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Identifying challenges in teaching chemistry among high and middle school physics and chemistry teachers in Morocco

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ABSTRACT

The current study sheds light on the challenges associated with chemistry teaching at the secondary level by analyzing the perspectives of Moroccan teachers and educational inspectors. The research utilized two data collection tools: a questionnaire and semi-structured interviews and collected input from a sample of 316 participants using a mixed-methods approach. The results reveal that the academic qualifications of teachers represent a significant barrier to the effective teaching of chemistry. Moreover, the high school chemistry curriculum is often characterized by high levels of abstraction which complicates understanding. The study also identifies other impediments, including inadequate initial and ongoing professional development for physics and chemistry teachers, insufficient cognitive development, and the lack of prior knowledge among unmotivated students. The study proposes a series of recommendations aimed at improving chemistry education in Morocco to address these issues. These include the implementation of comprehensive professional development programs for teachers, curriculum revisions to integrate practical experiences and real-world applications, and the enhancement of educational resources and infrastructure to promote more effective teaching and learning environments.

Contribution/Originality: The current study identifies the real obstacles of teaching and learning chemistry in middle school and high school to take correct and profitable decisions for improving the pedagogy of teaching chemistry towards improving the results of the learners.

1. INTRODUCTION

Chemistry incorporates numerous concepts and laws, the acquisition and comprehension of which are crucial for shaping learners' knowledge structures and facilitating the understanding of related scientific concepts (Alam, 2020; Rahayu, 2019). Historically, the study of chemistry originated with alchemy in ancient civilizations and progressed through significant milestones, such as the discovery of the periodic table and the development of chemical bonding theories (Jensen, 2021). This study focuses on the Moroccan educational system, particularly the challenges faced in teaching chemistry at the secondary level (Boumediane, Benabdelouahab, & Idrissi, 2022). However, learners frequently have misconceptions of some scientific concepts that are not accurate from a scientific perspective (Aleifat & Tabieh, 2025). For example, the students may believe that atoms are solid, indivisible

particles whereas in reality, atoms are made up of nuclei and electrons and have a complex internal structure (Kuhn, 2024). Similarly, they may think that chemical bonds are physical objects that bind atoms together whereas in reality, chemical bonds are electrostatic interactions that hold atoms together (Kozuch, 2024). These misconceptions can cause problems in learning the scientific concept for a variety of reasons. They may also make it difficult for learners to understand other relevant scientific topics related to the subject, thus hindering further learning (Perron, 2021; Perron, Hasni, & Boilevin, 2020). Research in the field of teaching chemistry has demonstrated several other issues in addition to the subject matter being taught that can contribute to learning and teaching challenges (David, 2019; Shidiq & Yamtinah, 2019). Further researchers have confirmed that challenges in understanding chemistry stem from students' misperceptions indicating that misperceptions play a key role in determining learning outcomes as they serve as a basis for further learning (Shelley & Kiray, 2019; Tümay, 2016). On the other hand, Xing et al. (2022) have indicated that the coursebook is another major cause behind the difficulties experienced in learning chemistry because it is considered the main reference for learners. However, the coursebook deals with scientific concepts with a high degree of abstraction and in a vague manner that hardly attracts student's attention leading to only memorization without comprehension. Other researchers such as Tümay (2016) and Timilsena, Maharjan, and Devkota (2022) have linked the difficulties in teaching chemistry to the use of the magistral method in teaching. These investigations have confirmed that teachers use the magistral method to present new technical terms and concepts without connecting them to practical reality and their importance in daily life. An additional inquiry has similarly highlighted that the social factor contributes to the low level of learners such as the study by Durišić and Bunijevac (2017) which revealed that the family plays an effective role in the learner's success or failure. Timilsena et al. (2022) and Zengele and Alemayehu (2016) have ascribed another factor behind students lack of understanding of chemistry related to the absence or lack of equipment and chemicals in school laboratories.

Moreover, some teachers' primary focus persists on the act of teaching and presenting the subject even if it is not compatible with the learner's intellectual maturity or their environment. Thus, they neglect to address specific misconceptions about chemistry among students (Marchak, Shvarts-Serebro, & Blonder, 2021). Last but not least, most teachers lack solid and sufficient training that can enable them to acquire a good understanding of the various teaching and assessment methods not to mention the wide gap between the advancement and development in the didactics of school subjects and the reality of teaching practices (De Quadros et al., 2011).

All the above-mentioned studies have confirmed that chemistry is an investigative subject that requires the learner to carry out experimental manipulations. As there is a great lack of basic teaching tools and materials, this leads to the rise of various problems and difficulties in the teaching and learning process of the chemistry subject. Scientific literature has also shown that the teaching and learning of chemistry are negatively affected by several factors leading to a low level of success among learners in high schools. For these reasons, the objective of the present study is to characterize the difficulties encountered by Moroccan physics and chemistry teachers during the teaching of the subject in middle and high schools using a survey designed for physics and chemistry teachers to characterize and determine the origins of the difficulties encountered in the teaching of chemistry and also the proposition of some recommendations. Two fundamental questions were asked to meet the current objectives:

1. How do secondary and middle school teachers perceive their readiness to teach chemistry?
2. What obstacles do teachers face in the teaching and learning of chemistry?

The significance of this research lies in its potential to enhance the understanding of chemistry teaching challenges in Morocco. This study aims to propose viable solutions to improve learning outcomes and ultimately increase student success in this discipline by identifying specific difficulties faced by teachers and students.

The document is organized as follows: The first section presents the abstract followed by the methodology in detail. The third section outlines the results obtained while the fourth section provides an in-depth discussion. Finally, the fifth section concludes the study.

