AN INVESTIGATION INTO CHEMISTRY TEACHERS CLASSROOM PRACTICES: A CASE OF FEDERAL CAPITAL TERRITORY PUBLIC SENIOR SECONDARY SCHOOLS CHEMISTRY TEACHERS

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Abstract

Many factors contribute to successful teaching and learning of chemistry. One of such factors is the teacher classroom practices. This paper reports on the study conducted to investigate chemistry teachers' classroom practices in terms of classroom climate and discourse and sense-making in chemistry classes. The study was conducted in the Federal Capital Territory (FCT). 45 teachers and 601 students participated in the study. Two instruments were used for data collection, namely Teacher Classroom Observation Schedule (TCPOS) and Chemistry Achievement Test (CAT). Both instruments were developed by the research and validated by experts. The reliabilities of the instruments were found to be adequate for the purpose of data collection. While TCPOS had a reliability coefficient of 0.78, CAT had coefficient of 0.73. Data collected from study were analyzed using descriptive statistics and Pearson Product Moment correlation. The result showed that although positive and significant relationship exist between teacher classroom practices and achievement in chemistry, the teachers' classroom practices were poor as regards to the tenets of the classroom practices investigated. Recommendations to solving the identified problems were made.

Introduction

Teaching is generally considered a complex practice that involves the constant and dynamic interaction between the teacher, the students and the subject matter. Wenger McDermott and Snyder (2002) perceive practice as embedded in a community, which is further recognized by a shared goal, common engagement, and a united repertoire. Practice has been explained as "a set of frameworks, ideas, tools, information, styles, language, stories, and documents that community members share" (Wenger et al., 2002, p.29). Practice thus is a way of talking about mutual, historical and social resources, frameworks and views that can maintain mutual engagement in action. Learners in a particular community share a basic body of knowledge that generates a shared foundation which allows members to work together productively (Wenger, 1998).

Practice has also been considered as an outcome of individual and communal meaning-making and agency that emerges in the local social environment (Skott, Moeskær & Hellsten. 2011). Teachers' classroom practices have been interpreted to include the entire instructional, curriculum, social and organisational techniques teachers' exhibit in the classroom in an attempt to facilitate an enabling environment for all categories of students' learning (Deku, Amponsah & Opoku, 2013). Professional competence is believed to be a crucial factor in classroom and school practices (Baumert & Kunter, 2006).

On the basis of theories and empirical findings, there are three broad domains of teaching practice that have been linked to positive student outcomes. These domains are social/emotional support, organization/management support, and instructional support (Hamre & Pianta, 2007). Increasing number of empirical evidence suggests that attending to each of these domains of teaching helps to fully understand the impact of classroom experiences on student performance (Pianta, Hamre, & Allen, 2012). This classification is a derivative of one particular observational tool, the *Classroom Assessment Scoring System* (CLASS). The CLASS Framework is a theoretically driven and empirically supported conceptualization of classroom interactions (Hamre & Pianta, 2007).

Similar classifications of teacher classroom practices have also been made by other scholars. For instance, Brophy (1999) presented 12 principles of effective teaching, including supportive classroom climates, opportunities to learn, curricular alignment, thoughtful discourse, scaffolding engagement, and achievement expectations, each of which are based on research findings and theories of teaching and learning. Besides, Pressley, Roehrig, Raphael, Dolezal, Bohn, Mohan &Wharton-McDonald (2003) from their studies of effective teachers have suggested that effective teaching strategies and practices can be organized into decisions regarding motivational atmosphere, classroom management, and curriculum and instruction.

One dimension of the social/emotional support is the classroom climate. Classroom climate has been defined by Sinclair and Fraser (2002) as the classroom environment involving the shared perceptions of the students and the teachers. The relationship between classroom climate and cognitive and affective outcomes has been well documented (Church, Elliot & Gable, 2001; Dorman, 2001).

