Perception and experience of heterosexism by non-heterosexual students in a chemistry classroom: An interpretivist study

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Abstract

There has been increasing awareness of equality, diversity, and inclusion in scientific disciplines over recent decades. This aim of this interpretivist study is to understand, from the perspectives of nonheterosexual students, the prevalence and nature of heterosexism in the chemistry classroom. In-depth interviews were conducted with ten students who self-identified as non-heterosexual and had attended chemistry classes at a Russell Group university in the UK. Participants reported both overt and subtle forms of heterosexism, including assumptions of heterosexuality in teaching practices, exclusionary peer interactions, and a lack of visible non-heterosexual representation in teaching content. These experiences negatively affected students' sense of engagement and passion for chemistry learning. The study highlights the need for chemistry educators to reflect on classroom language, teaching materials, and implicit assumptions about student identities. Key recommendations include using inclusive language and examples in teaching, avoiding heteronormative assumptions in classroom discourse, establishing formal support mechanisms to enable students to report incidents of heterosexism, and providing staff training to challenge heterosexist microaggressions. With collaborative efforts from educators, regulatory bodies, students, and institutional leadership, chemistry classrooms can become more inclusive, supportive, and conducive to learning for non-heterosexual students.

Keywords

Heterosexism; student experience; chemistry education; perception; diversity

1. Introduction

Heterosexism is defined as the attitude and ideology which assume heterosexuality (as well as its related power and privilege) to be normal and ideal, thereby privileging heterosexuality relative to homosexuality (Chesir-Teran and Hughes, 2009; Chesir-Teran, 2003). It is an ideological system which stigmatizes, denigrates, and denies any form of identity, relationship, behaviour, or community other than the heterosexual ones (Walls, 2008). Such a system is known to lead to the invisibility of the rights and voices of nonheterosexual individuals, resulting in explicit expressions of discrimination or victimization towards nonheterosexual individuals (Chesir-Teran, 2003; Cooper and Brownell, 2016; Lipkin, 1999). This situation could be reinforced in institutions and societies in which non-discrimination policies and inclusive programs are absent (Chesir-Teran, 2003).

In the UK, Equality Act 2010 is in place to protect people from discrimination based on sexual orientation and from harassment or victimisation (Government of the United Kingdom, 2024).

Even though the availability of related written policies can help fight against explicit homophobic behaviours and attitudes, implicit heterosexist ideologies still exist. This has been evidenced by the result of a recent ethnographic study of two state-funded schools in the North East of England (Atkinson, 2021), which found homophobia to be central to peer group culture in both schools, influencing not only the development of friendships among students but also the structure of generational and peer group hierarchies. This problem of homophobia appeared to stem from prejudices in the past, partly evidenced by an earlier report titled *Profiles of Prejudice*, published by the organization Citizenship 21 (2003), in which around 17% of respondents reported feeling less positive towards homosexual people, as well as by a later study in which homosexuality was viewed by some respondents as "*cultural threats to traditional English values and ways of life*" (Valentine and McDonald, 2004). Such kind of heterosexist attitudes and ideologies held in the UK not only undermines equality, diversity and inclusion (EDI) in the society, but also potentially imposes challenges to teaching and learning in various disciplines, particularly those that are susceptible to gender stereotypes (Hughes and Kothari, 2023; Linley *et al.*, 2018). One good example of these is scientific disciplines, in which stereotypes have been found to be visible in different aspects of education, ranging from the use of gender-biased language to teaching methods and teachers' attitudes (Kerkhoven *et al.*, 2016). The occurrence of heterosexism is not unique to the UK and indeed a global issue. It has been reported in countries ranging from developed countries (e.g., the United States (Salim *et al.*, 2020; Szymanski and Henrichs-Beck, 2014)) to developing countries (e.g., People's Republic of China (Chow and Cheng, 2010), Lebanon (Michli and Jamil, 2022) and India (Vanita, 2000)).

