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A Case Study on the Factors Influencing UAE High School Chemistry Students' Learning of Organic Qualitative Analysis: The Story of Rawaa

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Research Article

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Abstract

Background/purpose. Chemistry is one of the five science subfields typically covered in secondary schools in the United Arab Emirates. Chemistry is a branch of science that studies the properties, composition, and structure of substances. Numerous subfields fall under the umbrella of chemistry, including inorganic, organic, analytical, and physical chemistry. One topic covered in chemistry classes is the analysis of chemical compounds, which is divided into two types: quantitative and qualitative analysis. While qualitative analysis determines the kind of element or group present in each solution sample, quantitative analysis determines the quantity of each component or group present. Students' low achievement and poor chemistry performance are significant issues plaguing education in the UAE. For example, in the 2018 PISA international exam, the average science performance of 15-year-old UAE students was 434 points, which is lower than the OECD average of 489 points. This qualitative case study aims to identify the factors influencing Rawaa's (pseudonym) and grade 12 students' learning of an essential Chemistry concept (OQA) topic in Chemistry.

Materials/methods. A qualitative research approach was employed in the Rawaa case study to gain an in-depth understanding of the factors contributing to the difficulties that UAE students in grade 12 experienced while studying OQA topics in Chemistry, as revealed through interviews, class observation, and document analysis of Rawaa's study materials, including her journals, notebooks, and worksheets. The thematic analysis was utilized to examine the raw conceptual understanding of the topic using the qualitative data gathered.

Results. The results highlighted challenges within teaching OQA in chemistry, including resource constraints that impact practical instruction, curriculum-content misalignments, instructional method deficiencies, and issues with teacher motivation.

Conclusion. Recommendations include overcoming these challenges through the incorporation of practical-based approaches, enhancing resource availability, aligning the chemistry curriculum with instructional practices, and improving professional development (PD) for chemistry teachers to offer support to both instructors and 12th-grade students, thereby driving more effective learning environments in chemistry education.

1. Introduction

UAE secondary schools typically study all five science subfields, including chemistry, which is part of the general science curriculum (Balfakih, 2003). Chemistry studies the properties and structures of substances. Chemistry encompasses various subfields, such as inorganic, organic, analytical, and physical chemistry (Anim-Eduful & Adu-Gyamfi, 2022).

Learning about the analysis of chemicals is one of the most significant aspects of studying chemistry. Quantitative and qualitative analyses are the two primary subfields that comprise the field of chemical analysis. To differentiate between qualitative and quantitative analysis, qualitative analysis determines which elements are present in the solution, whereas quantitative analysis determines the number of elements in the solution. Relevant literature indicates that Emirati students require assistance in correctly identifying the functional group and determining the correct number and position of multiple bonds in organic molecules (Malkawi et al., 2018). Based on students' feedback, organic chemistry is a complex subject that places a strong emphasis on memorization and requires a significant amount of information to be absorbed (Anim-Eduful & Adu-Gyamfi, 2022). Essential parts of the UAE organic chemistry curriculum in high school, especially in grade 12, include identifying and characterizing the structures of unknown substances. For instance, alkenes and alkynes are unsaturated hydrocarbons that react with Br_2 in water. The visible proof of a reaction, in the form of the reddish-brown hue of bromine, either fading away or entirely disappearing, proves that the unidentified solution includes carbon double or triple bonds (Atkins & Beran, 1992). Saturated hydrocarbons have only one single carbon bond and do not change the cold alkaline or acidified tetraoxomanganate (VII) ($KMnO_4$) solution's purple color in any discernible way. Neither Br_2 in tetrachloromethane (Br_2/CCl_4) nor bromine in H2O Br_2/H_2O) reacts with alkanes (Atkins & Beran, 1992; Fieser & Williamson, 1992).To help students better understand functional groups in OQA and avoid common misunderstandings, Akkuzu and Uyulgan (2016) suggested using activity-based lessons to reinforce basic chemistry concepts, build on students' existing knowledge, and introduce new material. Results from the study by Asghar, Huang, Elliot, and Skelling (2019) indicate that students have a better understanding of common scientific concepts when their teachers employ well-planned instructional activities. Teachers can better address their students' alternative ideas when they employ suitable inquiry-based activities in chemistry classes.

Chemistry classes, especially those focusing on OQA, are more engaging and productive when held in well-equipped classrooms with all the required chemicals. To make the ideas more approachable, chemistry teachers should examine the process of detecting functional groups of organic compounds before instructing students in OQA using activity-based learning strategies. This case study aims to identify the factors that influence the learning of chemistry among Rawaa 12th-grade students and their classmates in the UAE, assess the subject's performance, and propose potential solutions that could be implemented to address these issues.

Many people consider chemistry one of the most challenging science courses to understand, and the degree of educational performance in chemistry is less attractive to students than in other subjects (Cardellini, 2012). As a result, it attracts the fewest students (Apu, 2020), particularly at the grade 12 level. Numerous science researchers have reported that students struggle to grasp concepts in organic chemistry (Anim-Eduful & Adu-Gyamfi, 2022). Like Rawaa, according to grade 12 students, organic chemistry is considered incredibly difficult to understand and memorize, with various ideas to acquire (Bhattacharyya & Bodner).

The researcher has not found any previous research in the UAE that uses OQA to identify the variables influencing students' comprehension of the subject in 12th grade. The findings of this study provide a foundation for enhancing students' understanding, which, in turn, may inform more effective chemistry lesson delivery. The results of this study also provide insight into the development

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of new pedagogical approaches and policies that can be implemented in the future to address potential crises in the educational system (Chen et al., 2020). Additionally, this study examines the challenges that chemistry students in senior high school encounter when learning OQA. The objective establishes what students hope to gain from OQA classes, what obstacles they face to learning, and what they anticipate from the courses themselves. Interviews are employed as a means of obtaining qualitative data from students. We conducted a more in-depth examination of the participants' perspectives on the instruction and learning of OQA. This is achieved through the refinement and elucidation of the qualitative data obtained from the students. An observation checklist is created using the results of the interviews with students.