According to the social learning theory, it is the meaningful environment which is the best predictor of a person's actions (Anderson, Hamilton & Hattie, 2004). Van Der Horst and Mcdonald (1997) have as well defined classroom climate as the psychological and social feeling or atmosphere that exists in each classroom. In this perspective Meier (1996), emphasizes that smallness (a low learner-teacher ratio) is a prerequisite for a climate which will be conducive to learning. According to him, in such a classroom it will be easier to cultivate and to develop democratic habits which usually emerges from authentic relationships built on face to face conversations by people engaged in common work and common work standards. According to Strivens (1985) and Lipoff (2011), the most effective classrooms appear to be those in which the atmosphere is 'task-oriented' but where at the same time the social and emotional needs of the students are met by establishing mutual respect and good rapport. Ryan, as cited in Charmberline (1999),in a study involving 500 students and 25teachers in 63 six-grade Mathematics classrooms found that teachers who were concerned with students' social and emotional needs were more successful in closing the gap in help seeking between higher-and lower achievers, which in the overall helped in the achievement level of lower achievers. Thus, according to Miller (1987) and reemphasized by Falsario, Muyong and Nuevaespaña (2014), an effective teacher's task is to analyze and nurture a climate thatis capable of being receptive to innovation and creativity.

The classroom climate can be described along positive and negative dimensions. Positive climate encompasses the degree to which students experience warm caring relationships with adults and peers and enjoy the time they spend in the classroom. To Nielsen in Chrisenduth (2006), positive classroom climate is where the atmosphere is conducive to teaching and learning, where everyone who has interest in the school expresses pride in it, where learners are given maximum opportunities to learn and there are high expectations for learners to achieve. Negative climates are those in which students experience frequent yelling, humiliation, or irritation in interactions with teachers and peers (Pianta, Hamre & Allen, 2012).

Several variables contribute to a positive classroom climate. Sinclair and Fraser (2002) named five variables contributing to classroom climate: (a) cooperation, the extent to which students cooperate with each other during class activities; (b) teacher support, the extent to which the teacher helps, encourages, and is interested in the student; (c) task orientation, the extent to which it is important the class stays on task and complete assignments; (d) involvement, the extent to which students participate actively in his or her class activities or discussions; and (e) equity, the extent to which the teacher treats all students equally including the distribution of praise and questioning. It is important to therefore note that the establishment of a positive classroom climate may not be dependent on the learner's social background or intellectual ability. The learners are likely to work better if they are provided with support and are taught in an atmosphere of confidence that they can and will succeed in the tasks they are set. Thus the teacher plays a vital role in creating a positive classroom atmosphere to enhance academic achievements of learners (Chrisenduth, 2006). However, according to Chrisenduth (2006) creating a classroom climate that optimizes learner-teacher interaction is often hampered in overcrowded classes. From the foregoing and as has been observed by Soyer (1996), the priorities of schools should be to create a climate for creative learning, to be a place for active learning not passive learning, a place where people learn to be creative not just conformity where they learn to co-operate as well as compete.

Another dimension of emotional support is the degree to which classrooms and interactions are structured around the interests and motivations of the teacher, versus those of the students (Pianta, Hamre & Allen, 2012). This dimension is commonly referred to as discourse making. Classroom discourse can affect various aspects of student learning in science (Smart &Marshall, 2012). As observed by Van den Oord and Rossem (2002), interactions between students and teachers have the potential to shape the course of student learning. It is therefore evident that the verbal communication between teachers and students in classrooms shapes the learning environment by influencing the type of talk that students engage in during instruction (Gee, 2001). This classroom talk, or discourse, often guides students in making meaning of science concepts (Duit & Treagust, 2003).Although Gee (2001) has defined discourse as an interplay between words, acts, values, beliefs, attitudes, and social identities within a group of individuals who contribute jointly to sense-making and construction of meaning, Smart and Marshall (2012) have argued that discourse is more than classroom talk. According to them it is a complex interaction between teacher, students, and these individuals’ unique perspectives manifested in verbal communications.