EDI in scientific disciplines has been gaining attention over the years. While efforts have been put in the literature to devise different ways to enhance students' motivation (Lisberg and Woods, 2018; Tan and Barton, 2010) and learning experience (Burke and Dunn, 2002; Han *et al.*, 2018; Owens and Weigel, 2018; Pearl and Christensen, 2017), comparatively less attention has been paid to exploring the individual accounts of students in a classroom setting. This situation has been improved in recent years, in which a growing body of literature has been published on students' experiences, including those of non-heterosexual students in scientific disciplines (Fitzgerald-Russell and Kowalske, 2024; Friedensen *et al.*, 2021; Hughes and Kothari, 2023; Miller *et al.*, 2022; Marosi *et al.*, 2025); however, understanding of individuals' lived experiences in scientific disciplines and their perceptions of the inclusiveness of their immediate environment is still limited. Addressing this limitation is pivotal to make the scientific community inclusive. The legitimacy of this need is further corroborated by the fact that non-heterosexual individuals working on science disciplines have been found to experience workplace inequalities (Cech and Pham, 2017; Cech and Waidzunas, 2021). Comparing with majors in non-science disciplines, science majors have been reported to be more prevalently regarded by queer students to be "less appropriate" for them (Forbes, 2022; Sondag *et al.*, 2022). This greatly influences the motivation of non-heterosexual students to major in science disciplines (Hughes, 2018; Linley *et al.*, 2018) and accounts for the fact that non-heterosexual students persist in science majors at a lower rate than their heterosexual peers (Hughes and Kothari, 2023). As chemistry is one major discipline in science, this study aims at investigating the situations non-heterosexual university students face in a chemistry classroom. By understanding their lived experience and by exploring struggles they may encounter, we can identify factors to enhance the success of nonheterosexual students during their study in chemistry. Findings of this study can also assist educators in chemical sciences in implementing decisions that foster a more respectful and inclusive learning environment for nonheterosexual students (Chan and Stewart, 2022).

2. Research paradigm and the physiological stances thereof

This study adopted an interpretivist paradigm, with the design and conception developed by the first author. The term "paradigm" is defined as a set of principles and assumptions made (regarding the essence of reality, the strategy to attain knowledge of the reality, and the nature of values) that govern the design of a study (Scotland, 2012). One important element constituting the research paradigm is axiology, which refers to the values and beliefs guiding the process of decision-making undertaken by a researcher (Morgan, 2017). It plays a particularly important role in the design of this study because, from the interpretivist perspectives, when a social phenomenon is studied, it is the researcher's beliefs and values that serve as a lens through which the interpretation of the meaning of data (and hence the construction of the social reality) is achieved (Saunders *et al.*, 2016). Because of this, it is not possible for the values, beliefs and conventions of a researcher as a human being to be totally excluded from a research environment. In other words, the interpretation and construction of the social reality can only be subjective and value-laden (Fellows and Liu, 2015). The main purpose of this study is, therefore, not to determine objective facts regarding heterosexism as numerous quantitative studies have done. Instead, with the curiosity to understand the social situation as it is (Burrell and Morgan, 2016), it is the objective of this study to comprehend students' perception and experience of heterosexism, in the context of chemistry education, within the realm of subjectivity and individual consciousness.

Ontology has been defined as the nature of reality and being (Kelly, 2017). It concerns mainly the essence of existence of a phenomenon. Under the lens of interpretivism [which, as stated by Williams (2000) (p. 210), aims at interpreting "*the meanings and actions of actors according to their own subjective frame of reference*"], social phenomena involving human subjects are distinct from physical phenomena in a way that they are neither static nor universal (Juan *et al.*, 2023). They are subjective and are dynamic constructs of not only context-related variables but also of researchers' social (and experiential) meanings and understandings. This is owing to the presence of consciousness in individuals in a social situation. Individuals are different from coerced puppets which will react to social forces or phenomena in exactly the same way whenever those forces and phenomena appear (Bhattacherjee, 2012). Instead, each of the individuals will react, experience and understand the same social situation differently and possess distinctive reasons for their own actions (Alharahsheh and Pius, 2020). Because of this, existence of multiple socially-constructed realities is possible, with no singular social reality being able to be free from subjectivity of the observer (Babones, 2016). From an interpretivist perspective, the prevalence, perceptions, and experiences related to heterosexism cannot be fully understood through quantitative research alone. While quantitative studies can provide meaningful insights by identifying patterns and trends, they may not capture the nuanced, context-dependent nature of heterosexism in educational settings. To gain a deeper understanding of how heterosexism manifests in a chemistry classroom, it is crucial to consider distinctions in culture, situational factors, and context, as these elements shape multiple social realities. The objective of this study is, therefore, to understand, rather than to predict or to generalize, the experience and perception of chemistry students. Findings of this study will be relative in nature and are bound by context-related variables ranging from time and culture to value.

Regarding the interpretivist epistemological stances (which refer to the set of beliefs and assumptions regarding the origin and acquisition of knowledge (Kelly, 2017)) adopted in this study, it is believed that knowledge of a phenomenon can be attained only when the motivations, beliefs, values, contexts and reasoning of individuals in a social situation are understood. In order to comprehend the "reality" of an individual, understanding participants'

experience is needed. As different individuals have different experiences due to variations in their sociocultural backgrounds, each of the individuals could have one reality. It is this rationale that underpins the selection of interviews as the means of data collection in this study. Through individual conversations with the research subjects, a deeper understanding of the phenomenon experienced by each individual is expected to be attained.