2. METHODOLOGY

2.1. Study Area

In this study, the anonymous survey was administered to 316 physics and chemistry teachers in middle and high schools in the Fez-Meknes region of Morocco. The survey sample was representative because it included teachers from nine provincial education directorates in the region: Fez, Meknes, Ifrane, Sefrou, Taza, Taounate, Boulemane, Moulay Yacoub, and El Hajeb (see Figure 1). Teachers from middle and secondary schools as well as inspectors participated in our questionnaire through Google Forms. The link to the electronic form was shared in the WhatsApp group of the physics and chemistry association of the Fez-Meknes region whose members include teachers and inspectors from the same region. Similarly, the responses were collected during workshops organized by the association at Sefrou at Al Hassan El Youssi secondary school and in Fez at Moulay Slimane secondary school. Additionally, the information was gathered at the national baccalaureate correction center at Youssef Ibn Tachfine secondary school in Fez and at the correction center in Meknes at Moulay Ismail secondary school. Furthermore, the collections have been conducted at Bensouda secondary school and Maati Bouabid secondary school in Fez as well as at the new secondary school in Taoujtate and at Mohamed VI secondary school in Immouzar Kandar, Cherif Idrissi secondary school in Taza, Ibn Battuta secondary school in Boulemane, and Ibn Sina secondary school in Taounate city.

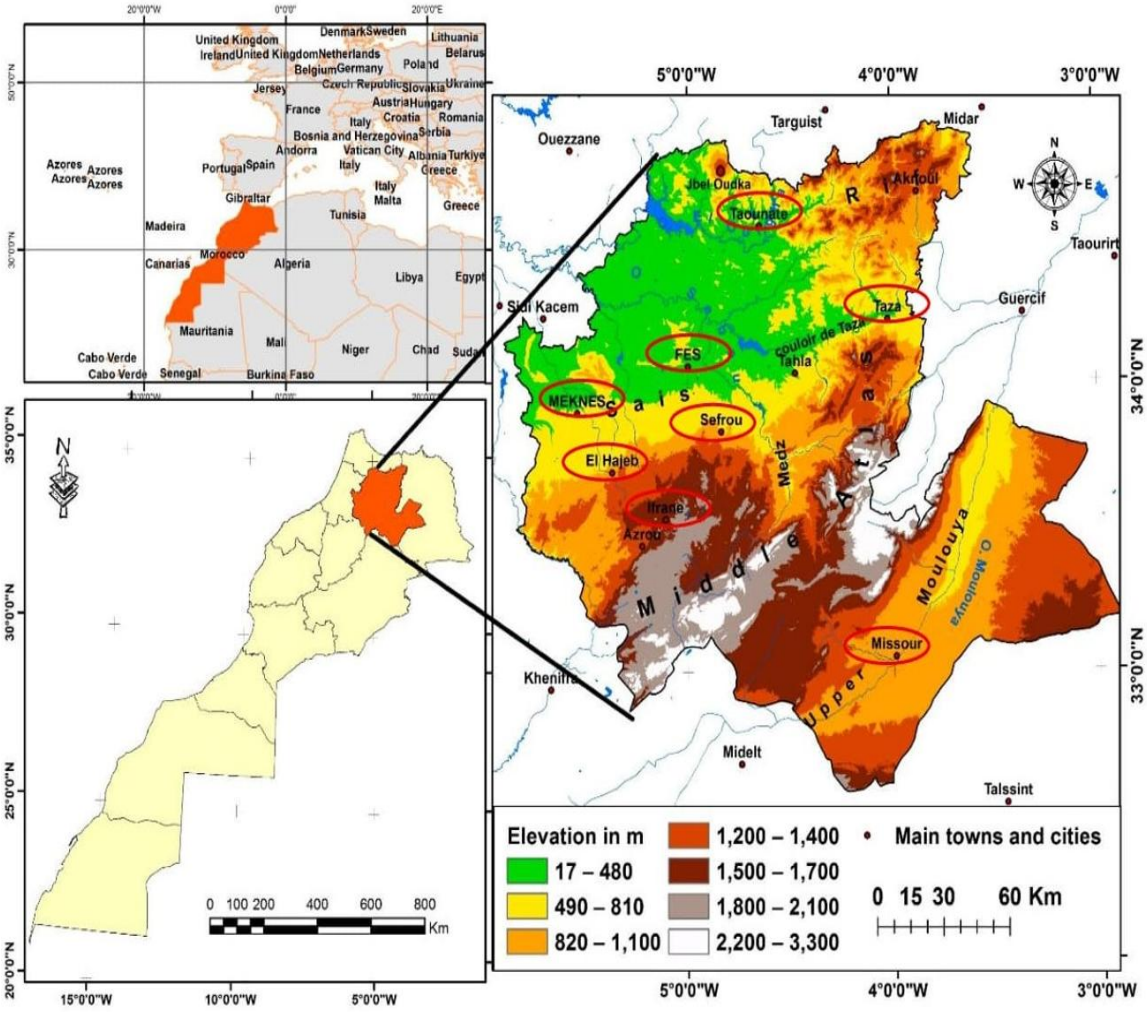

Figure 1. Study area representing the provinces and prefectures of the Fez-Meknes region.

Source: Belmahi et al. (2023).

2.2. Survey Design and Preparation

The objective of this survey is to ascertain the primary causes and factors contributing to learning difficulties in chemistry at the secondary and middle school levels within the Fez-Meknes region of Morocco. This study employed a closed and open-ended questionnaire which enables teachers to articulate their perspectives comprehensively rather than restricting their responses to a predetermined set of options.

2.3. Survey Axes

2.3.1. Information about Respondents

Details about the participants encompassed variables such as gender, age, teaching experience, employment location, career stage, level of education, and university specialization.

2.3.2. Chemistry Teaching Difficulties

At this stage of the study, various challenges in teaching chemistry were identified and articulated through 19 statements. The degree of difficulty or problem was quantified using a four-point Likert scale: Strongly disagree, somewhat disagree, somewhat agree, and strongly agree.

2.3.3. Proposed Solutions to Remedy Difficulties

The question is addressed to secondary school and middle school teachers aiming to find solutions to the difficulties behind teaching chemistry.

2.4. Survey Validity

The initial version of the survey was submitted for review to a panel of experts, including Moroccan inspectors, seasoned professors with over 30 years of teaching experience, and teacher-researchers. This review aimed to ensure that the survey's inquiries were aligned with the study's objectives and that the questions were clearly articulated.

The survey was subsequently refined to include new questions, organized into the previously established three axes based on the feedback and recommendations from these experts. It was subjected to a reliability test by calculating the Cronbach's alpha value.

The data analysis revealed a Cronbach's alpha coefficient of 0.77 which indicates good internal consistency among the questions in our survey. This level of reliability provides a solid foundation for making recommendations and developing interventions to improve the teaching of chemistry.