Understanding what makes OQA a challenging chemistry topic for Rawaa UAE high school students is the driving force behind this study. The goal is to determine the barriers to Rawaa's understanding as well as their perceptions of OQA. Interviews were used as a primary source to collect data from 12th-grade chemistry students and Rawaa. The collected qualitative data from students were analysed to delve deeper into students' perspectives on the learning of OQA within the UAE context. Few studies have focused on different levels of education and the analysis of various branches of chemistry. However, after a thorough review of the existing literature related to the UAE, it appeared that there was no research addressing the factors affecting grade 12 students' understanding of OQA. Hence, this study is the first to focus on this topic. The findings of this research are expected to inform the teaching and learning processes in the subject of OQA in UAE schools. Specifically, it is hoped that the findings will raise awareness among the academic and administrative staff about the factors that might have positive or negative effects on students' understanding of the OQA. Educational experts, policymakers, teachers, curriculum developers, and other concerned stakeholders may use the results of this research in implementing educational policies, innovative teaching strategies, and tailored programs to prepare teachers on ways to teach the subject better and help students understand

To guide this inquiry, the study addresses the following research questions:

- What factors influence Rawaa12th-grade UAE students' understanding of OQA?
- What are the challenges that Rawaa's 12th-grade students face in conceptualizing OQA, and how can these challenges be overcome?
- What sort of support do Rawaa 12th-grade students need to better understand OQA?

2. Literature Review

2.1. Teaching and Learning Chemistry Globally and in the UAE

Studying chemistry places enormous demands on both students and teachers. Despite chemistry's critical role and significance, the failure ratio remains exceptionally high worldwide (Hassan et al., 2017). Several factors, including students' backgrounds, lack of interest, untrained teachers, and traditional teaching methods with insufficient learning materials, may all contribute to students' poor achievement in Chemistry (Ogutu, 2020). However, understanding and addressing these factors can lead to significant improvements in students' performance in chemistry (Surya et al, 2021; Surya & Arty, 2021).

UAE students' scores are lower than the TIMSS international exam average of 500. Weak students' abilities in Mathematics during their early school years can significantly impact their learning in various science subjects, including Chemistry, which can, in turn, affect their educational achievement in later grades. Such an impact could result in fewer career opportunities for UAE graduates in science, particularly in Chemistry, due to students' decreasing interest in the subject (Akram et al., 2017). In a study about the variables related to achievement in Chemistry and

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performance of students in the UAE, Khalaf (2000) reported that home environment, prior knowledge, academic ability, perceptions and attitudes related to science and Chemistry, and students' awareness of instructional practices are the factors correlated with achievement and performance of students in Chemistry. Various measures (i.e., school size, prior achievement of students, and students' opinions on teacher efficacy) have been implemented in UAE schools and classrooms to target students, teachers, and the whole learning and teaching environment.

Parents' expectations and aspirations are among the most significant factors influencing parental involvement and its impact on school outcomes (Jackson, 2022). It is thought that parents link their hopes to their children and set academic objectives for them (Jeynes, 2007). This underscores the crucial role parents play in shaping their children's educational journey. Chu et al. (2015) emphasized the importance of teacher quality in improving students' achievement. When teachers have a greater understanding of the subject matter and knowledge, are focused on teaching, and teach higher-quality material, students may have more opportunities to learn further (Hanushek & Rivkin, 2010). Hanushek (2011) found that when a high-quality teacher teaches a student, their academic achievement improves. Several studies have examined the relationship between individual students' attitudes and academic achievement characteristics related to learning (Erdogan et al., 2008). According to the research, students with negative attitudes toward learning exhibit problematic behavior (Ming, Ling, & Jaafar, 2011). It has also been found that living in slums and impoverished areas contributes to students' poor academic performance (Farooq, Chaudhry, & Berhanu, 2011).

2.2. Organic Qualitative Analysis (OQA)

As per Buthelezi et al. (2020), Aliphatic hydrocarbons are categorized into two divisions:

Alkynes and alkenes, unsaturated compounds, and alkanes, saturated compounds. Aromatic hydrocarbons are exemplified by benzene. To support students' understanding of functional groups and prevent misunderstandings, basic concepts should be introduced initially, including fundamental chemistry theories (Hanson, 2017). Research has shown that instructors who facilitate activity-based teaching and a well-developed curriculum help students grasp scientific concepts more effectively (Asghar et al., 2019). Identifying carbonyl compounds such as ketones and aldehydes is critical in organic chemistry. Several tests are practiced, such as

- Brady's Reagent (a few drops of 2,4-dinitrophenylhydrazine react with the carbonyl groups, resulting in orange or bright yellow precipitates),
- Tollen Test (aldehydes are transformed into silver mirrors, causing a reflective sheen on the test tube lining),
- Schiff's Test (adding carbonyl compound to the reagent results in the formation of an oxide precipitate, confirming its presence), and
- Esterification (when carboxylic acid is heated with concentrated sulfuric acid, yielding alkyl alkanoate).

For the qualitative detection of amides, the amide solution is heated with sodium hydroxide, which produces ammonia gas due to amide hydrolysis. The pungent odor and fundamental nature of ammonia facilitate its qualitative detection of the amide functional group, as identified by Morrison and Boyd (1992). Moreover, regarding multimodal learning within the chemistry discipline, cognitive scientist Carey (2000). Proposed concept formation via experience-based extrapolation. This approach enables students to actively construct models, facilitating an understanding of the connections and differences among various scientific concepts and promoting effective learning in the chemistry subject.

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2.3. Factors Influencing Students' Learning of OQA

2.3.1. Attitudes Towards Chemistry and Science

Research conducted at the turn of the millennium reported elevated levels of declining student achievement and engagement within science education. Students needed to learn fundamental scientific concepts (Osborne et al., 2003). Students also displayed decreased enthusiasm and motivation towards science, which led to negative attitudes towards the subject. Studies also identified career disinterest as a factor contributing to enrollment decline. Further research within Europe and the USA attributed these concerns to deficiencies in pedagogical strategies and school curriculum content (Hofstein & Mamlok-Naaman, 2011). Secondary school students also hold positive emotions towards science-related subjects but have neutral attitudes overall (Montes et al., 2018).