In addition, while the possible existence of an external reality is not ruled out, the presence of an independently knowable reality is questionable. Due to the impossibility of conducting a study without involving a researcher, research findings are inevitably influenced and shaped by the researcher's worldviews. On the other hand, the foundation of interpretivism is the idea that reality is socially constructed. The phenomenon of heterosexism in a chemistry classroom is, therefore, not a naturally occurring one but instead, a socially constructed entity which varies from context to context. As the meaning of data is open to interpretation by the researcher, the social reality attained in the study will be co-constructed by me as well as the participants. In other words, the essential structure of the description of the participants' lived experience attained by data analysis will be validated by the participants so as to ensure that the constructed reality reflects the social reality to be studied.

3. Methods

3.1 Research design

This interpretivist qualitative study of non-heterosexual students' experience of heterosexism in chemistry class in the UK was designed based on the idea that human beings can be understood through their subjective experiences (Todres and Holloway, 2006). Its objectives were to study a phenomenon as it was experienced by the research participant and to describe the phenomenon directly without taking its causal history or psychological genesis into consideration (Husserl, 1962, 1970).

3.2 Data collection

Student participants, who had attended chemistry classes and self-identified as non-heterosexual, were recruited through purposive sampling from a Russell Group university in the UK. These participants were selected from various departments across the university and were asked to reflect on their experiences in chemistry classrooms, focusing on the prevalence and forms of heterosexism they encountered in the courses they had enrolled in. When reflecting on a variety of chemistry courses, their experiences were shaped by interactions with different instructors across all the chemistry courses they enrolled in. The study, therefore, focused on the prevalence and forms of heterosexism as a broad phenomenon within chemistry classrooms, examining how it manifested across various classroom settings, rather than focusing on specific instances or courses with individual instructors. To achieve credible and direct reflections on participants' views, a qualitative descriptive design was adopted. One-on-one semi-structured interviews were conducted by the first author who had no pre-existing relationship to any of the participants. The central research question guiding this study was: "How do non-heterosexual students perceive and experience heterosexism in a chemistry classroom?". To explore this question, the interviews were structured around three interrelated sub-questions:

- Have any incidents of heterosexism been encountered in your chemistry class?
- How does your non-heterosexual identity influence your engagement and study in chemistry?
- What could be done by your chemistry class to make it less heterosexist?

The interviews were performed either in a seminar room at the university campus or at a time and place arranged at the participant and researchers' convenience. The point of departure for each interview was formed by the participants' lived experience. The duration of the interviews was 30-60 min. All interviews were conducted in English, following the interview protocol (**Table 1**), and were audiotaped. The data collected were transcribed verbatim. Analysis of the collected data was conducted iteratively by the author throughout the process of data collection. Participants were recruited and interviewed continuously until data saturation was reached and no new themes and concepts were found to emerge.

3.3 Data analysis

Analysis of the data was performed based on the seven-step approach proposed by Colaizzi (1978). In brief, an interview transcript was first carefully read by the first author so that a deep understanding of the description was attained. Taking the context/objectives of the study into account, the interview transcript was reread during which phrases that directly relate to the phenomenon under study were extracted. Formulated meanings of each of the extracted phrases were then created and aggregated into clusters of themes. This process was repeated to analyse another interview transcripts. No new themes and concepts were found after analysis of the first seven interview transcripts; however, to better capture the depth and meaning of the experiences to be studied, additional participants were recruited and interviewed. In total ten interviews were conducted. Themes and codes identified during data analysis was presented in **Table 2**. After the process of thematization and the development of an exhaustive description, the essential structure of the description of the participants' lived experience was attained.

3.4 Ethical considerations

Before interviews were conducted, participants were provided with a consent form and an information sheet. They were informed of their rights to withdraw from the study. A code was assigned to each participant to represent their identity to protect their anonymity. Ethical approval was sought from the Human Ethics Committee at the participating university prior to data collection.

3.5 Reflexivity and trustworthiness

To enhance credibility, interview questions were set by the first author in a way that descriptive data reflecting real experiences were collected. Dialogues were paraphrased by the interviewer to accurately interpret participants' views. Reflexivity was maintained throughout the research process, with the first author keeping a journal to document personal reflections, assumptions, and potential biases that could influence data collection and analysis. Meanwhile, dependability of the study was achieved by audit trails performed throughout the process of data collection, thematization and analysis. The essential structure of the description of the participants' lived experience attained by data analysis was further validated by the participants through member checking. This allowed participants to review preliminary interpretations and provide clarifications or corrections to ensure accurate representation of their experiences.

Finally, investigator triangulation was employed. The second author, who had a laboratory-based chemistry background with no prior involvement in educational research on heterosexism and was not involved in data collection, participated in the validation process during data analysis. This author independently reviewed the coding framework, assessed the consistency of identified themes, and provided critical feedback on the interpretations. Discrepancies were discussed and resolved through iterative discussions, ensuring that the themes accurately reflected participants' experiences. The involvement of this author as an

independent reviewer helped minimize potential researcher bias and strengthened the rigor of the analysis.