2.5. Data Analysis and Recovery

The data were analyzed using Excel 2019 and GraphPad Prism 9.5.1 software. The significance of the differences between percentage results was assessed through one-way ANOVA. Tukey's multiple range tests were conducted using GraphPad Prism with a significance level of $p<0.05$ for the multivariable analysis. Additionally, principal component analyses (PCA) were performed to examine correlations using Minitab 19.1.1. A supplementary survey was conducted involving 20 physics and chemistry teachers to augment the questionnaire results (3 novice teachers with less than 4 years of experience, 6 experienced secondary school teachers with over 10 years of experience, and 10 veteran teachers with over 15 years of expertise). The survey participants were randomly selected to represent the nine provincial departments and the two educational levels (middle and high school) within the Fez-Meknes region.

2.6. Demographic Characteristics of Respondents

2.6.1. Distribution of Responders According to Gender and Age

The survey sample comprises 66.77% males and 33.23% females categorized into four age groups: 33.86% are aged 30 to 40, 20.57% are between 40 and 50, 26.27% are over 50, and 19.30% are between 22 and 30 (see Table 1).

2.6.2. Distribution of Responders According to Assignment Province

The surveyed teachers were distributed among various high and middle schools within the Fez-Meknes Regional Academy of Training and Moroccan National Education (see Table 1).

They were located across nine provinces: 41.77% in Fez, 25% in Meknes, 7.28% in Sefrou, 6.65% in El Hajeb, 5.38% in Taza, 4.75% in Taounate, 4.43% in Boulmane, 2.53% in Ifrane, and 2.22% in Moulay Yacoub.

2.6.3. Distribution of Participants According to Teaching Experience and Teaching Cycle

Regarding experience and teaching cycle, the sample is notably heterogeneous (see Table 1) comprising 35.44% of teachers with over 15 years of experience, 27.85% with 10-15 years of experience, 18.99% with less than 5 years of experience, and 17.72% with 5-10 years of experience.

The teachers are divided into the following two groups: 83.54% from the high school level and 16.46% from the middle school level.

2.6.4. Distribution of Respondents According to Study Level and University Specialty

In terms of university specialization (see Table 1), physics accounts for 40.82% of the specializations followed by physics and chemistry at 35.13%, chemistry at 23.42%, and other specializations at 0.63%. Specialization is a significant variable in this context.

Teachers with backgrounds in physics and chemistry may encounter greater difficulty in teaching concepts compared to those specialized in chemistry.

Regarding educational levels, the surveyed teachers possess diverse academic and professional qualifications: 38.29% holds a 5-year university degree, 19.94% have a 4-year university degree, 16.14% have a 3-year university degree, 15.51% have a 6-year university degree, 9.18% hold an 8-year university degree, and only 0.32% possess a 2-year university degree.

Statistical correlations between age, experience, and the socio-demographic profiles of the respondents are illustrated in Figure 2 using principal component analysis (PCA) in the C1-C2 plane.

The biplot graph (see Figure 2) reveals a positive relationship among several parameters: levels of education (3-year university degree and other levels), provinces (Taounate; Boulmane and Ifrane), educational level at middle school, specialization (physics and chemistry and other), and gender (female) with experience level 1 (less than or equal to 5 years) and age group 1 (between 22 and 30 years).

Additionally, a positive relationship was observed among other factors, such as educational backgrounds (baccalaureate plus 5, baccalaureate plus 4, baccalaureate plus 8), provinces (Fez, Sefrou, Meknes), educational level (secondary), specialization (chemistry and physics), gender (male), experience level 4 (more than 15 years), and age group 2 (between 30 and 40 years).

However, observations for age group 3 (between 40 and 50) and age group 4 (over 50) did not correlate with all variables. Furthermore, a weak and positive relationship was found between experience level 3 (more than 10 years and less than or equal to 15 years) and the level of education (baccalaureate plus 2 years).

Table 1. Socio-demographic profile of the respondents in the Fez-Meknes region of Morocco.

Variables	Sub-group	Number (N=316)	Percentage (%)
Gender	Man	211	66.77[a]
	Woman	105	33.23[b]
Age	22 to 30 years	61	19.30[a]
	30 to 40 years	107	33.86[b]
	40 to 50 years	65	20.57[a]
	>50 years	83	26.27[c]
Experience	≤5 years	60	18.99[a]
	>5 and ≤10 years	56	17.72[a]
	>10 and ≤15 years	88	27.85[b]
	>15 years	112	35.44[c]
Provincial assignment directorate	Fez	132	41.77[a]
	Meknes	79	25.00[b]
	Ifran	8	2.53[c]
	Sefrou	23	7.28[b]
	Taza	17	5.38[d]
	Taounate	15	4.75[d]
	Boulmane	14	4.43[d]
	Moulay yaakoub	7	2.22[c]
	Lhajeb	21	6.65[b]
Teaching cycle	Middle school	52	16.46[a]
	High school	264	83.54[b]
Study level	2-year university degree	1	0.32[a]
	3-year university degree	51	16.14[b]
	4-year university degree	63	19.94[c]
	5-year university degree	121	38.29[d]
	6-year university degree	49	15.51[b]
	8-year university degree	29	9.18[e]
	Other	2	0.63[a]
University specialty	Physics	129	40.82[a]
	Chemistry	74	23.42[b]
	Physics and chemistry	111	35.13[c]
	Other	2	0.63[d]

Note: The percentages of each variable denoted by different letters (a,b,c and d) indicate significant differences according to Tukey's multiple range tests at $p < 0.05$.