2.3.2. Language Proficiency

Students' language difficulties in comprehending English instructional materials correspond with Cummins's concept of language-rich learning environments. The students' inclination towards explanations in their mother tongue underscores the significance of acknowledging language diversity in teaching methods (García, 2009). As educators, researchers, and academic professionals, it is crucial to understand and address the language difficulties faced by international students from diverse backgrounds in university settings. These students often experience 'language shocks' due to disparities in language systems, perceptions, and attitudes, as noted by Fan (2010). These shocks fluctuate in stages and strength, impacting emotions and learning. Students face linguistic challenges with aspects such as tenses, plural nouns, pronunciation, articles, and prepositions that are not present or differ in their home languages. They also face challenges in understanding various cultural subtleties in criticisms, feedback, praises, greetings, and titles from a sociolinguistic perspective. The problems are consistent with the studies carried out by James (1980) and Chesterman (1998), showing influences from their native languages. Discrepancies in language affect both the linguistic and sociolinguistic aspects of communication, impeding the student's understanding and assimilation into the academic environment. By acknowledging and addressing these issues, we can empower these students and facilitate their successful integration into the academic environment.

2.3.3. Teacher Motivation and Professional Development

Boesdorfer (2019) argued that chemistry instructors/teachers across various educational levels guide students who pursue careers as biologists, chemical engineers, chemists, and other STEM experts while also fostering civic sense and participation. Improved inclusivity and instructional effectiveness positively correlated with increased student interest and achievement in chemistry subjects. According to Driel and Jong (2015), the multifaceted nature of chemistry instruction necessitates a comprehensive understanding of the subject matter, student dynamics, pedagogical strategies, and evaluative approaches. As educators facilitate students' understanding of Chemistry, they also require learning and training opportunities for their continual professional development to refine their instructional capabilities and expand their content knowledge. The training and development of Chemistry educators ensure up-to-date knowledge and pedagogical competencies, enabling them to convey complex chemical concepts effectively to students (Dragisich et al., 2016).

Furthermore, well-trained teachers adapt teaching methodologies to cater to diversified learning styles, fostering more engaging and inclusive classroom settings. Continual professional development equips teachers with the resources to integrate innovative teaching and modernized tech tools within lessons, improving the overall quality of education. Educational institutions that invest in the training and development of chemistry teachers improve the overall standard of instruction and cultivate a future generation of scientifically literate individuals, critical for societal and economic progress. The

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research by Guo et al. (2012) found that teachers who participated in ongoing professional development reported higher motivation, driven by increased confidence in their instructional competencies. Furthermore, the research conducted by Arthers et al. 2019 confirmed that PD opportunities provided to teachers directly/positively correlated with greater job enthusiasm and satisfaction, leading to improved instructional quality and fostering an engaged and motivated teaching workforce. Motivated teachers seek innovative teaching strategies and resources to fulfil the diverse needs of their students, thereby improving instruction effectiveness. Furthermore, they set high expectations for students and offer the required support (Han & Yin, 2016).

2.3.4. Laboratory Resources and Access to Practical Learning

According to Katsampoxaki-Hodgetts et al. (2015), when doing experiments, students should approach them like scientists. They need to identify problems, develop solutions, look for information, assess it, and discuss their findings with others. This process, known as scientific inquiry, helps students learn how to think and act like scientists. These studies found that laboratory activities can be more effective in helping students understand and apply science concepts. However, various challenges can hinder student learning in these environments, including inadequate resources and equipment, ineffective teaching strategies, and students' negative attitudes toward education. The studies also suggest that various approaches to teaching, such as inquiry-based or cooperative learning, can be more effective in promoting student learning and achievement than traditional lecture-based methods. In these traditional labs, the focus is primarily on teaching scientific terms, concepts, and facts. Concannon and Brown (2008) mention that they provide very detailed procedures and tell students exactly what they should expect to see during the experiments.

In this method, students follow a step-by-step recipe from the lab manual, and the outcome is already predetermined. Students begin these experiments already knowing the scientific theory behind them. In this format, students are mainly concerned with just following the instructions in the lab manual. Consequently, they need the opportunity to develop higher-level thinking skills. Furthermore, verbal feedback and remedial instructions can help improve students' problem-solving skills.

2.4. Gaps in the Literature

Despite extensive research on chemistry education globally, a significant gap remains in the literature regarding the specific challenges that UAE students face in learning OQA. Most studies have focused on Western contexts, where students have better access to laboratory resources and are taught in their native language (Buthelezi et al., 2020). Students in the UAE require assistance with language skills, resource constraints, and effective teaching methods. Students in the UAE, however, require assistance with teaching strategies, resources, and language proficiency. Additionally, although research has examined the obstacles students encounter in comprehending concepts related to organic chemistry, greater attention should be paid to the real-world consequences of these issues, specifically student-teacher relationships and classroom settings. Thus, this offers insights into how these elements—language difficulties, instructor motivation, and resource accessibility, for example affect students' comprehension of OQA. The case study contributes to the knowledge of chemistry education by providing valuable work and suggestions for enhancing student performance in OQA and other complex subjects, as outlined in the UAE curriculum framework.

2.5. Building on Existing Knowledge

This case study builds on existing research by providing a detailed examination of the factors that influence students' learning of OQA in the UAE. By using Rawaa's story as a lens through which to explore these challenges, this study provides a nuanced understanding of how students navigate the complexities of chemistry education in a resource-limited environment. The findings contribute to

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the ongoing discourse on the importance of practical-based learning, teacher motivation, and language proficiency in improving students' academic performance. Furthermore, the study challenges existing knowledge by highlighting the unique cultural and educational context of the UAE, where students must navigate both linguistic and resource-related obstacles. By addressing these factors, this case study provides actionable strategies for educators and policymakers to enhance the teaching and learning of OQA, ultimately leading to improved student performance in chemistry.

2.6. Theoretical Framework

According to constructivism, children are active learners who create meanings based on prior information from interactions with their surroundings. According to this theory, interactions, collaboration, observations, and engagements are the most important parts of students' learning (Ziling, 2018). Students will develop their understanding of a topic and apply it in various scenarios.

Teachers become facilitators, guiding students to construct their understanding of the world. Teachers must have a firm grasp of constructivist pedagogy. Therefore, every student in their classroom brings a particular worldview shaped by their life experiences. This will impact the level of learning that children achieve. Constructivism, which states that children learn best at the beginning of their educational journey, strongly emphasizes students building new information on top of their prior knowledge. This focus on past experiences is essential to learning because it recognizes and affirms each student's learning path.

Many different components make up constructivism. We learn by establishing connections between our prior knowledge and our beliefs, either within the framework of what we already know or as we engage in our daily lives, where learning often occurs.

