According to Bayram-Jacobs et al., (2019), lesson plans activate pedagogical methods to influence chemistry teaching and learning and encourage students to think critically through engagement and participation. In this regard, the exploratory study is proposed to assess current practices in chemistry education, particularly on acids, bases, and salts, which are challenging for students to apply critical thinking in The Gambia (Chief Examiner's Report [CER], 2017–2019).

Roxana (2018) explained lesson plan design as an instructional tool to enhance academic and high order thinking skills (Chun & Jordan, 2010). Therefore, adequate planning can enhance learning core competence through preparation, encouragement, and engagement. However, without an effective lesson plan, students' critical application of acids, bases, and salts learning could be compromised (Harvey, 2016) because the main indicators such as lesson topic, objectives, activities, evaluation, and conclusion would be a mere description but not to achieve the desire goals (Roxana, 2018). Today, however, even those students with the highest grade of success in chemistry could not critically analyse chemical concepts because lesson plans and teaching approaches could not prepare them to think critically (Widiastari & Redhana, 2021). One of the factors attributed to this anomaly in chemistry education is pedagogical methods (Bayram-Jacobs et al., 2019), learning resources (Joof, 2014) and teacher factors (Popova et al., 2016); one of those teaching categories that should be preserved and enhanced.

Among the teaching categories (lesson organisation, activity learning, pedagogical approaches, collaborative learning, teacher-student interaction, and instructional resources), can influence learning goals (Braskamp & Ory, 1994; Eilks et al., 2013). Teaching categories perhaps can describe and preserve the attainment of lesson objectives, purpose, and students' expectations. Particularly lesson organisation, where many opportunities can be provided, such as the modalities of teaching the content, students' collaboration, and engagement (Popova et al., 2016). It also minimises teacher-centred teaching methods (Byers & Eilks, 2009) and encourages student-centred methods (Joof, 2014). However, the teacher should be prepared to make this happen ((Bombardelli et al., 2021) by introducing more inclusive lesson collaboration and effective pedagogy (Simon-Adu & Karen, 2022). Knowledge of teaching is not as simple as it may be thought (Itbar et al.,2020), and it has been found challenging for teachers to relatively practice or engage students in task-based learning (Joof, 2014).

CHEMISTRY LESSON PLAN DESIGN

Collaborative learning is one of the teaching categories Eilks et al., (2013) described as an important opportunity for students because it encourages them to improve academically and critically as they form groups to solve problems (Johnson & Johnson, 2005). Notably, in the social constructivism approach, collaborative work is a prerequisite to supporting students learning (Akyol & Fer, 2010) because they can use the opportunity to explore skills and potential (Liu & Chan, 2010). So, a teacher should be obliged to engage students with different challenging tasks (lesson activities) for them to construct and apply knowledge cognitively. Qing et al. (2010) therefore suggests lesson activities (Task-based) are guiding principle for both teachers and students rather than merely presenting content knowledge with limited opportunities.

In addition, other studies acknowledged the importance of teaching and learning resources for better accomplishment of lesson activities during concept discourse (Igharo et al., 2011). For example, content teaching can be compromised without appropriate resources, including technology, because gap can be created between concept discourse and conceptual understanding (Teemu et al., 2020). However, Shulman (1987) argued that technology could be used to support, but pedagogy must be adequate before quality learning. The pedagogical approach drives technology integration itself, and its appropriateness can be used to measure teaching and learning.

Another study recognises cordiality of teacher-student interaction to bring about higher-level thinking skills, confidence, and self-esteem among students (Alvarez-Bell et al., 2017). In chemistry teaching and learning, teacher-student interaction can bring about student encouragement and active participation, confirming that the teacher has a multifunctional role apart from teaching. While implementing those roles, the teaching can move from teacher-centred to student-centred (Byers & Eilkes, 2009). Therefore, based on these findings on lesson plan design and chemistry teaching and learning, teachers need continuous professional development (Satter & Awan, 2019) or additional intervention to help them improve or address their immediate challenges (Hinduja et al., 2020). This is because most teachers pass through teacher training college, but do they understand the importance of teaching core competence (Lapcharoen, 2021). Even if they do, their experience or knowledge about teaching has no significant effect on their performance (Itbar et al., 2020). Ali and Hamza (2018) state that it can improve teacher performance and student learning, including achieving an institutional, educational goal. Therefore, how it happens in The Gambia, a case study is designed to assess teachers' lesson plan design and teaching and learning of chemistry concepts. In this background. The following research objectives guided the study:

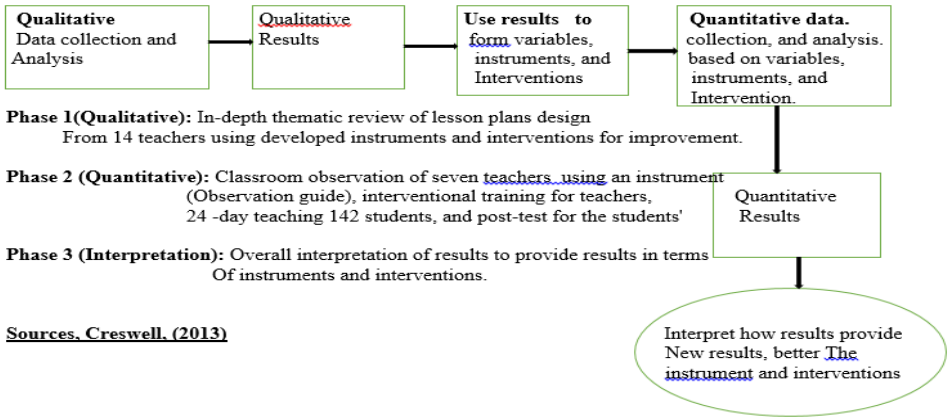
1. To assess the level of chemistry teachers' ability to design lesson plans
2. Determine the extent of teachers' use of various teaching categories that support learning.
3. To identify the effect of chemistry lesson plan design on students' academic performance.

Method

Research design

The study employed an exploratory sequential mixed method design to understand the causes of chemistry teaching and learning disorder at secondary schools (SS), particularly students' core competencies in acids, bases, and salts concepts (Creswell, 2009). The complimenting approach was a post-test control group design on a case study to assess chemistry lesson plan preparation to support chemistry teaching and learning (Frey, 2018). Social constructivism theory and practice guided the content discussion (see Akyol & Fer, 2010; Liu & Chan 2010). Moreover, the effect of chemistry lesson plan design on students' academic performance was identified.

Schematic diagram of Exploratory Sequential mixed Design.



This approach relies as much as possible on the teachers' lesson plan design and their classroom practice. Instead of focusing on methods, we emphasise the research problems (lesson plan as a possible disorder of chemistry learning at secondary schools) and use all three approaches, namely lesson plan assessment, classroom observations, intervention, and student assessment, to understand the problems (Creswell, 2013).

Sampling and Sampling Characteristics.

Two hundred and eighty-two (282) students were systematic randomly sampled from 568 students in 14 SS, targeting grade 11 in urban regions using a class register at regular intervals. According to the geographical distribution of the country, there are six administrative regions. Regions 1 and 2 are the urban centres, while Regions 3 to 6 are rural centres. Fourteen schools in regions 1 and 2 were purposively selected from 122 SS (Education Statistics [ES], 2018-2019) because of the chemistry students' population, resources, and proximity to the research (Lisa, n.d.). In addition, in each 14 SS, a chemistry teacher was selected by their length in the service (10 to 15 years) to understand teaching and learning better.

Two hundred and eighty-two (282) students sample were split into two by placing them into the experimental (141) and the control groups (141). According to their

academic results from schools, which determine them to be equivalent groups. A similar approach was used on 14 teachers in experimental (7) and control groups (7). This selection process was consistent with the suggestion reported in Muralidharan's (2015) study. *All participants signed a consent form, agreeing to participate voluntarily*.

Data collection and procedures

Procedures

a) Knowledgeable personnel (Ministry of Education, Gambia College-School of Education and the University of The Gambia -School of Education) were invited to review the two instruments:- Lesson Observation Guide (LOG) and Academic Performance Items (API), developed for their appropriateness
b) Personnel, including researchers, reviewed and validated the instruments by checking language clarity, comprehensiveness, and appropriateness. As a result, ambiguous or repeated questions were removed from the specifics covering general education, personality, attitude, and school management. In addition, API, which was 20 theory questions initially, was moderated to 17.
c) Both instruments (LOG & API) were piloted immediately after validation on four teachers and 40 students, respectively. API was piloted twice, during which two items were repeatedly not attempted by students, then removed, thus reducing the instrument from 17 to 15. The internal consistency was found (0.84) using Inter-Rater (inter-observer reliability) for LOG. In contrast, the reliability coefficient (Statistical Package for Social Science-SPSS v. 21) for API was 0.78 Cronbach's Alpha (Hinton et al., 2004).
d) Post-tests for both groups were conducted using 15 API within 2 hours to control internal and external threats that may emerge during the intervention (Frey, 2018).