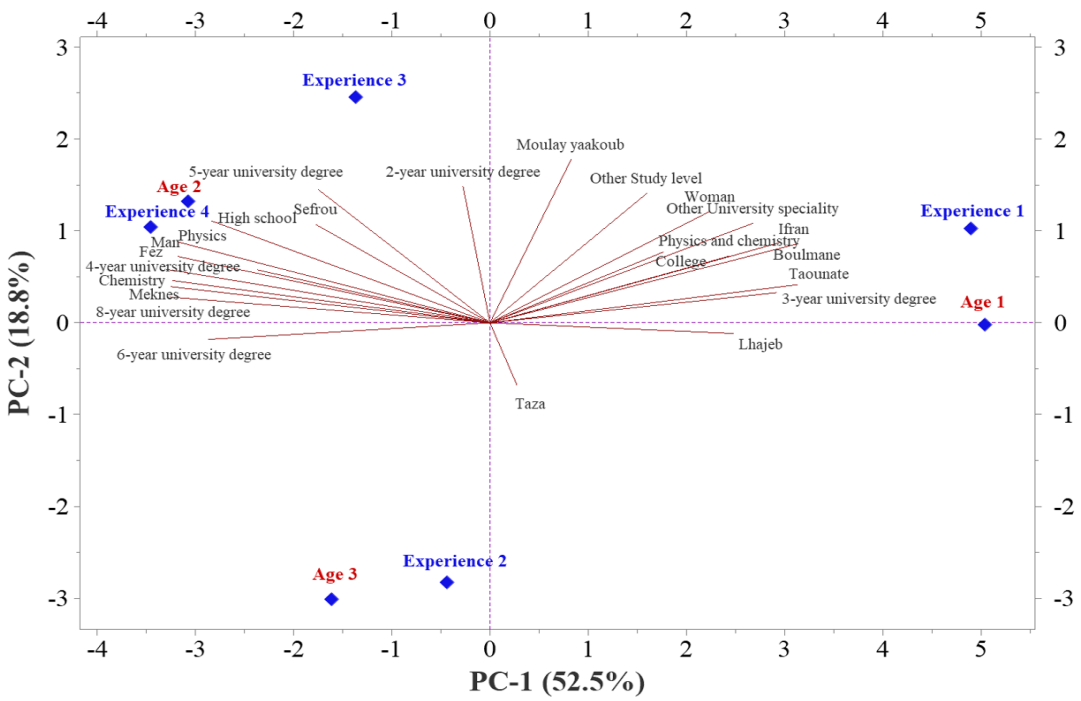

Figure 2. Statistical correlations by principal component analysis in the C_1-C_2 plane present the correlations of age and experience with the socio-demographic profile of the respondents. Age 1: 22 to 30 years. Age 2: 30 to 40 years. Age 3: 40 to 50 years. Age 4: >50 years. Experience 1: ≤5 years. Experience 2: >5 and ≤10 years. Experience 3: >10 and ≤15 years. Experience 4: >15 years.

3. RESULTS

The teaching of chemistry faces several significant challenges. Among these are the absence of continuing education, strained relationships between teachers and students, demotivation, and medical as well as social issues. Additional obstacles include students' educational orientation, insufficient prerequisites, confusion over scientific terminology, and lack of interest. Moreover, the misalignment of curriculum content with schedules, the language of instruction and the inherent complexity of the subject present substantial challenges. Finally, the lack of necessary materials, inadequate facilities for experiments, overcrowded classrooms, absence of laboratory assistants, and insufficient laboratory safety measures adversely impact the quality of chemistry education.

3.1. Teaching Difficulties in Chemistry

3.1.1. Difficulties Related to Teachers

As summarized in Table 2, the teaching of chemistry presents several significant challenges for teachers. The survey results indicate that 76.26% of respondents agreed or strongly agreed that insufficient training is a major obstacle in teaching chemistry. This suggests that teachers may struggle to effectively convey knowledge to their students without adequate training. Furthermore, 72.16% of participants identified the teacher and student relationship as a limiting factor. A positive relationship can enhance the learning environment for teachers and students whereas a negative relationship can hinder it.

Additionally, 63.29% of respondents indicated that teacher demotivation is a significant challenge. When teachers lack motivation and enthusiasm, they become passive conveyors of information negatively impacting student learning. Moreover, 60.13% of teachers reported that medical and social issues among teachers adversely affect the teaching and learning of chemistry. Inadequate initial training was also highlighted by 59.5% of respondents as a hindrance to effective teaching in this discipline. Finally, 54.43% of teachers noted that the university curriculum presents a substantial obstacle to teaching chemistry.

The survey's findings suggest that the percentages provided throughout this study underscore one of the research's strengths. Several teachers emphasized the lack of in-service training and the inadequacy of initial training as critical issues in the semi-structured interview questions regarding teaching difficulties.

Table 2. Difficulties related to teachers.

Obstacle types	Strongly disagree (%)	Somewhat disagree (%)	Somewhat agree (%)	Strongly agree (%)
University curriculum	11.39	34.18	41.14	13.29
Insufficient initial training	10.76	29.75	41.46	18.04
Insufficient continuing education	6.01	17.72	36.39	39.87
Teacher and student relationship	8.23	19.62	41.46	30.70
Teacher demotivation	11.08	25.63	33.54	29.75
Medical and social obstacles	12.34	27.53	44.94	15.19

3.1.2. Difficulties Related to Learners

The data collected regarding learner-related difficulties in chemistry instruction are summarized in Table 3. The findings reveal that a majority of survey respondents, 89.24% agree or strongly agree that students' educational orientation has a profoundly negative impact on the teaching and learning of chemistry. Additionally, 87.03% of teachers surveyed indicated that the lack of prerequisites among learners adversely affects the teaching of chemistry. Furthermore, 74.69% of respondents confirmed that confusion regarding scientific vocabulary in chemistry impedes content comprehension. Moreover, 67.73% of teachers reported that learners' lack of interest significantly obstructs the teaching and learning process. Medical and social obstacles among learners were cited by 62.66% of respondents as impediments to effective chemistry education. Finally, 55.69% of teachers highlighted that students' lack of politeness and misbehavior are detrimental to the teaching of chemistry. Additional barriers were

identified through semi-structured interviews with several teachers highlighting challenges related to students' perceptions of chemistry and underscoring the lack of prerequisites as a major issue.

Table 3. Difficulties related to learners.