Students can better organize concepts into categories and develop more insightful mental processes. Additionally, students realize that they are studying multiple concepts simultaneously. Everyone participates in the learning exercise with their own experiences; therefore, they will all go away with distinct insights. The core principle of constructivist learning theory is that each individual's viewpoint and life experiences are fundamental to their learning. The theory of constructivism is applied in this study to understand how students learn OQA in chemistry.

In Rawaa's case study context, constructivism plays a critical role in understanding how she navigated the challenges of learning Organic Qualitative Analysis (OQA). The difficulties she faced when learning OQA, such as language barriers and the lack of practical learning work using the lab, can be interpreted through a constructivist lens, where effective learning hinges on meaningful interaction with content, teachers, and peers. All this highlights Rawaa's struggle to connect classroom lessons with her own experiences, primarily due to the lack of hands-on laboratory work, underscoring the importance of active learning environments in acquiring complex chemistry concepts.

3. Methodology

3.1. Research Design

The study utilized a qualitative case study technique, specifically semi-structured interviews, student checklist observations, and document analysis, to gain an in-depth understanding of Rawaa and student experiences with OQA learning in grade 12. It is chosen to investigate the underlying causes of student failure rather than drawing broad generalizations.

3.2. Participants

The research participants were 12th-grade students, and Rawaa, one of the participants from grade 12, from an international private school in Al-Ain, UAE.

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The student Rawaa was selected for this case study as her work practices stood out from the others and were clearly rhizomatic. The student is from a different background and mentioned something different than others. She talked about language and how it affects her understanding of the topic, and she mentioned something essential for the teaching and learning relationship between the student and the teacher. Additionally, I saw that the student was distinct from others when I observed her classrooms since she mentioned several things that set them apart. And how she interacts with the teacher and chats with others stimulates my curiosity to learn more about her, her background, and her uninterest in studying chemistry. Since this is her first year in this school, she assisted me in identifying new and unique evidence that supports the study. She also focused on the spaces between the inside and outside schoolwork practices, the influence of affinity groups on students' engagement with certain work practices, and the processes involved in filling gaps in one form with another. In short, Rawaa's case study provides detailed answers to three critical questions, chosen through intentional sampling to guarantee relevance to the objectives.

3.3. Purpose of Qualitative Methods

This study employed qualitative case study methods, specifically semi-structured interviews, student checklist observations inside the classroom, and document analysis for Rawaa, to gain an in-depth understanding of students ‘and Rawaa's experiences with OQA learning. Unlike achievement tests or existing scores, which measure outcomes, these methods allowed students and Rawaa to express their challenges and perspectives freely. Interviews provided rich details on student experiences, while checklists during observations captured specific learning activities. Document analysis of curriculum materials offered context for understanding the intended learning goals. This combination provided a holistic picture of how students interact with OQA, going beyond simple performance metrics.

3.4. Data Collection

Data for this case study were collected through multiple qualitative methods, including semi-structured interviews, classroom observations, and document analysis.

1. Interviews: A deep dive into Rawaa's learning experiences was facilitated through semi-structured interviews with her and other students. This method enabled a comprehensive exploration of the challenges and coping strategies for understanding OQA, ensuring a thorough understanding of the topic. Observations: Classroom observations were conducted during OQA lessons. The researcher observed both the instructional methods used by the teacher and Rawaa's engagement with the material. An observation checklist for two chemistry teachers was used to ensure consistency in data collection, focusing on aspects such as teacher-student interactions, the use of practical work using labs, and classroom dynamics.

2. Document Analysis: Students' and teachers' documents, including Rawaa's notebooks, lesson plans, projects, and worksheets, and feedback from her teachers throughout the school system, were analyzed to provide context and corroborate the data obtained from interviews and observations. This triangulation of data helped ensure the reliability and validity of the findings.

3.5. Data Analysis Case Study

The qualitative part of the study included a second type of analysis, which involved case studies. The aim was to address the complexity of students' learning of OQA and to provide a detailed description of the factors that affect their learning and understanding of the rhizomatic nature of this topic's work practices. The student was selected for this case study as her work practices stood out from the others and were rhizomatic. The student is from a different background and mentioned something different than others. She discussed language and its impact on her understanding of the

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topic, and she highlighted an essential aspect of the teaching and learning relationship between the student and the teacher.

Additionally, I noticed that the student stood out from others when I observed her classrooms, as she mentioned several things that set them apart. Moreover, how she interacts with the teacher and chats with others stimulates my curiosity to learn more about her, her background, and her interest in studying chemistry. Since this is her first year in this school, she assisted me in identifying new and unique evidence that supports my study. She also focused on the spaces between the inside and outside of school work practices, the influence of affinity groups on students' engagement with certain work practices, and the processes involved in filling gaps between one form and another.

In short, Rawaa's case study provides detailed answers to three critical questions: the difficulties grade 12 students face in understanding OQA, what they face in understanding the topic, and the support they need.

3.6. Ethical Considerations

It's essential to consider ethical issues at every study step. In this case study research, I followed the rules and guidelines set by UAEU's Policy on Ethics. When collecting data, such as through interviews, it is essential to consider ethics. Participants willingly engaged, knowing they could withdraw from the study at any time. Before participating, it was ensured that the complete comprehension of the study's details and obtaining free, unpressured consent is crucial. The approval from UAEU's Ethics Office was attained in November 2023 for semi-structured interviews. The names of the students, teachers, or schools in the interview discussion were not mentioned. The advisor and the committee of co-advisors looked at the interview questions and stated that they were suitable for answering the research 31 questions. They all agreed that the interview questions' material was relevant and helpful in addressing the study issues being examined (Willett, 2014).

Specifically, according to Rawaa, Ethical issues were carefully considered throughout the study. Written and verbal consent was obtained from Rawaa prior to the commencement of data collection. She was informed that her participation was voluntary and that she could withdraw from the study at any time without consequence. To protect her privacy, a pseudonym (Rawaa) was used in all reporting. The researcher ensured that all data were anonymized and securely stored.

Additionally, the study adhered to ethical guidelines regarding the handling of sensitive data, particularly since personal and academic details were involved. The researcher took care to ensure that the data collection process did not disrupt Rawaa's learning or create any additional stress during her final year of high school.