Data Collection

a) ***Lesson Plan Design***: All 14 teachers were allowed to plan a lesson on acids, bases, or salt concepts and present it to the observers, including researchers, for comments and improvements. The primary indicators were reviewed thematically for consistency and appropriateness (Roxana, 2018).
b) ***Teaching Categories:*** At this phase, only seven teachers (experimental group) were allowed to use the improved lesson plans to teach and observed in the actual classroom within 70 minutes, while the other seven (7) teachers (control group) were only supported improving their lesson plans and to use it to teach students in control groups. A lesson observation guide (LOG), including scoring guidelines, was a free and adapted tool (Braskamp & Ory, 1994) used to collect data from each teaching category. Pointers were developed for each scoring guideline to evaluate teachers' practice and were interpreted on a Liker scale in descending order **(4 to 1**). The scoring guidelines include "*prominent evidence for the entire duration of the class session,"* **scale 4**, *"evidence for about 2/3 of the class session,"* **scale 3**, *"evidence for less than 1/3 of the duration or limited evidence during the entire class session,"* **scale 2**, *and "no evidence during the entire class session."* **scale 1**. These were critically scored and recorded independently by observers during teaching, later discussed, collated, and analysed. Based on our study focus and scope, Likert scales **4** and **3** were acceptable practices. Nevertheless, scales **2** and **1** were regarded as inadequate.

c) Therefore***, the researchers used quantitative and qualitative results found*** during lesson observation, including lesson plan design, to support teachers in the experimental group. The effect was assessed on students' academic performance**.** It took about two weeks to train teachers to design interactive lesson plans, improvisation, and pedagogical approaches, including the social constructivism paradigm and laboratory experimentation of chemical phenomena. Under this protocol, activity-based training (Joof, 2014) and collaborative learning (Eilks et al., 2013; Liu & Chan, 2010; Qing et al., 2010) were emphasised to develop hypotheses and promote their observation, inference freely, and conclusion skills within the following courses: 1) An introduction to the concepts of acids, bases, and salts, which allows teachers to review prior knowledge and develop hypotheses. In addition, 2) qualitative classification of substances using a pH indicator extracted from red cabbage and other conventional indicators such as phenolphthalein, methyl orange, and bromothymol, 3) quantitative measurement for acids and bases, 4) measurement and calculation of numerical values of the pH, which took them to construct a pH scale with both numerical and colour representations for each sample, 5) Identification of salts by exploring and distinguishing acids, bases, and salts while conducting solubility properties; and 6) antiacid titration using distilled water, bromothymol blue indicator, and 1M HCL. However, other sets of teachers (control groups) were supported to develop an interactive lesson plan design and hands-on activities using physical experimentation.

d) **Follow-up teaching at schools commenced** where all 14 teachers (Experimental and Control groups) were provided with teaching materials, including worksheets, reagents, and apparatus, for further teaching students (experimental and control) for about 24 days. This was -

e) followed by post-test using 15 open-ended questions (API) to compare the performance of the two groups of students.

Data analysis

Lesson plans were analysed thematically, considering the indicators' strengths and areas of improvement (Teemu et al., 2020). In addition, teaching categories (LOG) and post-test results (API) were analysed quantitatively using SPSS v.21 for frequency per cent (%), weighted Means and Standard Deviation, respectively.

The frequency per cent (%) generated from teaching categories was further interpreted by researchers. The frequency per cent (%) score for scales **4 & 3** fell between 60 to 100%, interpreted as "strong demonstration". Between 50 to 59% were interpreted as "moderate demonstration," and 0 to 49% as "weak demonstration." In contrast, on scales **2 & 1** with any frequency per cent (%), we interpreted them as "weak demonstrations" because they were regarded as inadequate practice, by our interpretation. These parameters used to determine teachers' practice where the same measures teachers assess students' tests or exams in the country. Whereas for API, the normality test was first determined on students' test scores and found no statistically significant but approximately normally distributed (Shapiro-Wilk test, p.05). Therefore, an independent sample t-test was conducted to test for significant differences between the two groups.