4. Results

4.1 Study design and demographic information of participants

This study is an interpretative study, in which data analysis was performed based on the way outlined by Colaizzi (1978). The approach of data analysis aimed at understanding the context and complexity of meaning in the experience of the participants (Smith and Osborn, 2008). By analysing the collected data using content analysis, valid and potentially reproducible inferences could be made from data to the context of the study (Krippendorff, 2004). This allowed gathering of new insights, knowledge, and new understanding of the "facts" in the study and could serve as a practical guide to look for actions.

In this study, ten interviews were conducted. While a single 30-60-min interview per participant might not be able to capture the entirety of their lived experiences, all interviews were designed for participants to reflect on and articulate their perspectives in meaningful ways. The semi-structured interview format also enabled flexibility, allowing participants to elaborate on their experiences, perceptions, and emotions related to heterosexism in chemistry education. Probing techniques were used to encourage participants to provide rich, detailed narratives. All these ensured a deeper understanding of their realities within the study's scope. Among all participants involved in this study, five of them were males and another five were females. In terms of their ethnicity, five of the participants were Asians, among which three were East Asians and two were South Asians. All East Asian participants were from People's Republic of China. Among the South Asian participants, one was from Pakistan and the other one was from India. Four participants self-declared to be Caucasians. Among them, three were from the UK and one was from the US. One participant self-declared as Black African and was from South Africa. Demographic details of each of the participants were summarized in **Table 3**. All these participants were living in the UK at the time of the study as either undergraduate or postgraduate students.

4.2 Learning and engagement in a chemistry classroom

Six participants indicated that their selection of chemistry disciplines was largely due to personal strength. This was shown by the response of one participant, "*I'm good at science and math. I think that really pushed me towards my current study in a chemistry-related discipline. If I'm good at it, then I might take advantage of that fact if I study it* (R1)". Another participant (R5) also mentioned that "*I like to continue to study chemistry just because, compared to my performance in other subjects, my performance is chemistry is much better*". Apart from personal strength, four participants mentioned that chances to interact with others in practical sessions, rather than sitting in a classroom all the time, was one important factor causing them to engage in chemistry. This was partially evidenced by the response of one participant (R10), who indicated that "*chemistry is quite a challenging subject but I enjoy learning it. I feel good when I work with others in a laboratory and solve problems together*".

In addition to the factors mentioned above, students' perception of the teacher in a chemistry classroom appeared to be an important factor determining the engagement of participants in chemistry. Seven participants stated that the quality of interactions with the chemistry influenced their perception and learning experience in a chemistry classroom. This was partly shown by the response of one participant (R1), who stated that "*it all depends on the teachers. Some teachers are more engaging, make their class more engaging than that of other teachers. Also, some teachers are more interesting than others, even I think that most of chemistry*

teachers I encounter are a bit boring. I feel like they're not really interested in their own subject". A similar response was given by another participant (R2), who stated that "*I really enjoy chemistry classes because I like the teacher, who is engaging and can make the subject interesting*". This demonstrated the important role played by the teacher in determining the interest and motive of students in studying chemistry.

Despite the diversity of factors driving a student to study chemistry, heterosexism appeared to play a significant role in undermining the passion and engagement of non-heterosexual students in a chemistry class. Eight participants indicated that experiences of heterosexism were disengaging in nature. This was explicitly shown by the response of one participant, who stated that "*heteronormativity definitely affects my engagement in chemistry…I feel that I am living in an environment that is not very open…I already know that my teacher is not very open either… I feel I am excluded in my class* (R2)". One of the major sources of heterosexist incidents experienced by students in a chemistry class appeared to come from their fellow classmates. This was revealed by one participant, who mentioned that "*my classmates in my chemistry class like to say homophobic slurs…they treat heterosexuality to be the norm and I dare not say otherwise* (R3)". Another participant also shared that "*there were definitely certain classmates who made jokes about homosexuality and stuff during the class* (R5)". This problem appeared to be compounded by the fact that teachers in a chemistry class did not take the problem seriously, offering acquiescence to the situation without giving proactive intervention. This was revealed by one participant who shared the marginalized experience of one classmate: "*One of my classmates is believed by others to be gay and everyone mocked him as being feminine because of that. He faced a lot of discrimination by other classmates in the chemistry class as well as other classes…teachers however have not intervened proactively* (R4)".