4. Results

To ensure the reliability of the findings, the study incorporated triangulation of data by reviewing student and Rawaa's work and documents shared between teachers and students. A more comprehensive understanding was achieved by comparing the information provided by the students with the data obtained through lesson observations and student-teacher documents within the school.

4.1. Interviewer's Knowledge and Credibility

In qualitative research, the researcher's knowledge and credibility play a crucial role (Patnaik, 2013). This is particularly true when conducting interviews, as the interviewer must possess technical expertise and strong interpersonal skills. In the context of this research, the researcher holds an administrative position and acts as the head of the department in a school setting. She has been working at the same school for over eight years. Furthermore, the researcher boasts over 13 years of experience in teaching and learning gained from working in the UAE and the United States. These

extensive experiences enhanced the researcher's credibility in the eyes of the interviewees (Patnaik, 2013).

Moreover, the researcher's familiarity with the school, its students, teachers, and staff further strengthens her position. As a part of and working at the same school, the researcher has developed a deep understanding of the institution's dynamics. As the head of the department, she regularly conducts observational visits and uses checklists to assess the performance of the two chemistry teachers. This established rapport and familiarity for the researcher to collect data and information. The teachers felt comfortable and were more willing to assist in providing the required documents and information.

Additionally, the researcher's familiarity with the laboratory materials, chemicals, and processes, along with the support of the lab technician, allows her to access the necessary information and even obtain pictures of the lab setup. Being the head of the science department enables her to keep an open line of communication with the teachers. That helped to create a relaxed environment where teachers can openly share their truthful information. Similarly, students felt at ease during the interviews, making the data collection process more effective and reliable.

4.2. Case Selection

Rawaa was selected as the subject of this case study due to the unique challenges she faced in learning OQA, which set her apart from her peers. Her difficulties with language proficiency, combined with her relationship with her chemistry teacher, provided a distinctive perspective on the broader issues that high school students in the UAE encounter. Her participation in the study offered rich, detailed insights into the specific factors that hinder student understanding of OQA, making her an ideal candidate for this case study.

4.3. The Story of Rawaa (Case Study)

Rawaa (pseudonym) was the first to respond to my request for participants from the grade 12 students in the first interview with eight students, and Rawaa was chosen for the case study, as I mentioned before, for many reasons; I then called Rawaa to verify that she is a grade 12 girls' students. We scheduled her interview appointment based on her availability, which is significant since her interview was at the end of semester two, when final exams are held. Still, when I called her, she did not mind, and she was the first to respond, as I mentioned earlier, compared to other students who were selected for an interview.

Rawaa recommended after 1:00 p.m. so that she would not interrupt her study hours at school, especially since the student has extra classes every day practicing for the next day's final exam. She agreed to meet me on the school campus, in my office in the girls' section. When she arrived at my office, I was waiting for her and was the only one present. I observed that she was nervous, as evidenced by her fidgeting with her hands. I asked her to select any seat around the conference table, and she chose the chair closest to the door.

As an introduction, I told her a little about myself and expressed my interest in the study in which she would be participating. I reassured her that she was under no need to answer any question that made her feel uncomfortable. I received the go-ahead to initiate conversation by obtaining written and verbal consent, and I set up my notebook on the table in a strategic manner to begin writing. This interview lasted 30 minutes.

4.3.1. Rawaa Background and Language

Upon initial observation, Rawaa appeared to be a timid and introverted individual. Born on September 10, 2005, she was 17 years old at the time of our interview. Growing up in a bustling city in the United States, specifically Texas, her native language is English. However, her proficiency in

Arabic could be improved, as she only knows a few words and primarily communicates in an American accent. She began by discussing her family structure and upbringing. During the early years of her life, her immediate family lived with her father's grandparents due to financial struggles, as her father was a full-time student at that time. Her immediate family consisted of her father, mother, an older sister, and a younger brother. She was the middle child of the family. Her voice brimmed with excitement as she recounted her family's experience of moving into a home her father had personally constructed on a spacious half-acre plot once their financial situation had stabilized. However, her tone turned sombre as she revealed they had only resided in the new house for a mere year. Their departure was due to her father's completion of his education in the United States, having earned his associate's degree in medicine. Subsequently, he secured a remarkable job opportunity as a doctor in the United Arab Emirates, prompting the family's relocation to the Middle East.

According to Rawaa, initially, she was excited about living in Arab countries due to her family's connection to Iraq. Her father's grandfather hailed from Iraq, but due to the circumstances of war long ago, they moved to the United States and established their lives there. Rawaa candidly admitted, "To be honest with you, I do not know much about my country, Iraq, but I have heard from my grandparents that it is a beautiful place. Unfortunately, we can no longer reside there, so my dad relocated to an Arab country, although it is not our homeland." Consequently, he deemed Abu Dhabi an excellent choice for the entire family, and four years ago, we moved when I was in 9th grade.

During Rawaa's fourth grade, her parents divorced, which compelled her father to return to his grandfather's house with her and her two siblings. Her father pursued higher education and obtained a bachelor's degree in medicine. This achievement led him to secure a good job in Abu Dhabi, where he worked for the first four years. However, the entire family relocated to Al Ain this year because her father is currently employed at Twam Hospital. As a result, this marks her first year in Al Ain City and this school.

As for my mom, Rawaa says she does not live with us. She remains in the United States. Although she holds a bachelor's degree in psychology, she does not work in her field. Instead, she works part-time as a nurse for a senior citizens' home and as a library aide for a middle school.

4.3.2. Rawaa Parental Expectations and Aspirations for Education

Rawaa went into detail about her elementary and middle school experiences, which led her to attend an American school in high school and pursue her degree in chemistry, especially in grade 12. Her dad encouraged her to attend an elite high school in Texas. It was considered an early college high school in conjunction with a Community College, and the curriculum was highly challenging, counting as both high school credits and college credits. She stated she hesitated to apply during her eighth-grade year because she did not feel she was smart enough. As she spoke of her acceptance into the elite high school, she was excited to say that she was among the top 10% of high school students in this large city to be accepted into such an esteemed institution. She chuckled as she said many of her friends who were not accepted called her a "Nerd."