In such classrooms, teachers frequently ask for students’ ideas and thoughts, follow students’ lead, and provide opportunities for students to have a formative role in the classroom. In these classrooms, students are not just allowed to talk but are actively encouraged to talk to one another (Pianta, La Paro & Hamre, 2004). Although there is a combination of teacher and student talk in these classrooms, there is a clear and intentional effort by teachers to promote students’ language use, including explicit attempts to facilitate peer conversations (Justice, Mashburn, Hamre, & Pianta, 2008; Pianta et al., 2004). Teachers can therefore promote rich instructional discourse through verbal interactions that fosters exchanges of ideas, concepts and views. At the other end, a non-discourse making classroom is dominated by teacher talk, and student utterances are rarely attended or responded to in any meaningful way. Learners in such classrooms have been found to have high levels of internalizing problems (NICHD ECCRN, 2003) and with slow pace of cognitive and affective development (Pianta et al., 2003).Teachers and their classroom practices are one of the important factors for ensuring productive educational outcomes, especially in relation to school performance and educational quality (Orji, 2006c). Ultimately, students can leave the classroom with their knowledge and attitudes dramatically altered from what they were before they entered, which is the essence of education. Given the foregoing, this study sought to find out chemistry teachers' classroom practices in terms of classroom climate and discourse and sense-making in chemistry classes. The study further investigated the relationship between these factors and students' achievement in chemistry.

The following research questions guided the study:

1. What is the nature of FCT chemistry teachers' classroom practices in terms of classroom climate?
2. What is the nature of FCT chemistry teachers' classroom practices in terms of discourse and sense-making in chemistry classes?
3. What is the relationship between these teacher classroom practices and students' achievement in chemistry?

Method

The study adopted an *ex post facto* research design, since there was no manipulation of variables. According to Gall, Borg & Gall (1996), the main reason for using an ex post facto design is that many cause and effect relationships are not open to experimental manipulation. Furthermore, the authors argue that an ex post facto design allows the researcher to study cause and effect relationships either where experimental manipulation is impossible, or where the purpose is to examine many relationships in a single research study. The population of this study comprised all the SSII chemistry students and their teachers in the 56 public senior secondary schools in the Federal Capital Territory (FCT). These schools are located within the six Area Councils of the Federal Capital Territory (FCT). According to the FCT Secondary Education Board Students' Enrolment data for 2015/2016 academic year, the population of SS II science students in the FCT is (9125) 6,129. Also, according to FCT SEB, the population of chemistry teachers in the FCT senior secondary schools is 120. About 70 of these teachers teach chemistry in

SS II. Out of the 56 senior secondary schools, 45 schools were randomly selected from the 6 Area Councils. Table 2 presents the number of public senior secondary schools in each Area Council.

Table 1: Sample Size of FCT Public Senior Secondary Schools (SSS) Used for the Study

Area Council	Number of SSS	Number selected
Abaji	4	3
Bwari	11	9
Gwagwalada	8	6
Kuje	7	5
Kwali	5	3
AMAC	21	19
Total	**56**	**45**

From each of the 45 selected schools, 20 students in an intact class were randomly selected to participate in the study. Thus, 900 SS II science students, which constitutes 15 % of the total population, participated in the study. However, only the students who answered all the questions contained in the Chemistry Achievement Test (CAT) were used for the analysis. In all 601 students were used for the study. 45 chemistry teachers, male and female, participated in the study. This number constitutes 38% of the total population of chemistry teachers in the FCT senior secondary schools

Two instruments were used for data collection. The instruments are Teacher Classroom Practices Observation Schedule (TCPOS) and Chemistry Achievement Test (CAT). Both instruments were developed by the researcher. TCPOS has two parts. Part A was designed to obtain information on the teachers' demographic data. Part B was a 17-item observation schedule with two sections A and B. Section A was used to observe teachers classroom practices in terms of classroom climate. Section B concentrated on the area of discourse and sense-making in a chemistry classroom teaching. The rating scale had 4 points ranging from "never = 1", "rarely = 2", "sometimes = 3", "always = 4". A guide on how carry out the observations was also developed and used during the classroom observation.