4.3 Experience and signs of heterosexism in chemistry education

Heterosexism was suggested by participants' narratives as being implicitly present in the practices and teaching content of the chemistry classroom. One area of curriculum that our participants identified as having a high prevalence of heterosexism was the part related to physical phenomena that involved positive and negative entities. An example of such phenomena was ionic interactions, in which cations and anions formed ionic bonds. Eight out of the ten participants indicated the occurrence of heterosexism when such concepts were taught by their chemistry teachers. One participant (R7) mentioned that "*in a physical chemistry class, at that time we learnt about cations and anions. Because like charges repel each other while opposite charges attract, the teacher would use opposite-sex relationships and same-sex relationships to explain it. And no one in the class has questioned about it*". Another participant (R6) also stated that "*if the teachers were trying to explain an example, they would use a married couple of a man and a woman rather than same-sex couples. If they spoke about anything to do with marriage, they would refer to a man and a woman…This happens when they tried to make explanation of some concepts like ion attraction more interesting to us*". One participant (R3) conveyed his perception of heterosexism in how their teacher selected romantic relationships as an analogy in the chemistry classroom. He also shared his observation regarding the dual standards adopted by their teacher in selecting the type of relationships to explain concepts. He said in the interview that "*the teachers always like to use a romantic relationship between a male and a female to talk about how oppositely charged ions are attracted to each other. They try to use heterosexual relationships as an analogy to talk about attractions of opposite charges in a chemistry classroom…however, when they explain concepts like 'like dissolves like', they have not use romantic relationships between the same sex as an analogy. The whole teaching approach is very heterosexist*". Apart from ionic interactions, other concepts such as lock-and-key models (relating the interactions

between enzymes and substrates) and protein docking were susceptible to heterosexist teaching practices in a chemistry classroom. The latter was demonstrated by the response of one participant (R8), who mentioned that "*when protein docking was discussed, complementarity of personalities between two people in love was used as an analogy. The two people involved are assumed to be a male and a female. I think it is the norm in my class to equate human relationships to be the opposite-sex ones*".

Half of the participants also shared that heterosexism was experienced when teachers talked about discoveries made by scientists. This was demonstrated by the response of one participant (R1), who stated that "*when teachers explain the history of chemistry and discoveries of theories and stuff like that, they often avoid saying anything about the discoverer if the person who discovered it is homosexual or if has anything to do that…the teachers avoid saying that just because it is a controversial subject in their mind*". The participant also mentioned that this phenomenon occurred not only in chemistry lessons in high school in the US but also in the university in the UK. While some chemistry teachers avoided mentioning non-heterosexual relationships in a classroom, others used non-heterosexual relationships as something deviating from the *"norm*" as a way to attract students' attention. This was revealed by one participant (R4), who shared that "*my teacher has introduced prominent scientists to us in a chemistry class…at that time he told us that a specific scientist was regarded to be gay in order to attract the attention from the class. He, however, would try to attract our attention by telling us the suspected sexual orientation of a scientist if that scientist was regarded not to be a heterosexual…he just assumes being a heterosexual is normal and being non-heterosexual deviates from the norm*".

Apart from the occurrence of heterosexism in formal teaching, three participants reported that heterosexism occurred during teachers' casual conservations. This was exemplified by the response of one participant (R2), who stated that "*at the end of an academic year…..my chemistry teacher has wished us success and she has made comments like….'I want all my students to like grow up and be successful and like get married and meet'. And I know what the teacher means is to want all her female students to marry to the men and vice versa. This is the kind of stereotypes. I mean, I guess it is because our teacher has a religious belief. Her comments, therefore, tend to be heteronormative*". Another participant (R9) also shared a similar experience in a practical session: "*I remember…in a practical session when we were asked to do an experiment, the teacher asked us to be careful in handling the chemicals. He said, in a cheesy manner, to female students that if they got hurt, they could not find boyfriends. He also said to male students that if they got injured, they could hardly find girlfriends later.*"

Not only did heterosexism manifest verbally in a chemistry classroom, but it was also found to happen in a nonverbal manner. Illustrations used in textbooks appeared to be a major source of heterosexist nonverbal cues in chemistry. This was revealed by the response of one participant (R2), "*In our textbooks and handouts used for practical sessions in a chemistry class, when there are illustrations, some of them would just be depicting heterosexual couples…like having a man to match with a woman…implying that heterosexuality is the norm…there are basically no figures or illustrations in a textbook that matches a man with a man or a woman with a woman*". A similar problem was stated by another participant (R7), "*Illustrations in some chemistry books may depict a 'family' as having one man, one woman and a child. They will not draw a "family" as having two men and a child or having two women and a child. No one however has questioned this representation of 'family'. This is very heterosexist*". In addition to textbooks, heteronormative visual cues were found in teaching materials made by the teacher. This was evidenced by the response of one participant (R9), who shared that "*when the Mallard*

reaction was taught…in that PowerPoint slide, an illustration was put to depict how a family cook together in a kitchen. In that illustration, a man, a woman and a child were drawn, offering the impression that a family is supposed to be established by two opposite-sex people". Apart from illustrations found in teaching materials, occurrence of heterosexism in a chemistry classroom was manifested via teachers' and students' nonverbal cues. This was revealed by one participant (R7), who noted that "*when some scientists were introduced in a chemistry class, sometimes some classmates would make a joke by saying that these two male scientists may actually be a couple. Even it was a joke, by looking at their facial expressions and how they react, it is not difficult to see that they are teasing non-heterosexual romance*".