Her curriculum at the elite high school was challenging. Students accepted were required to enrol in both high school and college-level credits simultaneously. This type of education required a great deal of time management to balance high school and college coursework with her personal life. She endured challenges in grade 8 during the first year of high school as she strived for A and B grades. She spoke of the pride she felt as she conquered the challenge by earning a college course while still in high school. Rawaa was very humble as she stated,

I would not like to show off that I had already earned college-level credits when I graduated from eighth grade. This is because only some have been allowed to earn college-level credit in education

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while in high school. I have pride, and I do not rub it in anyone's face. (Rawaa, personal communication, March 13, 2023, second semester)

The curriculum she later expanded was college-bound courses. She completed a course in English and a course in foundation chemistry. She stated that her challenge was her chemistry class because she had to complete a college-level introduction to chemistry course to fulfill the requirements for her associate's degree. She took the required placement exam and scored 51% or higher, qualifying her for college-level science. She succeeded only at the beginning of her eighth-grade academic year.

As Rawaa transitioned to live with her family in Abu Dhabi, she said she did not choose to live in the UAE. It is her dad's and family's choice, as she believed it was better given their financial situation and would be better for the whole family. Still, she feels sorry about herself because she wants to continue what she started in the United States.

She expressed her surprise upon learning that the program she had initially enrolled in, which allowed high school students to take college courses, did not exist in the UAE. Regrettably, she recounted her dedicated efforts and hard work during her eighth-grade year when she joined the university to participate in the program and take relevant courses. However, her current situation in the UAE, where she attends an American school as a ninth grader, is different. The educational programs in the United States vary from those in the UAE. Despite the challenges, she strives diligently to connect with fellow students.

She further shared that her deep interest influenced her choice of a college major in the United States, focusing on animals. Her fascination with watching Animal Planet and the enchantment she felt while observing animals had a profound impact on her. During high school, she cared for pets and found joy in this responsibility, which brought her happiness. One memorable incident occurred during her eighth-grade class, where they watched a movie about illegal poaching. This disheartened her, knowing that such actions were prevalent in society, and she resolved to make a positive impact by safeguarding animals. With conviction, she declared, "This is my calling, and this is what I am going to do" (Rawaa, personal communication, April 13, 2023).

Rawaa mentioned feeling well-prepared because of the two college courses she took while still in high school at a prestigious high school in Texas. Despite having completed these two courses, she was still classified as a first-time freshman at the American school she attended, marking her first year in this new educational environment. However, she was granted credit toward her diploma for the courses she had previously taken.

In addition, Rawaa took the EmSAT and SAT exams and scored well in both. Furthermore, her final high school grade point average for the first and second semesters was an impressive 90.00 or higher.

4.3.3. Rawaa Grade 12 Experience & Difficulties in Learning Chemistry

Rawaa then spoke about her grade 12 experience. She believed she was ready for the life and coursework of grade 12, but after her first two semesters, she realized she was not yet ready for the final semester in grade 12 or university. She commented*, "I feel I am struggling this semester and have no motivation at all "(Rawaa, personal communication, May 13, 2023).*

All the students in grade 12th are currently discussing the challenges they face in learning OQA. However, it is worth noting that, as I mentioned earlier, Rawaa consistently raises specific difficulties during these discussions. The other students do not discuss these particular challenges, making Rawaa stand out as the primary student who openly shares her obstacles. According to Figure 1 provided by NVIVO, Rawaa's concerns about learning OQA surpass those of her classmates.

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Additionally, in Figure 2, Rawaa has chosen a unique set of topics to discuss, focusing solely on her own experiences. This individualistic approach sets her apart from the other students, highlighting her distinctiveness. As a researcher, Rawaa's perspectives can greatly assist me in my research endeavors. Her insights may uncover new aspects and contribute valuable information to enhance my work.

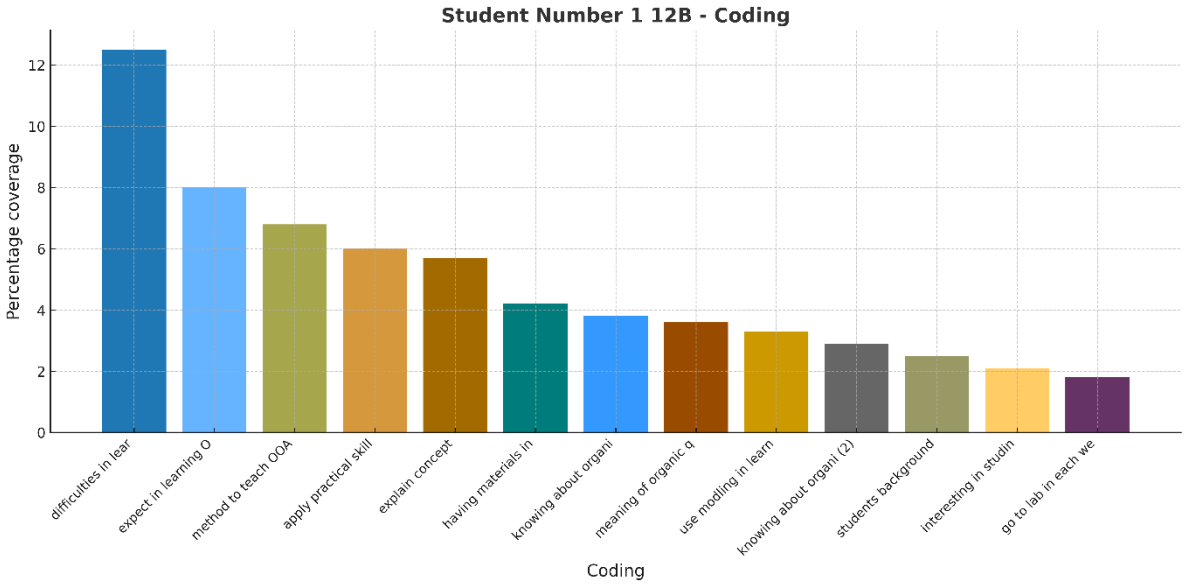

Figure 1. Rawaa, most students talk about difficulties compared to other students.