Obstacle types	Strongly disagree (%)	Somewhat disagree (%)	Somewhat agree (%)	Strongly agree (%)
Learners' lack of interest in chemistry	8.23	24.05	36.08	31.65
Lack of politeness among learners	12.34	31.96	36.39	19.30
Insufficient student prerequisites	3.48	9.49	35.13	51.90
Student's academic orientation	4.11	6.65	25.00	64.24
Learners' confusion about scientific vocabulary	5.38	19.94	43.99	30.70
Medical and social obstacles	9.18	28.16	42.09	20.57

3.1.3. Difficulties Related to the Teaching Subject

The responses obtained concerning the obstacles related to the subject taught were statistically analysed separately for each response. The data were presented in the form of histograms for each response category (see Figure 3). The results (see Figure 3A) indicate that 87.35% of respondents agreed or strongly agreed that the syllabus content was not aligned with the timetable which poses a significant challenge to the teaching and learning of chemistry. This misalignment may pressure teachers to expedite the curriculum resulting in gaps in students' understanding and comprehension. Additionally, 73.42% of respondents reported that the language of instruction hinders the teaching of chemistry leading to confusion and barriers for teachers and learners (see Figure 3B). Finally, 53.43% of teachers noted that the complexity of the subject itself hampers the teaching and learning process (see Figure 3C). During the semi-structured interviews, teachers corroborated that the timetable is not suitably adapted to the program content.

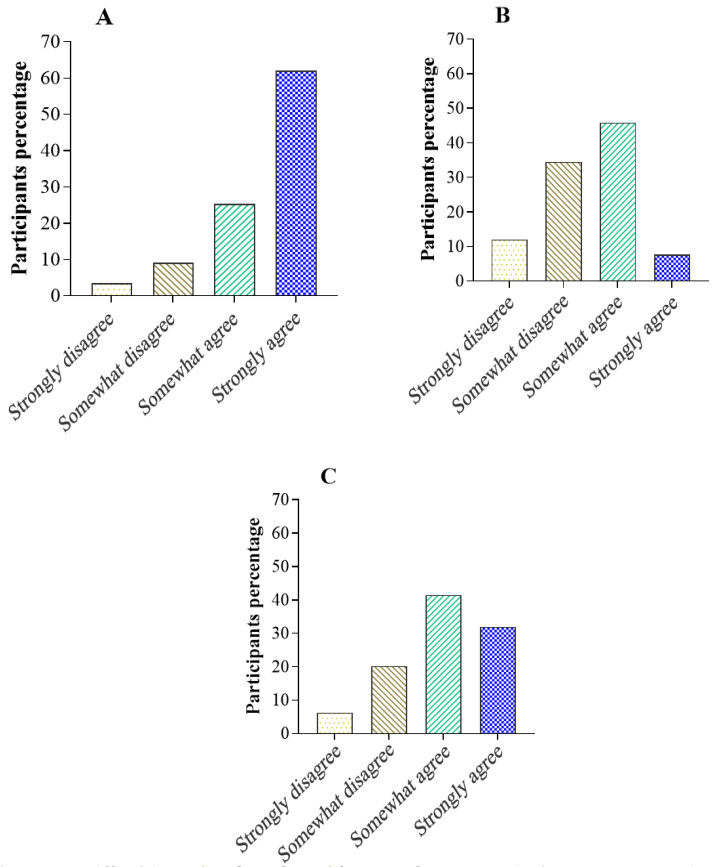

Figure 3. Difficulties related to the subject taught. A: Curriculum content not in line with timetable. B: Difficulty of content. C: Teaching language.

3.1.4. Difficulties Related to Teaching Conditions

Concerning difficulties associated with teaching conditions, the responses were analyzed statistically, and the data were presented as histograms for each response type (see Figure 4). The results indicated that 88.61% of respondents agreed or strongly agreed that the lack of equipment and chemicals posed a significant obstacle to the teaching and learning of chemistry. Additionally, 86.71% of respondents reported that the absence of rooms designated for experiments hindered the teaching of chemistry. Furthermore, 85.45% of teachers identified overcrowded classrooms as a major challenge.

Moreover, 83.23% of teachers noted that the lack of laboratory assistants impeded the teaching and learning of chemistry. Additionally, 78.79% of respondents cited inadequate safety measures in laboratories as a detrimental factor affecting the teaching of chemistry. During the semi-structured interviews, teachers underscored the challenges of overcrowded classes and the insufficiency of appropriate teaching resources and infrastructure in their schools.