Regarding the underlying cause of heterosexism in a chemistry class, eight participants attributed it to the lack of awareness of heteronormativity among teachers and stakeholders. One participant (R9) stated that "*they just take heterosexuality for granted and assume it to be the norm without criticizing*". Another participant (R7) also mentioned that "*no one has questioned about it or see it to be a problem in a classroom. When they think it is the only right way of establishing a family and having two people to be together, they will not question about it*". Two participants also attributed the prevalence of heterosexism in a chemistry class to the intention of the chemistry teacher to make the lesson more "*acceptable*" to students with diverse backgrounds. This was revealed by the response of one participant (R1), who stated that "*the range of students in a chemistry class can be very wide. So some students may be conservative and some may be liberal. I think in the eye of the chemistry teacher, it is easier to please everyone by just sticking to that heteronormative agenda. It is like, if they don't get involved in controversies, they can spare from receiving complaints from conservative students and their lessons can be more acceptable to everyone*.

4.4 Needs and expectations in a chemistry classroom

Regarding ways to establish a more inclusive non-heterosexist chemistry classroom, seven participants mentioned the need of classmates and teachers to be aware of the problem of heterosexism. One participant (R9) even reckoned this as a precondition of establishing an inclusive chemistry classroom for non-heterosexual participants: "*Enhancing the ability of both students and teachers to reckon problems in heteronormativity is the key. If they do not possess this capacity to combat the bigotry, nothing else can be done effectively*". Furthermore, three participants pointed out the importance of teachers not to make assumptions on people's sexual orientation in a heterosexist manner. This idea was exemplified by the response of one participant (R2), who shared that "*one thing I think that can help is to engage everyone without excluding non-heterosexual people by heteronormative concepts in a classroom…another thing is to stop assuming people's sexual orientation…it is very important for the teacher not to impose heterosexism on people in a chemistry class in school*". One participant (R1) also stated the need of the teacher to respect pronouns, and not to make assumptions on gender simply based on physical appearance of a student. As mentioned by the participant, "*I think that most of the time when you are at university and even in high school, respect to students' pronouns is ignored. I think the teacher should ask about my pronoun…I think this is fundamental*".

In addition, three participants stated the need of halting the use of opposite-sex relationships as an analogy to explain physical phenomena that involved complementary entities. One participant (R6) called for the use of same-sex relationships as an analogy if opposite-sex relationships were used: "*If a concept has to be explained, it would be good if the teacher does not always frame it in a heteronormative way. Therefore, speak about both opposite-sex and same-sex couples, rather than just keeping the heteronormative view when discussing topics*". The importance of explicitly recognizing the contributions made by non-heterosexual scientists

to advancement of chemistry in a classroom was also raised by one participant (R1), who urged the need to "*acknowledge people from the LGBTQ+ community on discoveries and stuff like that in a chemistry lesson*". However, the tone adopted when same-sex relationships were highlighted was the key because one participant (R4) shared how same-sex relationships were used by her chemistry teacher as something "*special*" to attract students' attention to the teaching contents, making her felt excluded from the class when the teacher insinuated that "*being non-heterosexual deviates from the norm*".

5. Discussion

This study adopted the interpretivist paradigm in student design to understand students' perception and experience of heterosexism in a chemistry classroom. In-depth interviews were used as the means of gathering data regarding the lived experience of ten participants, who have experiences in attending a chemistry classroom and can provide insider knowledge and insights regarding the prevalence of heterosexism during studies in chemistry. Based on analysis of the collected data, heterosexism has been perceived by students not only via verbal cues received in a chemistry classroom, but also via nonverbal cues. The latter exists in forms of perceptions or senses (e.g., visual aids used in teaching materials), vocal features (e.g., teachers' intonation and stress) and body movement (e.g., classmates' facial expression, gesture, and interpersonal distance). While verbal cues of heterosexism have gained more attention in the literature because they are more easily observable and to capture in a study, nonverbal cues of heterosexism should not be ignored. The role of nonverbal cues in the process of message conveyance is particularly important in situations in which emotions, identities, and status roles significantly influence communication (DePaulo and Friedman, 1998). As supported by an earlier study (Röndahl *et al.*, 2006), non-verbal communication and heteronormative assumptions could create stress and feelings of exclusion for non-heterosexual individuals. The findings of this study corroborated this and revealed the possible role played by nonverbal cues in conveying heterosexism in a chemistry classroom. This implies that in future research on the nature and prevalence of heterosexism, not only verbal cues but also nonverbal ones should be taken into account.