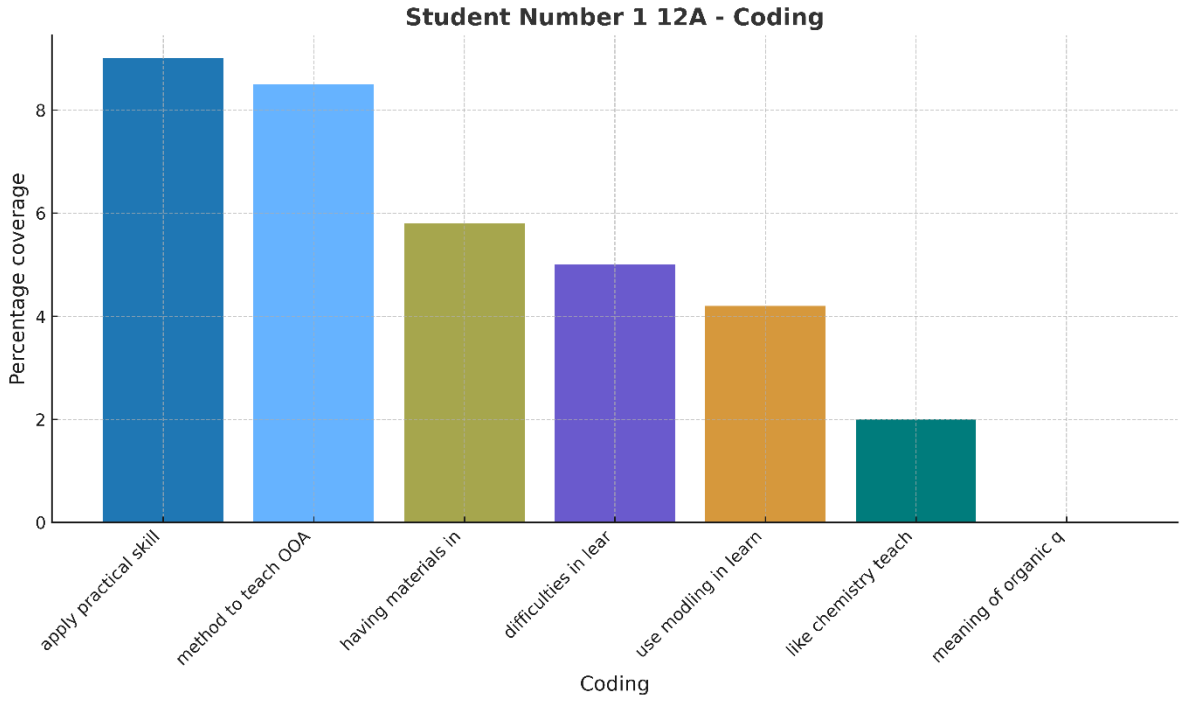

Figure 2. Chosen a Unique Set of Topics to Discuss

As Rawaa recounted her experience, a tinge of disappointment could be heard in her voice. Her final exam and preparation coincided with the arrival of numerous new students in her class during the second and third semesters. Assigned to a group with seven other students, she was handed a stack of papers. The chemistry teacher instructed them to independently solve the worksheets as

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quickly as possible and submit the answers by the end of the week. These eight worksheets were to be considered homework by the teacher.

Left to her own devices, Rawaa did her best to create her answers and find the correct solutions. However, she felt lost because the chemistry teacher covered the material quickly, particularly when it came to naming functional groups. Rawaa believed that the teacher needed to slow down, as functional groups were not an easy topic and required more time for comprehension.

4.4. Language Capability

Connecting the Rawaa case study with the literature review, one factor that can impact how well students learn about OQA is their language proficiency. Apart from students' feelings about it, other factors can affect how well students learn about OQA in chemistry. One crucial factor is their language skills. Some studies have examined how classroom language can either facilitate or hinder students' understanding and performance in chemistry (Alieto, 2018; Beka, 2016; Macaro, 2019). This is especially important in the UAE because many teachers come from different countries where English is spoken differently, which might differ from what Emirati students are used to.

So, how well a student can use language can impact their performance in science and overall (Jarrah, 2020). Adding to her frustration, the teacher spoke Arabic, which Rawaa needed help understanding, since many new students in the class struggled with English and came from public schools. Rawaa had requested the teacher to explain in English, but instead of accommodating her, he began shouting at her, accusing her of wasting his time. Consequently, he sent her to the supervisor, claiming she was disrespectful and aggressive towards him. Rawaa expressed her disdain for this teacher, clearly showing her negative sentiment toward him (Rawaa, personal communication, May 17, 2023).

4.5. Rawaa's Difficulties in the New School and Chemistry Teacher

Rawaa expressed her struggle as she transitioned from an American school in Abu Dhabi to her current school, which was filled with new students and uncooperative teachers. She found navigating the classes required for her grade 12 degree difficult and needed help to earn extra marks or handle the situation. The chemistry teacher, in particular, could have been more helpful and consistently spoken in Arabic, as mentioned earlier, since most local students requested explanations in Arabic. Whenever Rawaa tried to communicate with him in English, he would become angry, ignoring her and refusing to explain in either language. This posed a significant challenge for her, leading to her intense dislike for the chemistry teacher, whom she described as mean (Rawaa, personal communication).

Furthermore, Rawaa blamed her chemistry teacher for being unfamiliar with the challenges faced by transfer students in a new school and environment, and for failing to communicate more effectively with her and her parents. She particularly needed assistance in chemistry, but she vividly remembers leaving her alone at the table while she struggled to solve the worksheet.

Moreover, she adds that I dislike chemistry teachers altogether. (Figure 3) Below, which shows (case classification by using NVIVO), is Rawaa, unlike the chemistry teacher, who has a bad relationship with him.

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Case Classifications – Person

Name	Gender	NationalityRelationship with Chemistry T	Like Chemistry Subject	Class
Student Number 1	Male	Emirati	Bad	Like	A
Student Number 2	Male	Emirati	Bad	Unlike	B
Student Number 3	Male	Non-Emirati	Good	Like	C
Student Number 4	Female	Emirati	Good	Unassigned	D
Student Number 5	Male	Emirati	Bad	Unlike	A
Student Number 6	Male	Emirati	Good	Like	B
Student Number 7	Male	Non-Emirati	Bad	Unlike	C
Student Number 8	Female	Non-Emirati	Bad	Unlike	D

Figure 3. Support and Guidance to Assist Rawaa in Improving Her Understanding of OQA.

Seeking guidance, Rawaa turned to another chemistry teacher willing to communicate with her in English. With his help, she completed her first semester and achieved a good score.