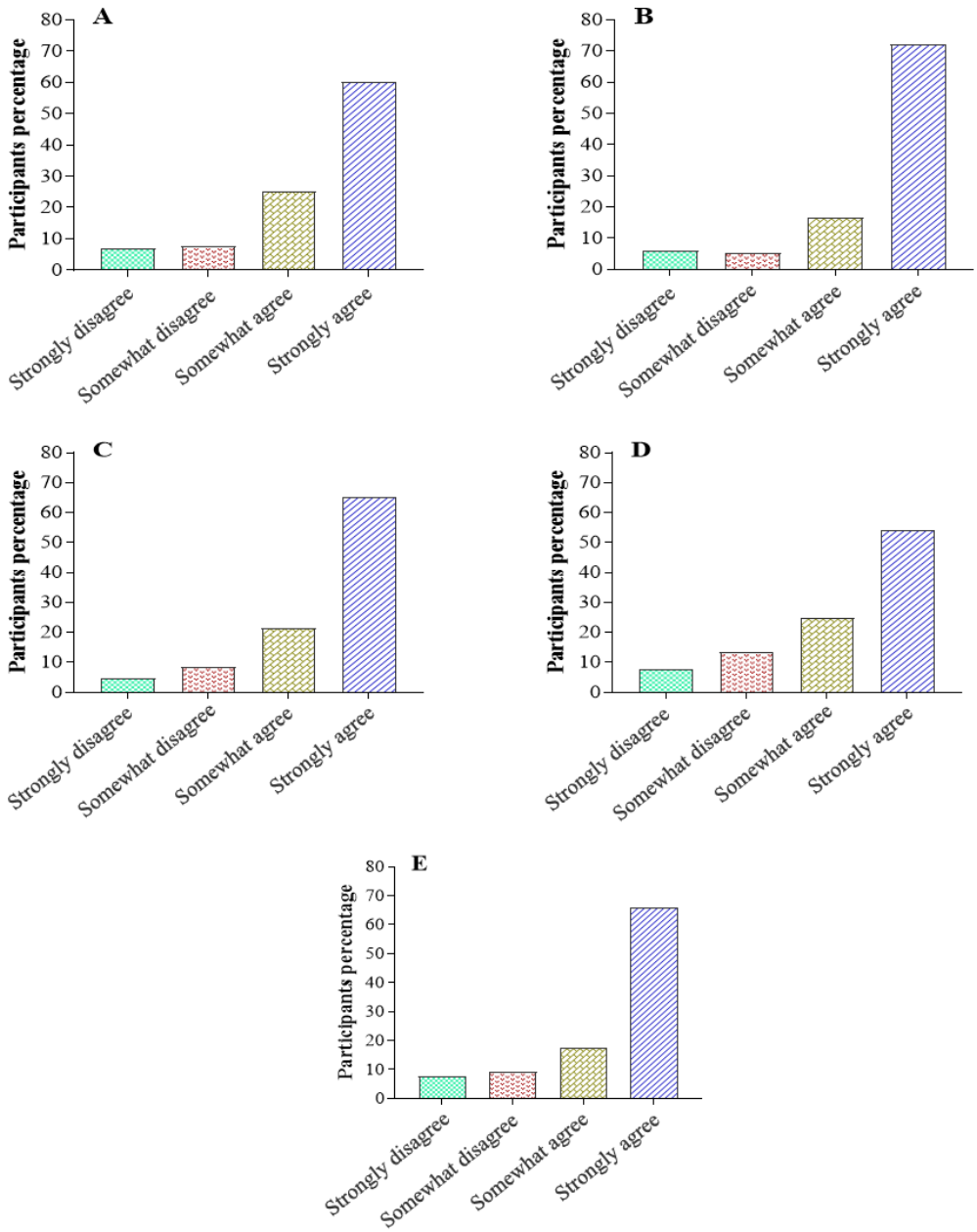

Figure 4. Difficulties related to teaching conditions. A: Class overcrowding. B: Lack of equipment and chemical products. C: Insufficient experimental rooms; D: Lack of safety in the laboratory. E: Absence of preparators.

3.2. Correlations

The correlations between university specialization and teaching experience and the respondents' difficulties in teaching chemistry are summarized in Figure 5 using principal component analysis in the C1-C2 plane. The results of the correlations (see Figure 5) reveal that teachers with 15 or more years of experience are divided into two groups with distinct specializations. One group, specializing in physics and chemistry displayed strong disagreement regarding the existence of difficulties associated with teaching conditions, learners, and the subject matter. On the other hand, a subgroup within this specialty entirely disagreed about the obstacles related to teaching conditions. In contrast, the group of teachers specializing in physics exhibited complete agreement on the existence of difficulties associated with learners, the subject matter, and teaching conditions. However, a subgroup within this specialization showed partial agreement on barriers related to teachers. It is noteworthy that the half-lines representing these groups on the graph have small angles between them and almost identical lengths. This suggests consistency or similarity in the variability of data between these groups within the principal component analysis space. The proximity of the lines in this space may indicate a correlation or association between the groups. Additionally, observations linked to the "exp2" and "exp3" experiments, relating to the chemistry specialty, are represented by closely positioned points in the biplot (see Figure 5). This proximity forms a cluster suggesting that teachers specializing in chemistry with 10 to 15 years of experience or 5 to 10 years of experience share similar characteristics. These characteristics are also observed among teachers specializing in physics with more than 15 years of experience although the intensity may vary.