In this study, classmates were found to be one possible source of heteronormative discourse, either verbal or nonverbal, in a chemistry classroom. This was exemplified by the response of one participant who perceived heterosexism by observing the facial expressions of his classmates in reacting to jokes on non-heterosexual romance. Our finding is consistent with the observation made by Atkinson (2021), who discovered that peers play a role in reinforcing the dominance of heterosexism, influencing both friendship dynamics and social hierarchies. Another important source of heterosexism, as revealed in this study, is the teaching practice and teaching contents adopted in a chemistry classroom. This can range from the use of heterosexual relationships as an analogy to explain chemistry concepts to the depiction of heterosexual relationships in illustrations used in course materials. Such high prevalence of heterosexism in a chemistry classroom could actually be a combined effect of the problems of the school management team and students' parents who advocate heterosexuality as the norm in the children's growing environment (including families and schools). The latter is supported by the fact that dozens of librarians in schools in the UK have recently been asked by the parents to remove LGBTQ+ books from school libraries (Guardian News, 2024). The situation is compounded by the fact that such requests from heteronormative parents have been endorsed by the management teams of a number of schools in the UK (Guardian News, 2024). Such endorsement partly evidences the acceptance of heterosexism by teaching and administrative staff in the educational setting, but more importantly, it highlights the broader societal and educational context in which heterosexism is perpetuated, which, as revealed in this study,

extends beyond K-12 environments and into higher education. This, along with our findings, underscores that heterosexism is a systemic issue within the UK education system.

In fact, growth in a heterosexist environment may render the student likely to be heterosexist in their adulthood (Fish, 2006; Hong and Garbarino, 2012; Valentine, 2016), causing heterosexism to be passed from one generation to another. According to Vygotsky's sociocultural theory (Edwards, 2003), development is a process at both interpersonal and intrapersonal levels. It is a result of social interaction contextualized by the cultural setting to which the children are exposed. In other words, social interaction is a major factor driving the process of child development and learning (Howe and Mercer, 2012). Behaviour of a person is the result of learning through interaction and observation (Bandura, 1977). In other words, the thoughts and behaviour of all people are shaped by their previous social interactions (Guerrero and Floyd, 2006). Instead of being inherent in nature, heterosexism is acquired through social consensus (Duhigg *et al.*, 2010; Davis-Delano and Morgan, 2016). From a sociocultural perspective, heterosexism is learned rather than innate and is shaped by socially prescribed interpretations that individuals experience or observe over time (Guerrero and Floyd, 2006). Although societal consensus influences how individuals interpret heterosexism, this impact often operates unconsciously (Hetzel, 2011; Philippot *et al.*, 1999). For this, the most important factor influencing the experience of heterosexism is something go beyond individual consciousness (Hetzel, 2011; Valentine, 2016). It is, therefore, hard for individuals to be aware of the problem of heterosexism as motivations underlying it are not what they are conscious of or consciously involving. This also makes halting heterosexism in a classroom technically challenging. To rectify the situation, future collaboration between the government and regulatory bodies should focus on combating heteronormativity in schools and beyond, ensuring that children are protected from heterosexist ideologies instilled by their parents, teachers, and loved ones. Special attention should also be provided to non-heterosexual students to prevent them from becoming victims of heteronormativity as this will discourage their participation in school (Hughes and Kothari, 2023) and will deprive their opportunities to learn as effectively as their heterosexual counterparts do (Friedensen *et al.*, 2021; Marosi *et al.*, 2025). Combating heterosexism is, therefore, crucial not only for fostering inclusivity in educational settings but also for challenging the broader societal structures that sustain discrimination.

6. Implications for practice

Chemistry education tends to emphasize objectivity, technical rigor, and content-focused instruction (Schummer, 2010; Sjöström, 2007). While these characteristics are central to scientific training, they can unintentionally marginalize discussions of identity, inclusion, and social context. In classrooms where neutrality and technical content dominate, the personal dimensions of learning are often overlooked or treated as irrelevant (Holbrook, 2005). This can foster a culture of silence around issues such as sexuality, allowing heteronormative assumptions to go unchallenged. For non-heterosexual students, the absence of inclusive language and the persistence of heterosexist practices in classroom settings can lead to feelings of invisibility and discomfort. Even in the absence of overt discrimination, a lack of recognition and support may contribute to environments that feel psychologically unsafe or alienating (Jones, 2021). While the examples in this study arose from participants' experiences at UK institutions, these broader dynamics—such as the erasure of non-heterosexual identities and the limited integration of equity-focused pedagogy—are likely present across many higher education chemistry settings. By drawing attention to these systemic issues, the study encourages chemistry educators and departments across institutional contexts to explore how

their teaching practices, materials, and classroom cultures might better support non-heterosexual students.