CAT on the other hand, is a two-part instrument. . Part A concentrated on students' demographic data and Part B contained 30 multiple choice questions covering areas of chemistry taught the students in SSI and first term of SSII. Students' scores in CAT were used as a measure of their achievement in chemistry. In developing the test items, attention was paid to the senior secondary chemistry curriculum with due consultation with the SSI and SSII schemes of work. The purpose of this was to make sure that the students were not tested outside what they had been taught. The areas of chemistry covered were particulate nature of matter, chemical equations and combinations, gas laws, separation techniques, periodic tables, mass-volume relationships, carbon and its compounds, acids, bases and salts. Each question has four options, one correct answer and three distracters, from which the students selected the correct answer to the question. The students were allowed 60 minutes to attempt the questions. Each correct answer attracted two marks while any wrong response got zero. The maximum number of marks obtainable by a student was 60 or 100%.

The drafts of the instruments were given to two teacher educators, one in Chemistry/Education for face validity and content analysis. The experts checked the adequacy of content coverage of the items, clarity of the items, adequacy of the items in addressing the purpose of the study, research questions, appropriateness of the suggested response options or categories, whether or not the responses are exhaustive. After taking care of the suggestions made by the teacher educators, the instruments were given to a measurement and evaluation expert, a senior secondary chemistry teacher and a senior secondary mathematics teacher for their inputs. Their comments and suggestions were used to modify the instruments.

The validated instruments were then pilot-tested through a single administration in two public senior secondary schools in Gwagwalada Area Council that were not part of the schools used for the study. The administration of the instruments was done by the researcher and a trained research assistant. Forty students and 2 teachers participated in the pilot-testing of the instruments. While reliability of CAT was obtained using Crombach’s coefficient Alpha, the inter-rater reliability for TCPOS was obtained by computing the product moment coefficient of the scores assigned by the researcher and the trained research assistant. The reliability coefficients of 0.73 and 0.78, were obtained for CAT and TCPOS, respectively. Data collection for the study lasted for a period of eight weeks. Each school was visited four times. On each school visit, the teacher lesson observation took place. In all, four lessons were observed in each of the schools and an average score of the observations was computed and used for the analysis. The Chemistry Achievement Test (CAT) was administered on the students the last day of each school’s visit. Research questions 1 and 2 were answered using percentages, mean and standard deviation. To answer research questions 3 and 4 two statistical tools were respectively employed. They are Pearson Product Moment Correlation and independent t test.

Result

Table 2: Descriptive Statistics of Teacher Classroom Practices: Discourse and Sense-making in Chemistry Class

S/N	Items	NV (1)	RY (2)	SM (3)	AL (4)	Mean	SD
1	The vast majority of the students were engaged in the lesson and remained on task.	-	23 (51.1)	18 (40.0)	4 (8.9)	2.60	.65
2	Student asked questions to clarify their understanding of chemistry ideas or procedures. *Logistical questions – "may I sharpen my pencil?" don't count.*	6 (13.3)	18 (40.0)	17 (37.7)	4 (9.0)	2.40	.84
3	Students shared their observations or predictions	10 (22.2)	19 (42.2)	14 (31.1)	2 (4.4)	2.14	.80
4	Students explained chemical ideas and/or procedures	12 (26.7)	18 (40.0)	14 (31.1)	1 (2.2)	2.11	.83
5	Students justified chemical ideas and/or procedures.	12 (26.7)	18 (40.0)	14 (31.1)	1 (2.2)	2.11	.83
6	Students listened intently and actively to the ideas and/or procedures of others for the purpose of understanding someone's methods or reasoning.	9 (20.0)	23 (51.1)	12 (26.7)	1 (2.2)	2.11	.75
7	Students challenged each other's and their own ideas that did not seem valid.	15 (33.3)	22 (48.9)	6 (13.3)	2 (4.5)	1.90	.77
8	Students defended their chemical ideas and/or procedures	6 (13.3)	27 (60.0)	12 (26.7)	-	2.11	.63
9	Students determine the correctness/sensibility of an idea and/or procedure based on the reasoning presented	6 (13.3)	24 (53.3)	12 26.7	3 (6.7)	2.22	.77
10	The teacher and students engaged in meaning making at the end of the activity/instruction. (There was a synthesis or discussion about what was intended to be learned from doing the activity.)	5 (11.1)	19 (42.2)	18 (40.0)	3 (6.7)	2.40	.77
						2.21	

