Chemophobia: Teachers to the rescue

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Abstract

Chemistry is a crucial science subject in the Nigerian senior secondary school. It is one of the core physical science subjects required for admission into most science related courses in tertiary institutions. However, there has been a decline in the achievement of students in Chemistry over the past years. Research studies over the years within and outside the country have reported that the fear of chemistry learning, evaluation and handling of chemicals (chemophobia) has a significant negative impact on the achievement of students in Chemistry. These studies further reported significantly high level of chemophobia among students both in secondary and tertiary education. Chemophobia has further been reported to affect not only the cognitive achievement of students but also their attitude and self-efficacy. The enrollments of students in science classes and in choice of career paths have also been negatively affected by the issue of chemophobia in students. This article therefore seeks to elucidate the factors that trigger chemophobia in students and how chemistry teachers can come to the rescue as facilitators of learning, to effectively improve and sustain excellent achievement of senior secondary school students in Chemistry.

Keywords: Chemophobia, chemistry education, chemistry anxiety, chemistry teachers

Introduction

Chemistry as a subject is a crucial physical science subject stated in secondary level curriculum and also in tertiary level as perquisite requirements for admission into tertiary institutions for most science and technology related courses (Salisu & Nuru 2023; Erdal & Mustafa, 2014; Yusuf 2014,). Chemistry is that branch of pure science that involves the study of matter, its properties, structure, composition transformation and interaction with energy. Akpan (2016) simplified the definition of chemistry in his statement that Chemistry is the study of matter and the changes that matter undergoes. The impact of chemistry is shown in every sphere of human life and could be found in materials and processes around us. Chemical substances which are products of chemical processes are found in foods, beverages, clothes, soaps, fuels, medicines, explosives

and so on. Chemistry related fields have contributed significantly to economic growth and sustainability in both developing and developed countries.

Nigeria as a developing country needs more of its citizens to be effectively involved in these chemistry-related careers to bring sustainability to our local chemical and allied industries. Unfortunately, research has shown that a great number of students have fear and anxiety towards the learning of chemistry as a subject and also exhibit fear and anxiety in handling chemicals or performing related experiments(Jegede 2007; Akanazu & Okoli 2019; Nwafor, Eke, & Ibe 2023; Salisu & Nuru 2023). This fear or anxiety towards Chemistry is termed Chemophobia.

This perceived fear and anxiety of students towards chemistry has been reported to impact chemistry achievement and their choice of career with more students avoiding chemistry-related courses (Nkiko 2021; Ibiyengibo & Nenalebari 2022; Iguisi & Edosomwam 2022). Nigeria is presently on a brink of economical abyss. Most of the relevant fields needed for the sustainability of our economic growth are chemistry-related because there is need for the citizens to embrace more of local production and industrialization of materials, food and drugs. The country needs more dynamic and positively oriented students in these fields.

Students often look upon chemistry as a burden to be endured than as experience of meaningful activities and learning of concepts to be valued. This negative mindset makes the learning of chemistry to become stressful and creates an atmosphere of chemophobia (Chen, 2013). This article highlighted the reported causes of chemophobia and how chemistry teachers can come to the rescue of students to eradicate chemophobia in students both in secondary and tertiary institutions.

CHEMOPHOBIA

Chemophobia has been described as the occurrence of "fear of chemicals" and "fear of chemistry as a learning course" (Eddy, 2000). Chemophobia is also referred to as chemistry anxiety and according to Turney and Lindsay (2003), chemistry anxiety represents students' feelings such as fearfulness, uneasiness and physical appearances of these emotions towards chemistry.

Anxiety is a fundamental human emotion consisting of apprehension that typically appears when a person perceives an occurrence as being threat to the ego or self-esteem (Harris et.al, 2003). According to Muris et al. (2010) anxiety can also be defined in terms of physical symptoms such as feeling of heart beating too fast, unsteady, and shortness of breath. In term of learning, anxiety problems are among the most common emotional difficulties that youth face and are associated with academic difficulties and negative developmental path (Weems et al., 2013).

Chemophobia can also be defined as a mindset of students about chemistry which they believe to be difficult and abstract, involving the handling dangerous chemicals, solving difficult numerical problems an memorization of abstract facts and concepts (Woldeamanuel, Antagana & Engida 2013).

Chemophobia and Student Chemistry Achievement

Performance of students in Chemistry especially in certificate and matriculation examinations has been on a decline over the years, especially in recent years.

Table 1.1: Students average score in West African Senior Secondary School Examination Chemistry paper 2 (2020-2023)

Year	Mean Score in Paper 2	Standard deviation
2020	54.0	17.83
2021	49.0	15.94

2022	45.0	12.04
2023	34.0	14.35

Source : WAEC Chief Examiner's Report 2020-2023.