Results

Chemistry Lesson Plans Design

The strength and Areas of improvement.

The study's indicators show that lesson plans were an essential tool in the classroom (Roxana 2018). Each teacher was able to distinguish students' and teachers' activities to evaluate lessons using oral questions. Opportunities such as group and collaborative learning were highlighted in their typical plans, even though students' involvement was restrictive or controlled in some plans. In addition, the coherence and appropriateness were relatively demonstrated in achieving learning objectives.

Teaching Categories.

Lesson Organisation.

This section involves setting up and sharing lesson objectives, purpose, relationships with the previous lesson, expectations, and opportunities for students to think. Therefore, in Table 1, "no evidence during the entire class session" was 71%, showing poor demonstration; "evidence for about 2/3 of the entire class session" and "prominent evidence during the entire class session" each had 14%, indicating weak demonstration.

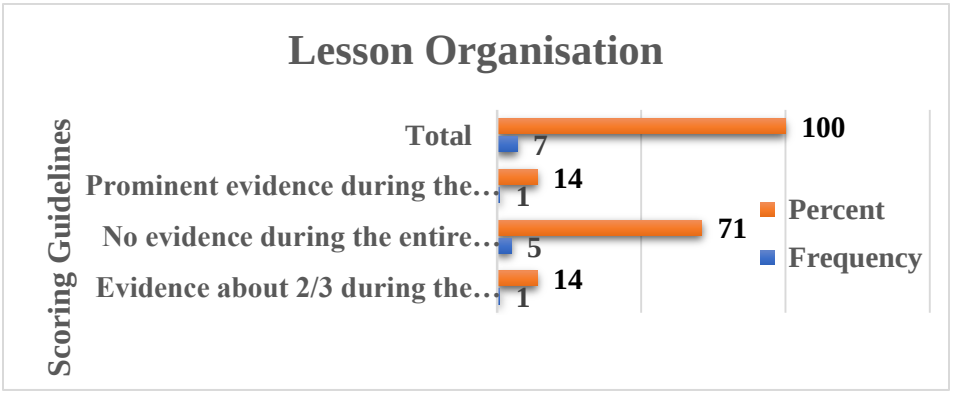


Figure 1. Lesson organisation by teachers

Activities Teaching.

Activities teaching, including steps, the definition of unfamiliar terms, explaining concepts with different strategies, promoting constructive criticism, and clarifying misconceptions. However, "no evidence during the entire class session" and "limited evidence during the entire class session", each scored 14%, revealed weak demonstration. "Evidence for about 2/3 of the entire class session" was 43%, indicating weak demonstration, while "prominent evidence during the entire class session" got 29%, showing another weak demonstration (Table 2).

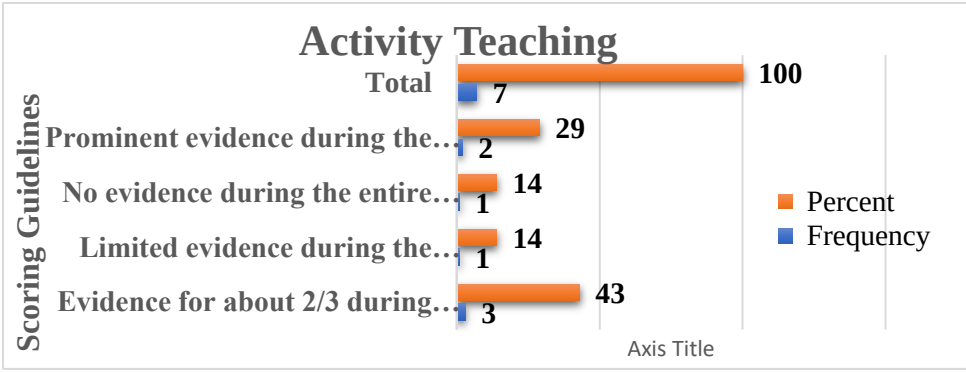


Figure 2 Activity Teaching practice by teachers

Pedagogical Approaches

It involves but not limited to assessing students' prerequisite knowledge, waiting time during teaching, encouraging students' engagement, promoting active participation, assessing formative questions, forming groups, and promoting critical thinking. For example, in Table 3, "no evidence during the entire class session," "limited evidence during the entire class session," and "evidence for about 2/3 of the entire class session" each scored 14% showing a weak demonstration. In comparison, "prominent evidence during the entire class session" was 57%, indicating moderate demonstrations.