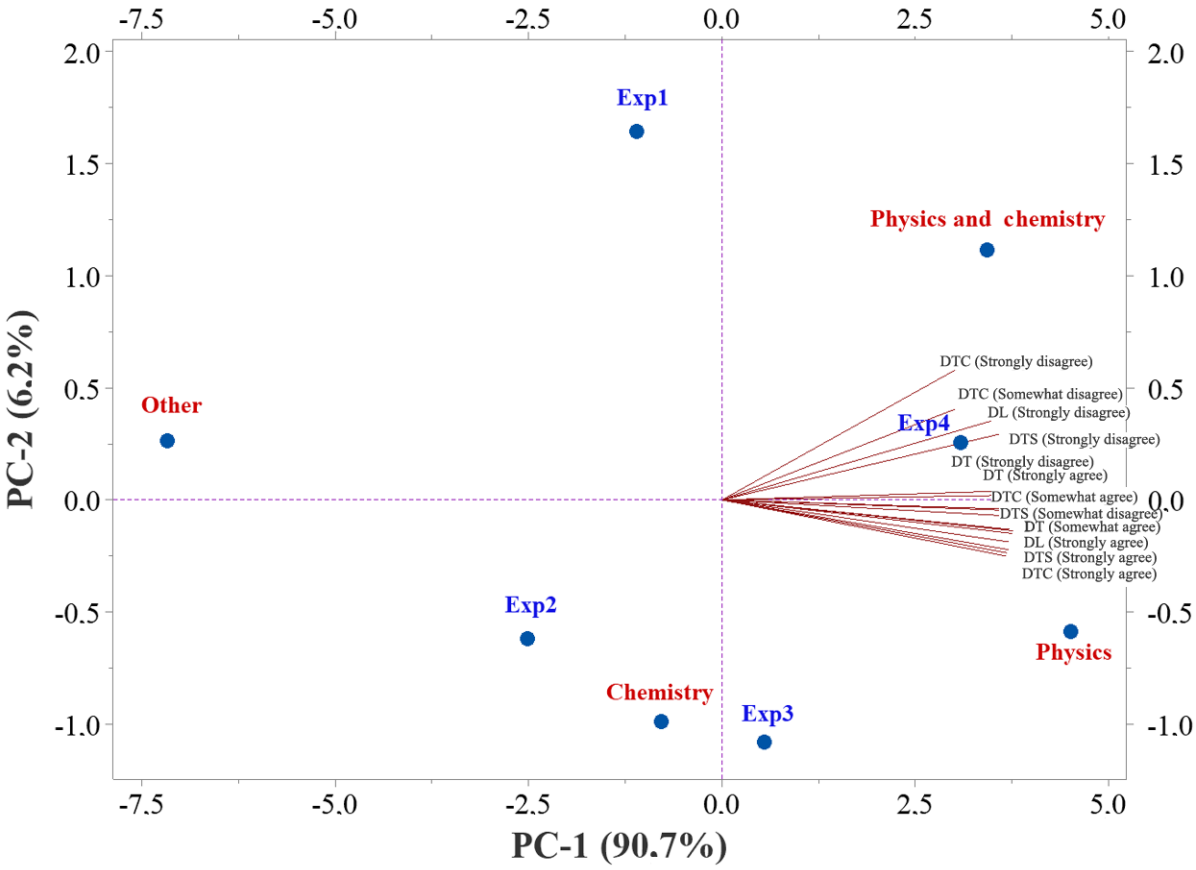

Figure 5. Statistical correlations by principal component analysis in the C_1-C_2 plane present the correlations of university specialty and experience with the teaching difficulties in the chemistry of the respondents. DT: Difficulties related to teachers. DL: Difficulties related to learners. DTC: Difficulties related to teaching conditions. DTS: Difficulties related to the teaching subject. Exp1: ≤5 years. Exp2: >5 and ≤10 years. Exp3: >10 and ≤15 years. Exp4: >15 years.

3.3. Proposed Solutions to Remedy the Difficulties

Among the 316 individuals surveyed, 103 responded to the open-ended question in our questionnaire: "Do you have any recommendations for remedying these obstacles?" The respondents identified 18 solutions to address the difficulties mentioned in this study as summarized in Table 4. The most frequently cited solution at 18.33% was the need for increased infrastructure (e.g., chemicals, equipment and practical classrooms). The second most common recommendation at 12.66% was the adaptation of the program to the hourly volume, including periodic revisions of the curriculum every decade. Regarding linguistic reform, 10.66% of respondents suggested that the language of chemistry instruction should be the one spoken by learners and well-mastered by teachers. Teacher motivation which includes proposals for salary increases and enhancing the societal role of teachers was highlighted by 8.66% of respondents. Learner motivation was also deemed crucial ranking just after teacher motivation at 7.66%. Continuing professional development for teachers, both in quality and quantity was valued by 7.33% of respondents. The integration of Information and Communication Technologies (ICT) in the teaching and learning process was another important solution supported by 6.66% of respondents. 6.33% of respondents recommended reducing class sizes to 24 to 26 students to address overcrowded classrooms. Regarding educational guidance, 4% of respondents called for the selection of suitable students for continued studies in scientific subjects. The recruitment of laboratory assistants in middle and high schools was also supported by 4% of respondents. Familiarizing students with the use and handling of materials and chemicals was recommended by 3.33% of respondents. Additionally, 3% advocated for addressing the prerequisite knowledge for chemistry learners. Other proposed solutions included didactic transposition and understanding the psychology of learners as well as providing psychological support and monitoring the learner's academic file supported by 1.66% of respondents. At 1.33%, respondents recommended separating the teaching of physics and chemistry and assigning a specialized teacher for each subject as practiced in some Arab countries. Finally, sharing the experiences of veteran teachers with newcomers and creating appropriate problem situations to eliminate learners' misconceptions were each endorsed by 1% of respondents. Additionally, 0.66% of participants recommended reducing learners' misuse of social networks.

Table 4. Solutions proposed by respondents.

Solutions	Frequency	Percentage (%)
Remediation of pre-requisites in chemistry learners	9	3.00
Motivating learners	23	7.66
Give importance to orientation	12	4.00
Give importance to the language of instruction	32	10.66
Recruitment of preparators in high schools and middle school	12	4.00
Motivate teachers	26	8.66
Share the experience of old teachers with new teachers	3	1.00
Make the most of ICT in the teaching and learning process	20	6.66
Familiarize learners with the use and handling of chemicals and materials	10	3.33
Adapting the program to the timetable and renewing it after each decade	38	12.66
Good didactic transposition with content adaptation	5	1.66
Understanding the psychology of learners and supporting them psychologically with a follow-up of their file	5	1.66
The teacher must create suitable problem situations to help the learner eliminate his or her misconceptions.	3	1.00
Keep classrooms uncluttered	19	6.33
Give great importance to infrastructure (Chemicals, equipment and practical classrooms)	55	18.33
Value continuing teacher training	22	7.33
Separate physics from chemistry and assign a teacher to each subject as in some Arab countries.	4	1.33
Reduce the misuse of social networks by learners	2	0.66
Total	300	100

4. DISCUSSION

4.1. Difficulties Related to Teachers

The survey responses reveal that insufficient continuing education is perceived as the primary challenge hindering the effective teaching of chemistry. The absence of ongoing professional development influences teachers' competencies, reducing their effectiveness impacting learner performance. This finding aligns with the study by Copriady, Zulnaidi, Alimin, and Albeta (2021) which suggests that inadequate in-service training may stem from a shortage of qualified personnel, time constraints or insufficient materials and chemicals. Teacher incompetence can lead to strained learner-teacher relationships which generally obstruct pedagogical activities, particularly in chemistry education. According to Ruiz-Díaz (2022) respondents indicated that unsuitable learner and teacher relationships negatively affect chemistry instruction. Additionally, teacher demotivation, stemming from factors such as salary, inadequate infrastructure or psychological issues was identified as a significant obstacle. This result is confirmed by those who emphasize the need to motivate teachers by enhancing their salaries. The medical and social problems faced by teachers and learners also have a negative impact on teaching and learning (Amedu, Dwarika, & Aigbodion, 2025). Respondents confirmed that insufficient initial training hinders the teaching of chemistry. This finding aligns with Tekkumru-Kisa, Coker, and Atabas (2022) who demonstrated that inadequate initial training can be associated with the quality of teacher training in higher education institutions. Moreover, the role of university education in the teaching and learning process of chemistry was also highlighted as a key factor. This finding is consistent with the survey by Chakour et al. (2019) focused on the university education of geology teachers.

The university curriculum negatively impacts the teaching and learning of chemistry as confirmed by the results of our research. However, a subset of teachers considers that the university curriculum does not have a significant effect on the teaching of chemistry. This can be attributed to their potential benefit from the experience of colleagues specialized in chemistry or the use of educational videos on certain platforms and media that discuss specific chemistry content, such as experiments. The position of this barrier can also be explained by the divergence in student and teacher training processes which results in different teacher competences. In this context, teachers specializing in physics and chemistry may confront different challenges compared to those with a background solely in physics.