**.values in parenthesis represent percentages.*

N = 45; NV denotes Never, RY = Rarely, SM = Sometimes, AL = Always, SD = Standard Deviation.

From Table 2, except for item 1, the mean scores for all the other 9 items were low ranging from 1.90 to 2.40. The weighted average of 2.21 reveal that majority of the teachers sampled for the study rarely exhibited classroom practices that support discourse and sense-making during chemistry lessons. Considering the items used in measuring this variable, it does clearly show that chemistry teachers' classroom practices do rarely support students' active participation in chemistry lessons. Students were more passive than active in most of the chemistry classes observed.

Table 3: Descriptive statistics of Teacher Classroom Practices: Classroom Climate

S/N	Items	NV (1)	RY (2)	SM (3)	AL (4)	Mean	SD
1	Active participation of all students was encouraged and valued.	12 (26.7)	21 (46.7)	10 (22.2)	2 (4.4)	2.23	.74
2	The teacher displayed respect for students' ideas, questions, and contributions.	5 (11.1)	13 (28.9)	24 (53.3)	3 (6.7)	2.45	.78
3	Interactions reflected a productive working relationship among students.	-	18 (40.0)	24 (53.3)	3 (6.7)	2.60	.55
4	Interactions reflected a collaborative working relationship between the teacher and the students.	3 (6.7)	24 (53.3)	14 (31.1)	4 (8.9)	2.48	.70
5	Wrong answers were treated as worthwhile learning opportunities	8 (17.8)	23 (51.1)	13 (28.9)	1 (2.2)	2.17	.74
6	Students were willing to openly discuss their thinking and reasoning.	5 (11.1)	21 (46.7)	17 (37.8)	2 (4.4)	2.37	.77
7	The classroom climate encouraged students to engage in chemistry discourse.	7 (15.6)	18 (40.0)	15 (33.3)	5 (11.1)	2.37	.84
						2.38	

**.values in parenthesis represent percentages*
N = 45; NV denotes Never, RY = Rarely, SM = Sometimes, AL = Always, SD = Standard Deviation.

Table 3shows that out of the seven items listed on classroom climate, only one yielded mean scores above 2.5. These is item 3. The remaining 6 items yielded low mean values of 2.17 to 2.48. The lowest mean value of all the items is recorded in item 5 (Mean = 2.17), indicating that wrong answers by students were rarely treated by teachers as worthwhile learning opportunities. On a general note, the weighted average of 2.38 indicates that the classroom climate of the chemistry classes observed are rarely supportive for effective chemistry teaching and learning. This entails that the classroom climate in most chemistry classes observed do not support active learner-learner and teacher-learner interactions during teaching and learning. More so, the active participation of all students were rarely encouraged and valued by the teachers (Mean = 2.23).

Table 4: Pearson correlation coefficient of the relationship between achievement in chemistry and teacher classroom practices

		Achievement	TCP
Achievement	Pearson Correlation	1	. 316*
	Sig. (2-tailed)		
	N	646	646
TCP	Pearson Correlation	.	1
	Sig. (2-tailed)	316*	
	N	646	646

Note: Significant at p<0.05; TCP = teacher classroom practices, Achievement = Achievement in Chemistry*

From table 4, which shows the bivariate zero order correlation between achievement in chemistry and teacher classroom practices in terms of classroom climate and discourse and sense-making in chemistry class. It is obvious that there is significant and positive correlation between achievement in chemistry and teacher classroom practices and TCP (0.316), Thus increase in TCP will also lead to increase in achievement in chemistry.