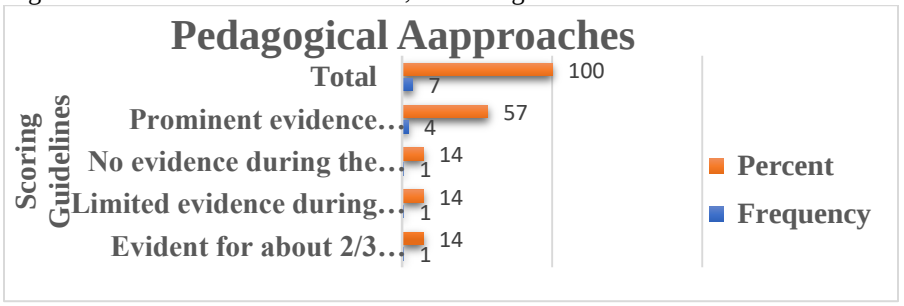


Figure 3. Pedagogical approaches by teachers

Teacher-Students Interaction

Another sensitive category involves listening to responses, modifying and improving them, avoiding students' embracement or belittling, respect, sensitivity to diverse learners, giving assistance while students are in groups, encouraging them to generate ideas, and responding appropriately to students' answers or behaviour, amongst others. In this aspect therefore, in Table 4, "no evidence during the entire class session" was at 14%, showing weak demonstration; "limited evidence during the entire class session" and "evidence for about 2/3 of the entire class session" each scored 43%, revealing weak demonstration.

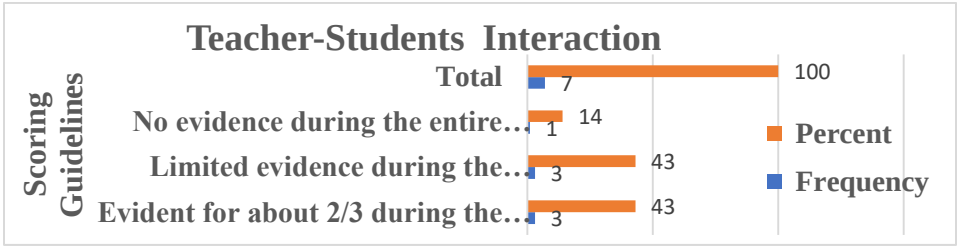


Figure 4. Teacher-Students interaction

Collaborative Learning

In Table 5, "no evidence during the entire class session" scored 29%, a weak demonstration, while "Limited evidence during the entire class session" was 57%, indicating a weak demonstration. "Prominent evidence during the entire class session" was 14%, showing a weak demonstration.

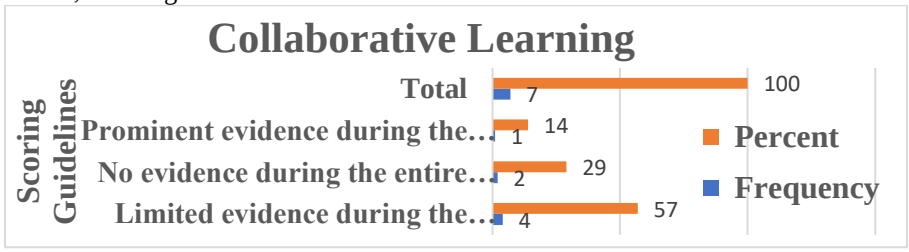


Figure 5. Collaborative Learning practice by teachers

Instructional Resources

Provides precise tasks for students, opportunities to interact, share, discuss, time management, synthesis of group activities, and other teaching and learning resources. For example, in Table 6, "no evidence during the entire class session" scored 43%, and "prominent evidence during the entire class session" was 57%, indicating moderate demonstration.