The poor achievement in Chemistry examinations is of great concern to all stakeholders in education. The under achievement of students in chemistry can pose a threat of scarcity of qualified human resource in chemistry related fields (Ardura & Perez-Bitrian 2018; Christensen & Knezek 2017; Smith &White 2019).

Although many factors have been identified and reviewed over the years as being responsible for this decline in performance, empirical studies have reported chemistry anxiety as one of the significant attributable factors of poor performance in chemistry. Studies within (Jegede 2007; Nwafor, Eke, & Ibe 2023; Salisu & Nuru 2023; Akanazu & Okoli 2019) and outside the country (Chhetri, Chhetri & Giri 2022; England & Brigati 2019) have identified Chemophobia as having a significant but negative correlation with performance of students in chemistry. According to the various reports, students tend to exhibit anxiety and fear in chemistry at three major levels: in learning chemistry (concepts, principles and calculations), evaluation (chemistry tests and examinations) and laboratory activities (handling of chemicals and performing experiments).

Chemophobia is one of the obstacles that contribute to the decline of excellent student achievement in chemistry (Erdal and Mustafa, 2014). Hence, it is of high significance to review factors that contribute to or trigger chemophobia in order to procure solutions and promote the improvement of achievement of students in chemistry.

Chemophobia and student affective variables

Affective variables are construct that pertain to the students emotions, feelings and perceptions. They include the attitude of students, self–efficacy, self-esteem and other

psychological and psychosocial variables that students exhibit. Studies have shown that chemophobia correlated negatively not only to performance, but also to issues of perception and attitudes towards chemistry (Hong, 2010; Mallow, Kastrup, Bryant, Hislop, Shefner & Udo, 2010; Woldeamanuel, Antagana & Engida 2013). Chemophobia typically exists among secondary school students when they feel worried towards chemistry content and context. Furthermore, students self-efficacy which is a person's beliefs concerning his or her ability to perform successfully on a given task has also been reported to have significant but negative correlation with chemistry anxiety (Kubarnoglu & Akim 2010). This reveals that students' belief in their ability to succeed in chemistry tasks, courses, or activities influences their level of chemophobia.

Chemophobia and career choices

Chemophobia has resulted in loss of interest in chemistry as a subject among students (Erdal and Mustafa, 2014; Ibrahim and Iksan 2018). They opined that the negative feeling of fear and anxiety for chemistry learning and handling of chemicals has impacted negatively on the enrollment and career choices of students in chemistry related fields, resulting in students opting for non-chemistry related courses as career paths (Hong 2010; Kubanoglu & Akim 2010; Yusuf 2014). This report could be due to the fact that chemistry is one of the major admission subjects into most science-related fields like medicine, engineering, nursing, and architecture. The fear of failure in chemistry and anxiety about ability to understand chemistry concepts could affect the choice of career of the intending students.

Chemophobia and Gender

Studies generally indicated that the students, whether male or female, show great anxiety towards the learning of chemistry, however, they reported higher level of anxiety in females (Jegede, 2007; Woldeamanuel, Antagana & Engida 2013, Akanazu

& Okoli 2019). According to Farhane-Medina, Luque, Tabernero, and Castillo-Mayén (2022), the difference in brain system involved in fight or flight response in female and male may account for the difference observed in anxiety levels of male and female in chemistry. What a male student may perceive as a challenge and stay to fight and overcome it, may result in a desire to flee in a female and this may increase the anxiety level of the female student. Nevertheless, some studies have reported no disparity in the level of chemistry anxiety of males and females (Salisu & Nuru 2023; Cheng@Chong 2013).

Causes of Chemophobia in chemistry students

Several studies have reported various causes of chemophobia in students. Findings from both teachers and students perspectives revealed the following most recurring factors:

1. Low evaluation score: When students score consistently low grades in chemistry tasks, it can trigger chemophobia (Ali & Mohsin, 2013).
2. Poor teaching methods: The way teachers teach and the technique they adopt in teaching can trigger or reduce anxiety in students. (Jegede 2007; Britner, 2008; Kurbanoglu et al., 2009; Usher & Pajares, 2006)
3. low self efficacy: Students who have strong belief that they can succeed in chemistry-related tasks and activities will be more likely to select such tasks and activities, and work hard to complete them successfully (Britner & Pajares, 2006). Alternatively, students who do not believe that they can succeed in chemistry-related activities will avoid them if they can and will put forth minimal effort if they cannot.
4. Inability of the students to connect or relate chemistry to other subjects or real life experiences: Sirhan (2007), anxiety and fear of learning chemistry can

occurs when students cannot make a connection or relationship between real life activities and the concepts, principles, theories and experiments taught in chemistry as a subject. This statement is further corroborated in the findings of Kurbanoglu and Akim 2010; Blakely, 2011.

5. Inability of the students to solve difficult tasks in chemistry (Nelson & Harwood 2011). Students are likely to be anxious in learning chemistry when they cannot effectively interpret the abstract knowledge of chemistry in term of theories, concept, principle or problem-solving calculation.