Findings of this study suggest several ways in which chemistry classrooms could become more inclusive for non-heterosexual students. Participants' experiences indicate that heterosexism can manifest in both overt and subtle ways, influencing the experience and engagement of non-heterosexual students in the classroom. To address this problem, chemistry educators and institutions should implement targeted strategies that mitigate heterosexist biases. One strategy is to adopt inclusive language and representation in chemistry education. Educators should actively avoid making heteronormative assumptions when discussing examples and concepts in the chemistry classroom, particularly when teaching physical phenomena involving positive and negative entities (e.g., cations and anions). Teaching materials should reflect diverse identities, ensuring that non-heterosexual individuals see themselves represented within the discipline. Prior research has demonstrated that representation plays a key role in fostering a sense of belonging and engagement among marginalized students (Carter *et al.*, 2023; Paul, 2023). Apart from avoiding heterosexist explanations of concepts, by acknowledging the contributions of non-heterosexual chemists, educators can foster a more welcoming learning environment in chemistry education.

In addition to inclusive teaching practices, formal support mechanisms shall be established to provide students with clear pathways for reporting and addressing incidents of heterosexism. Institutions should ensure that students are aware of the resources available to them and that reporting processes are confidential and accessible. Training should also be provided to teaching staff to equip them with the knowledge and skills needed to recognize and challenge heterosexist microaggressions in the classroom setting. As indicated by a previous study (Anabel and Rafael, 2017), faculty members who participated in a training program on inclusive education and disability reported feeling more motivated toward EDI in education and better equipped to create inclusive learning environments. Beyond individual classroom practices, institutional commitment is pivotal when combating heterosexism in the classroom setting (Kuhlemeier *et al.*, 2021). This could be manifested through the integration of initiatives to address heterosexism into broader EDI efforts, ensuring that these initiatives extend beyond isolated courses or departments in chemistry. Embedding such initiatives within institutional policies would signal a long-term commitment to addressing heterosexism and fostering an educational culture that supports all students regardless of sexual orientation.

7. Concluding remarks

Heterosexism is a sociopolitical construct undermining the equal opportunities of individuals in a society and, in the context of chemistry education, has made non-heterosexual students feel excluded, thereby potentially jeopardizing engagement in learning activities among these students. To explore the prevalence and occurrence of heterosexism as perceived and experienced by non-heterosexual students in a chemistry classroom, ten in-depth interviews were conducted. The influence of heterosexism on non-heterosexual students' learning and engagement in a chemistry classroom was examined, with the sources and signs of heterosexism also being explored. Insights were gained into the needs and expectations of non-heterosexual students in the context of chemistry education. Despite this, one of the limitations of this study is that the points of view of teachers have not been included. This is justifiable in a way that the focus of this research is only to explore the perception and experience of heterosexism through the eyes of students. Yet, both students and teachers are pivotal to make teaching and learning in a classroom setting possible. The awareness and perspectives of teachers regarding heterosexism in a chemistry classroom remain to be further studied.

Furthermore, interviews were conducted in this study until data saturation was observed. The accuracy of the data collected could, however, still be affected if false or vague memories occurred when participants recalled their past experiences. It is also worth mentioning that, as with all interpretivist research, we acknowledge the influence of our positionalities on the research process. Efforts were made to minimise this influence through reflexive practices, member checking, and investigator triangulation. Nonetheless, complete neutrality is neither possible nor desirable in qualitative inquiry (Skovlund *et al.*, 2023). Finally, motivations, beliefs, values, contexts, cultures, and reasoning of each participant are unique. These factors shape each participant's perception and experience of heterosexism and contribute to the social reality observed. Findings of this study can, therefore, only be interpreted within the context of the characteristics of the participants. Their generalizability is highly limited. Despite this, findings of this study offer transferable insights into the ways heterosexism may be experienced by non-heterosexual students in chemistry classrooms. The themes identified—such as the sources and forms of heterosexism—may resonate with students in other chemistry programs or STEM disciplines with similar cultures. These findings invite educators to reflect on the normative assumptions embedded in their teaching practices and consider how inclusive practices can be fostered more broadly.

In fact, culture has a significant influence on both verbal and nonverbal encoding and decoding processes in a classroom and hence teacher-student interactions (Matsumoto, 2001; Matsumoto and Yoo, 2005). For the former, cultures exert substantial influence on our verbal language, from the syntax to the diction to the pragmatics of a language. For the latter, culture can affect our nonverbal behaviour, such as our facial expressions, gestures, distance, gaze, and posture. Though some sorts of nonverbal behaviour (such as greeting behaviour) could be highly similar across cultures, some (such as touching behaviour) could differ greatly. In future research, the perceptions and experiences of participants from diverse cultural and background characteristics could be examined to explore how cultural variation shapes students' experiences of heterosexism—along with its prevalence and manifestation in teaching practices and curriculum development—in chemistry classrooms. The ways in which these dynamics play out across different institutional, cultural, and national contexts are particularly worth further investigation.

Data availability

The authors confirm that all data generated or analysed during this study are included in this published article.

Conflict of interest

The authors have no competing interests to declare that are relevant to the content of this article.

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