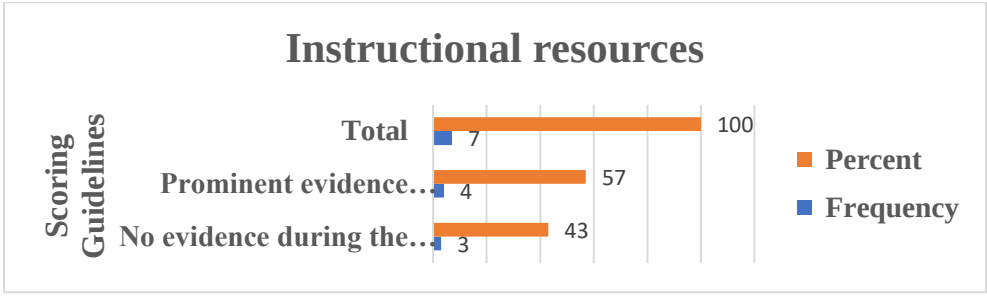


Figure 6. Instructional resources utilisation and provision

The effect of chemistry lesson plan design on Students' performances.

The post-test results show that the experimental group had a mean of 40.30 with a standard deviation of 18.971, while the control group's mean was 28.180 with a standard deviation of 13.753 (Figure 7), which shows a mean difference of 12.121 (Table 1).

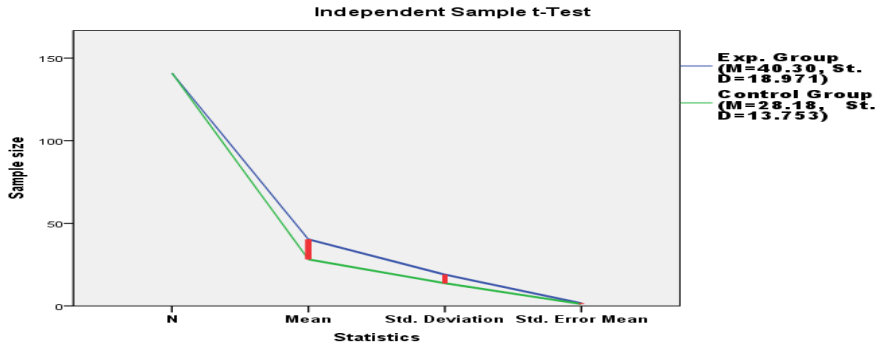


Figure 7: Academic Achievement Means and Standard Deviations for Exp. & Control group.

Table 1: Independent sample t-test for Experiment and Control groups

	t-test for Equality of Means							
	F	t	df	Sig. (2-tailed)	MD	SD	95% Confidence interval of the difference	
							Lower	Upper
Experimental & Control Groups	20.888	6.142	280	.000	12.121	1.973	8.236	16.005

Discussions

Chemistry Lesson Plan Design

Strength

The reviews showed that teachers were confident in lesson plan design, even though they used the same trajectory. Lesson topics to conclusions were operational indicators that teachers often considered and applied relevant information despite being unrealistic. Regardless, their ideas and efforts show that planning was a critical instructional tool to support teaching and learning (Margarita & Rodriguez, 2007). Its importance extends beyond improving teaching and learning but keeping track of what the teacher was doing (Fer & Nellie, 2019).

The worksheets were provided for students, and works were proposed to be done either in groups or individually. Also, safety precautions were highlighted as students supposed to interact with acids and bases, which was another essential strength

in the lesson design. In addition, the plans highlighted numerous statements to brainstorm or recap the lessons to mark the beginning of the lesson (introduction). Activity columns for students with specified resources to perform the task were also stated, hoping to engage students in active participation, even though most activities were teacher-centred (Masoka & Gathambiri, 2008). Accordingly, lessons were evaluated and concluded with activities either as assignments or classwork (Coenders et al., 2010).

Areas of Improvement

Almost all teachers were challenged to design an interactive lesson plan and might be challenging to retract the activities and students' learning (Hanna et al., 2020). One of the ultimate goals for a teacher in the classroom was to provide the best for students, and if this goal was not met, the teaching quality could be compromised. Their plans were not activity-based learning (Joof, 2014), encouraging students to participate, but mere memorisation (Hanna et al., 2020). In the same vein, lesson objectives and activities were so ambiguous that they may not be achievable, as demonstrated during regular teaching. Setting up too many objectives might cause unresolved questions or misconceptions, and, for example, misconceptions may stay in students' minds longer if corrections are not done. Therefore, teachers should endeavour to prepare adequately and employ student-centred instead of teacher-centred teaching methods (Eilks et al., 2013). Teachers should not be doing every activity (Byers & Eilks, 2009) with limited opportunities or activities to do (Hanna et al., 2020).