3.0 TEACHERS TO THE RESCUE

Teachers are the facilitators of learning in the classrooms. Hence the onus lies on the teachers to help the students alleviate their misconceptions about chemistry which trigger chemophobia. Research has revealed some classroom dynamics that could be put in place by the teachers to rescue students from chemophobia, especially in the secondary school chemistry classes. The following are techniques that chemistry teachers can put in place to reduce chemophobia in students.

Teaching aids

The use of teaching aids, images, simulations, videos and demonstrations in explaining chemistry concepts would help the students to relate theories to real life applications. It would also clear the misconception that chemistry is abstract.

Teaching design

Teachers start from the basics and move from simple to complex, familiar to unfamiliar. This would facilitate understanding of difficult concepts in chemistry and allow smooth transition from one topic to the other without stress.

Use of mnemonics

Mnemonics are memory strategies consciously used to improve memory (Adepoju, 2014). They are said to be powerful learning tools that help students to memorize large information at the same time (Putnam, 2015). For example, students can be taught to memorize the first 30 elements of the periodic table using mnemonics. Findings have reported that the use of mnemonics in teaching students reduce stress and anxiety (Mocko, Lesser, Wagler & Francis 2017) and also improve achievement gain (Ekpuyaman, 2021).

Teaching methods

Poor teaching method can kill the interest of students and increase anxiety of students in that course. Studies have shown that the use of student-centered interactive and collaborative approach in teaching reduce students' anxiety towards chemistry as compared to students that have been taught using teacher-centered learning approach (Hong, 2010; Erdal & Mustafa, 2014; Yusuf (2014). Furthermore, teachers can choose appropriate innovative strategies that have been empirically proven to improve achievement and reduce stress. These instructional strategies such as use of analogy (story telling), interactive engagement (Ayodele, Olagunju & Balogun 2011) and inquiry-based instruction in which students are mentally and physically active in their learning environment can be implemented (Uzuntiryaki & Capa Aydin, 2009). Using these student interavtive and analogy (story-telling) teaching strategies have been found to increase self-efficacy of students t(Ayodele, 2014), hereby giving no room for chemophobia.

Use of motivation

Motivation according to Loewen and Reinders (2011) is the desire and incentive of an individual to engage in a specific activity. It is an important component for students to achieve success in any learning environment (Bukhari et al., 2014; Yulselturk & Bulut,

2007). Moreover, studies have shown that students lacking in motivation have high anxiety level, hence they recommended that teachers should motivate their students to reduce the level of student anxiety (Caymaz & Aydin 2021; Sahu & Tripathi 2024). A highly effective way of motivating the students is to reward improvement and not grade. When a student is applauded for the successful completion of simple tasks, it gives them confidence in their ability to attempt more complex ones and when improvement is lauded rather than the particular score, it would boost the self-efficacy belief of the student thereby reducing the anxiety level in that subject.

Laboratory experiments and safety rules

Teachers should outline and explain comprehensively the safety rules and guidelines in handling chemicals within and outside the laboratory. The fear of chemicals should be demystified. All containers used in holding chemicals should be labeled as such and danger symbols inscribed on them. Moreover, teachers should insist on the use of relevant safety gadgets when students come into the laboratory. Moreover, students should be introduced to hands-on chemistry early enough so as get them familiar with apparatus, reagents and procedure. In most of our secondary schools, experiments are only conducted in SS3 classes and only when it is few weeks to the certificate examinations. Ogunleye (2010) earlier reported this in his survey study and this was later corroborated by the reports of Ifepe and Anekwe (2022).

CONCLUSION

The issue of chemophobia and its effect on chemistry achievement, career choices, self-efficacy and other affective variables cannot be over-emphasized. There is urgent need for chemistry teachers being the facilitators of learning in the classroom and laboratory, to rise to the aid of students. The way and manner that chemistry as a subject is presented to students in the classroom would greatly influence the attitude, interest and

level of anxiety of the students towards the subject. The use of adequate teaching aids, mnemonics, innovative teaching methods and motivation would go a long way to alleviating chemophobia among students, especially senior secondary school science students.

SUGGESTIONS

The following suggestions are made as panacea to chemophobia in chemistry classrooms at all levels:

1. Chemistry educators should adopt interactive and innovative teaching methods like use of analogies, story-telling, play-way-game and so on, rather than the conventional lecture method
2. Use of mnemonics can be employed to teach concepts that need to be memorized
3. Teaching aids should be part of instructional materials that teachers should employ to experiential knowledge as oppose to abstract.
4. Use of motivation would help remove anxiety and foster self-efficacy
5. Chemistry educators should be retrained in classroom dynamics that would boost confidence in students and alleviate chemistry anxiety in chemistry classes.

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