Discussion

This study reveals that, chemistry classrooms observed lacked discourse and sense-making during lessons. Chemistry classroom learning situation that is not organized within an environment that supports students' discourse and sense-making would not be expected to yield desirable outcomes. This is because, as has been observed by Van den Oord and Rossem (2002), interactions between students and teachers have the potential to shape the course of student learning. Generally, as seen in table 2, the classroom observed rarely provided opportunities for productive student-student interactions and teacher-students interactions (weighted average is 2.21). This clearly indicates that chemistry teachers' classroom practices failed to support students' active participation in chemistry lessons, thus creating a learning environment in which students were more passive than active, could not challenge each other's ideas and could not defend their ideas and/or procedures. Learners in such classrooms have been found to have high levels of internalizing problems (NICHD ECCRN, 2003) and slow pace of cognitive and affective development (Pianta et al., 2003).

Active chemistry teaching and learning requires productive conversations among students and between teacher and students. The classroom climate in most of the chemistry classes observed in the study, to a great extent, did not support active students' participation during chemistry teaching and learning as shown in table 3 (weighted average = 2.38). The details of the finding as shown in table 3 depict classroom atmosphere that students were denied the opportunity to willingly and openly discuss their thinking and reasoning and only a few teachers treated wrong answers as worthwhile opportunities for learning. Although there were a few classes in which the teachers encouraged active participation of students, displayed respects for students' ideas, questions and contribution, the prevailing classroom climate in the majority of the chemistry classes did not make for effective learning environment. This is because, according to Strivens (1985), the most effective classrooms appear to be those in which the atmosphere is 'task-oriented' and where the social and emotional needs of the students are met by establishing mutual respect and good rapport. This prevailing classroom situation, however, may not be unconnected with the high teacher-students ratio in most of the classes. According to Chrisenduth (2006), creating a classroom climate that optimizes learner-teacher interaction is often hampered in overcrowded classes. This study also explored the relationship between teacher classroom practices and academic achievement in chemistry. The finding that there is a positive relationship between students' achievement and teacher classroom practices supports the earlier study by Schwerdt and Wuppermann (2008). The authors showed that the classroom practices exhibited by a teacher exerts positive influence on the students' academic achievement.

Conclusion

The study was designed to investigate chemistry teachers' classroom practices in terms of two key components of classroom climate and discourse and sense-making in chemistry classes. The result of the study revealed that, although positive and significant relationship exist between these factors and students' academic achievement in chemistry, the teachers who taught in most of the chemistry classes used for this study exhibited practices that are not in line with the tenets of the two factors under consideration. Following the findings, it appears that the teachers lacked adequate trainings on best practices for effective chemistry teaching and learning.

Recommendations

On the basis of the findings of this study, the following recommendations are made:

1. The FCT Secondary Education Board (SEB) and the FCT Education Resource Centre, should design and implement capacity-building programmes for chemistry teachers and other science teachers on classroom practices, especially in the areas of Discourse and Sense-making in chemistry classes and classroom climate. Other States in Nigeria should also take similar action.
2. A large class size hampers effective use of classroom practices that enhance learners' active participation in chemistry classes, which will in turn impact on learners' achievement in chemistry. To address the present situation of class sizes of more than 70 students to a teacher, the government of FCT should build more classrooms and then employ more chemistry teachers. This will reduce the students-teacher ratio to at least 40:1, which is the recommended ratio in the Nigerian National Policy on Education. This situation is not only applicable to schools in the Federal Capital Territory.
3. Irrespective of the effectiveness of a chemistry teacher classroom practices, the absence of basic facilities and resources for chemistry teaching will incapacitate active chemistry teaching and learning. In the light of this, relevant agencies and groups should make determined effort towards making resources adequately available in schools for the teaching and learning of chemistry.

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