Furthermore, even though sample oral questions were not provided at evaluation, they emphasised "lesson was successfully taught", almost in all plans. Writing sample evaluation questions was as important as the lesson activities and content. A scenario could be a teacher who prepared a lesson to teach and was absent. Another teacher can be assigned to teach the lesson in class. It might be challenging for the substitute to teach and evaluate students without a comprehensive guide, even if prior knowledge was adequate. This suggests that it was essential to provide clear and unambitious instructions in the lesson plans for anyone can use.

In another situation, the teaching and learning resources were limited to textbooks, chalks, chalkboards, and A4 paper. These resources, however, were not even adequately specified for the activities they should be used. Although few plans mentioned some necessary reagents and apparatus, excluding technology, which it may be thought was not an option.

Teaching Categories in Chemistry Classrooms

Generally, teaching categories were challenging for teachers, as indicated by the frequency per cent scores. According to Hinduja et al., (2020), teachers need support even though they were professionally trained to become teachers. On this basis, continuous professional development (CPD) was factored in most countries' development agendas for teachers, particularly in chemistry education. Because chemistry education has been affected by many factors such as instructional hours, pedagogy, and teacher salaries (Blonder & Mamlok-Naama, 2019), these factors were one of the challenges that may affect teachers' lesson organisation, as determined by their frequency per cent scores (Table 1). Despite the fact that these teachers were teaching from ten years and above,

they could not influence the good practice of lesson organisation or support students academically. However, Lapcharoen (2021) found no relationship between competence and teacher academic achievements. Itbar et al., (2020) also found no significant effect of teacher experience on the performance. This means that students may not have the opportunity to explore and interact with the materials in such classrooms. Without this opportunity, students may be discouraged from working or forming groups.

Activity learning was also inadequately demonstrated (Table 2), as shown by their frequency per cent scores on guidelines. The 29% of teachers who showed practice evidence were supported by the technology (smartboards), even though they did not include technology in their lesson resources. Others spend more time explaining the theoretical concepts without experiments or hands-on activities (Masoka & Gathambiri, 2008), not knowing that students learn best in active mode and from different perspectives (Bayram-Jacobs et al., 2019). Consequently, it took students longer than usual to grasp critical phenomena about "how" or "why" colour change after adding bromomethyl indicator during titration between sulfuric acids and sodium hydroxide solution. Similarly, the quantitative measurement and calculation of acids and bases, which were supposed to be students' activities using the physical materials, were done by teachers and asked students to observe and explain. In reality, students should follow the procedure with unambiguous instructions sheets until they reach conclusions.

In contrast, the pedagogical approach was moderately demonstrated with 57% (Table 3), which shows teachers were flexible in the classroom to influence quality teaching and learning. Pedagogical approaches are essential to achieving curriculum objectives and improving teacher quality. Susan and Margaret (2015) and (Qing et al., 2010) added that appropriate pedagogy promotes relationships amongst subjects. Electron transfer, for example, can be taught by using the example of the work of electrons in an electrochemical cell in physics and chemistry or osmotic pressure in biology. Connecting these ideas with scientific knowledge or principles can assist students in appreciating sciences and their relationships.

Teacher-student interaction was another critical and crucial category in teaching. This category was expected to be cordial and responsive every time as it can reflect positively on students learning needs and challenges (Alvarez-Bell et al., 2017). However, the frequency per cent generated in Table 4 was inadequately practised. During lesson observation, at some point, students were not responding to questions due to inappropriate teacher-student interaction. Their responses or answers were not adequately considered in the class, and the teacher ended up doing everything while the students copied notes. Masoka and Gathambiri (2008) classified this as teacher-centred Teaching in Africa because teachers do everything, including problem-solving. In a particular classroom, students were bullied, which was against Policy (Education Policy [EP]2004-2015). Their wrong answers can be encouraged and motivated by giving them what was appropriate and correct than just condemning them.