4.2. Difficulties Related to Learners

The negative influence of educational orientation on chemistry instruction can be ascribed to learners' inadequate time invested in determining their academic trajectories and selecting fields that do not harmonize with their cognitive capacities and personal inclinations. This phenomenon often results in learners favoring scientific disciplines over literary ones to avoid the perceived challenges of learning. As a result, students may grapple with chemistry which frequently necessitates memorization, thereby impeding the teaching process and negatively affecting academic outcomes. Furthermore, parental pressure to pursue educational paths that are discordant with students' intellectual aptitudes and abilities further diminishes the quality and quantity of learning (Byrne, Flood, & Willis, 2002).The findings also indicate that the deficiency of prerequisite knowledge significantly impedes the teaching and learning process in chemistry. According to the observation by Ogunleye (2014) schools don't have necessary resources and make it difficult for students and teachers to deal with the learning process. This limits the variety of beneficial teaching methods and reduces opportunities for students to engage. Furthermore, the majority of respondents indicated that overcrowded classrooms make teaching and learning less effective. This observation is supported by Benzidia, Ait Alioua, Ouasri, and Abid (2021) reported that middle school learners often conflate physical and chemical transformations as well as fusion and dissolution. Learners' lack of interest poses another substantial challenge to chemistry education. Ménard and Trant (2020) suggested that this disinterest may arise from various factors, including content presentation, teaching methodologies and learners' gender. Furthermore,

medical and social obstacles impede the teaching and learning of chemistry. Kucukkaragoz and Meylani (2025) demonstrated that adverse school conditions leading to respiratory illnesses and asthma, adversely affect students' academic performance. Finally, the lack of politeness among learners can disrupt the chemistry teaching and learning process. Agyekum (2019) confirmed that negative teacher and student interactions lead to instability while positive relationships enhance the efficacy of the educational process.

4.3. Difficulties Related to the Teaching Subject

The surveyed teachers identified the misalignment between curriculum content and the timetable as a significant barrier to teaching chemistry. This finding is corroborated by Dawal and Mangut (2021) who reported that such misalignment is a major factor contributing to the failure of learners in the basic sciences, particularly chemistry. They recommended reducing the curriculum content to a manageable size. Additionally, the interviewed teachers noted that the language of instruction poses a challenge to chemistry teaching. This observation aligns with Patra, Alazemi, Al-Jamal, and Gheisari (2022) who demonstrated that the language in which questions are framed can significantly impact learners' performance. Furthermore, the strategic vision 2015/2030 of Morocco as outlined by the Higher Council for Education Training and Scientific Research (2015) underscores the importance of language skills through lever 13. The inherent difficulty of chemistry content also poses a substantial challenge to the teaching and learning process. This finding is consistent with the study by Karima, Oussama, Mounia, and Karima (2022) which revealed that concepts such as Redox reactions are particularly difficult to teach and retain, with learners often unable to distinguish between oxidation reactions and Redox reactions.

4.4. Difficulties Related to Teaching Conditions

Survey respondents confirmed that inadequate infrastructure, including a lack of equipment, practical rooms, and chemicals is a significant obstacle to the effective teaching and learning of chemistry. This finding is corroborated by Yangambi (2023) who reported that school equipment has a serious impact on student learning and achievement. Schools that don't have necessary resources make it difficult for students and teachers to deal with the learning process. This limits the variety of beneficial teaching methods and reduces opportunities for students to engage. Furthermore, the majority of respondents indicated that overcrowded classrooms make teaching and learning less effective. This observation is supported by Ouellette et al. (2018) who demonstrated that large class sizes leave teachers feeling overwhelmed and students unmotivated, leading to poor academic performance (Klusmann, Richter, & Lüdtke, 2016). Overcrowded classrooms hinder teachers' ability to provide individualized attention and create a motivating atmosphere, potentially resulting in burnout, stress, and distraction. Additionally, the survey highlighted the issue of insufficient laboratory assistants, a challenge confirmed by Barrasso and Spilios (2021). Laboratory assistants are necessary for providing support and training to teachers unfamiliar with practical work, thus reinforcing the effectiveness of chemistry education. Lastly, according to the research by Ménard and Trant (2020) respondents noted that inadequate laboratory safety is a major obstacle that impedes the teaching and learning of chemistry. Laboratory accidents globally result in serious physical injury or even death, thereby interrupting laboratory activities and compromising the quality of chemistry education. Collectively, these challenges negatively affect teachers' work and students' performance. Addressing these obstacles is key to ensuring an effective teaching and learning experience for everyone.

5. CONCLUSION

The results of the current study illustrate the great challenges faced by chemistry teachers in Morocco, especially in the Fez-Meknes region which affect their educational roles and student learning outcomes. The main obstacles identified by the surveyed teachers include the content of the curriculum, student participation, the classroom environment, and the teachers themselves. In addition, teacher education at the university level has

emerged as an extremely important issue which emphasizes the need for appropriate training and professional development. The survey facilitated the identification of specific barriers to the effective teaching of chemistry in the Fez-Meknes region. Respondents suggested several insightful recommendations to overcome these challenges. Firstly, they emphasized the importance of harmonizing the curriculum with appropriate teaching hours to better accommodate diverse learning profiles. Secondly, they highlighted the urgent need to provide continuous professional development to teachers to enhance their motivation and effectiveness. Thirdly, they emphasized the need to improve infrastructure and provide students with adequate equipment. Finally, they recommended further studies to address and alleviate the obstacles related to teaching and learning chemistry comprehensively.

6. IMPLICATIONS AND FUTURE DIRECTIONS

The poor performance of students in chemistry at Moroccan middle and high schools with the lack of sufficient research into the obstacles related to teaching and learning prompted us to undertake a research project. This project aimed to identify these obstacles through a survey developed and validated according to established standards. These obstacles have a negative impact on learners' results and teachers' teaching methods. Identifying these obstacles will enable us to reflect through future research which will be focused on the evaluation of the means to fight against these obstacles such as the rewriting of pedagogical content and making it available to industries, repairing infrastructures and motivating teachers and learners to have a positive impact both on the teaching and learning of chemistry.

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