Collaborative learning was another difficult task for teachers, as indicated in Table 2. Consequently, learning misconceptions emerged when students calculated titre values and reported their findings independently. For example, the addition of 2 cm^3 of

bench sulphuric acid (H_2SO_4(ag)) to 2 cm^3 of barium chloride ($BaCL_2$(ag)). Each student was asked to report their findings, and most of them reported that ($BaSO_4$) barium tetraoxosulphate (VI) was observed instead of a white precipitate. After our investigation, "why," coincidentally, we found the same answers provided in the teacher's marking scheme, which shows that teachers also have challenges in scientific reporting on experimental procedures (Bayram-Jacobs et al., 2019) and content knowledge (Teemu et al.,2020). In scientific reporting, there is no way you can observe the formula or name of a white precipitate or substances in the test tube because these are not observable features. Teachers were almost doing every activity, discouraged in many studies (Eilk et al., 2013; Byers & Eilks, 2009). Students can guide themselves through the activities with a correct and unambiguous instruction sheet. Students' collaboration was not for grouping but to support one another to improve (Johnson & Johnson, 2005) and restore their confidence in the subject matter (Harvey, 2016). It also could be a platform to manage the classroom, including respecting students' opinions during concept discourse.

Instructional resources were also moderately demonstrated with a frequency per cent of 57 (Table 6). Teaching and learning without evaluating and providing resources may be tantamount to learning deficiency because they are one of the pedagogical tools that should not be underestimated (Bayram-Jacobs et al., 2019). The importance of resources was not limited to only provision but also as a platform for students to engage effectively through hands-on and minds-on (Eilks et al., 2013). However, most resources were limited to chalks, chalkboards, A4 paper, textbooks, and pupils. Few mentioned or utilised reagents, apparatus, and worksheets due to inadequate resources in schools (Igharo et al., 2011), and there was no way they could improvise without the support (Joof, 2014). For example, in some classrooms, protective gear (gloves and lab coats) to protect students against acid burning was utterly missing, and students were worried and afraid to touch acids with their bare hands. Similarly, the missing bromomethyl indicators during experimentation could have been improvised with red cabbage to test for acids or bases rather than waiting for the school to provide them.

The Effects of chemistry lesson plan design on students' performance

Performances show that teachers need professional development, as significantly reflected (Ali & Hamza, 2018). The independent sample t-test shows that the Mean difference between the experimental and control groups was 12.121 (p=.000, t=6.142, and df=280) at a 95% confidence level (Table 7). Other studies similarly found significant difference in their exploratory evaluation (Satter & Awan, 2019; Byers & Eilks, 2009; Ali & Hamza, 2018). Therefore, the results show that additional intervention was needed to improve teachers' performance. Hinduja et al., (2020) similarly recognised the importance of intervention on teachers to improve students' performance. Nevertheless, there were controversies after the intervention for continuity if the underlining challenges such as instructional hours, pedagogy, and teachers' motivation are not improved (Blonder & Mamlok-Naama, 2019).

Conclusion

The study was a participatory approach with few selected chemistry teachers and students. It revealed the strength and areas of improvement in teachers' lesson plan design by showing all operational indicators. This study found that teachers were confident in lesson plan design, even though they used the same trajectory. Lesson topics

to conclusions were operational indicators that teachers often considered and applied relevant information despite being unrealistic. Regardless, their ideas and efforts show that plans were critical instructional tools to support teaching and learning.

The actual reflection of teachers' lesson plans was manifested during teaching actualisation in classrooms. It was found that teachers' pedagogical approach and instructional resources utilisation and practice were moderate among the teaching categories. Other categories in the study were inadequately practised, and these teachers taught for more than ten years at secondary school. These results show that teachers need continuous professional development, as it positively reflects on students' academic performances, favouring the experimental group. Other factors can be attributed to the differences in performances, such as teaching approaches from teacher-centred to students-centred, instructional resources, the ability of students, and motivation. The intervention in the educational research was another important phenomenon that can encourage the researcher to use all approaches available to understand the problems.

Similarly, the positive relationship between years of teaching and effective teaching practice was not found in this study and therefore suggested for future studies. The attributes were the teachers' irregular planning of the lessons, the nature of instructional hours, teacher and students' motivation, and teachers' pedagogy. This implies that effective lesson plans and teaching can lead to better learning of core competencies in the Gambian context if they were to be monitored and improved extensively. However, a further study that will determine the level of effectiveness of the case study by comparing the difference between pre-test and post-test scores may be needed in the future, as this will indicate a better measure.

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