In November, as the second semester approached, Rawaa faced familiar struggles. Determined to seek guidance, she turned to the resources at her school, specifically the Science department. Coincidentally, during a parent-teacher meeting to discuss the upcoming second-term exams, Rawaa had the opportunity to meet with her chemistry teacher, including the department head. In this meeting, she once again received advice from her chemistry teacher, who was present. However, to her frustration, Rawaa was given a list of materials she needed to cover for the upcoming semester.

When Rawaa attempted to attend chemistry classes in the second term, she discovered that many topics needed to be covered. It became apparent that the three chemistry classes offered were insufficient, and additional chemistry classes were necessary to cover all the required material for the second semester. Rawaa communicated her frustration, and her chemistry teacher started rushing again to cover as much as possible, given the circumstances. This unexpected situation presented a significant challenge for Rawaa, intensifying her frustration. (Rawaa, personal communication).

4.6. Rawaa Relationship with Teachers

Upon completing semester 2, Rawaa was disappointed with her grades. She attributed the unsatisfactory grades to a lack of communication between the teachers and herself. The first class that Rawaa discussed with me was organic chemistry. She stated that she failed the subject due to the large number of assignments, random quizzes, excessive homework and worksheets, and a family emergency back home. With regards to her class (physics), this course was challenging, but she did pass with a good score because the content was nothing but lectures and PowerPoint presentations. The teacher was not enthusiastic about his teaching, and this was a true reflection of how he presented information to the class. As she spoke of organic chemistry again (Introduction to Hydrocarbon), she became enthusiastic; she and the teacher were able to communicate, and she listened to him when he had questions; she received a good score in this class.

The tone of her voice became unsettling as she spoke of her 8G (Introduction to Chemistry) class. Rawaa and the instructor of this course had a disagreement based on the treatment she received in this class. One of her written midterm exams was displayed on the overhead for all the other students to see, bearing her name, and the instructor began to critique the exam paper verbally, allowing other students in the class the same opportunity. When a private meeting was set up between the two, Rawaa stated that she had verbalized to her how humiliated she felt in front of the class. The instructor's response, as Rawaa stated, *"It is a college class, and you have to take some sort of criticism in order to get better" (Rawaa personal communication, May 13th, 2023)*

Rawaa continued to say that this was the treatment she received throughout the semester, and she quit participating in class discussions. However, she was proud to say, *"I did beat her in the end;*

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I completed the course with a B" (Rawaa, personal communication, May 13, 2023). Rawaa proceeded to share her experiences during her third semester. In her Genetics class, she once again encountered disrespectful behavior from her teacher. Rawaa revealed that she received a low mark on a final research project assignment and received unclear feedback (*Figure 4),* prompting the teacher to request a meeting in their office.

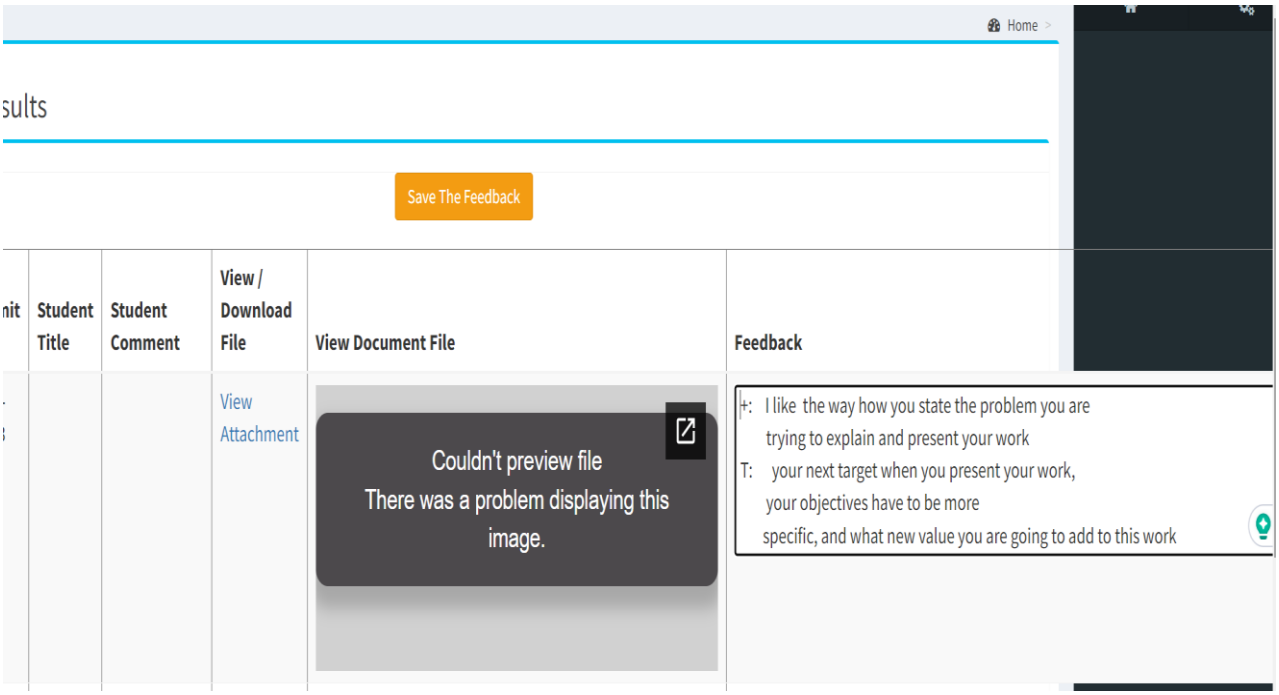

Figure 4. Rawaa Final Research Project Assignment Submission through the School System and Received Unclear Feedback.

During the meeting, the teacher criticized Rawaa's research paper, calling it "dirt." Confused by this response, Rawaa explained that she had followed the teacher's recommendation by seeking assistance and feedback from the leader of their group home, who was responsible for approving and submitting the project on behalf of the group. Per the teacher's instructions, Rawaa's responsibility in the project was to finalize the ideas and hand them over to the group leader before submitting them to the teacher. However, most of the workload fell on Rawaa's shoulders, as many students lacked enthusiasm for collaborative work.

Given the approaching deadline, Rawaa chose to work independently (Figure 5) and assume additional roles beyond her own. Despite taking on this additional burden, she was blamed for aspects beyond her control. She expressed her frustration, stating that she had repeatedly complained to her biology teacher about the challenges of working in a group. Still, he showed little concern and dismissed her concerns, emphasizing the need for teamwork to complete the project.

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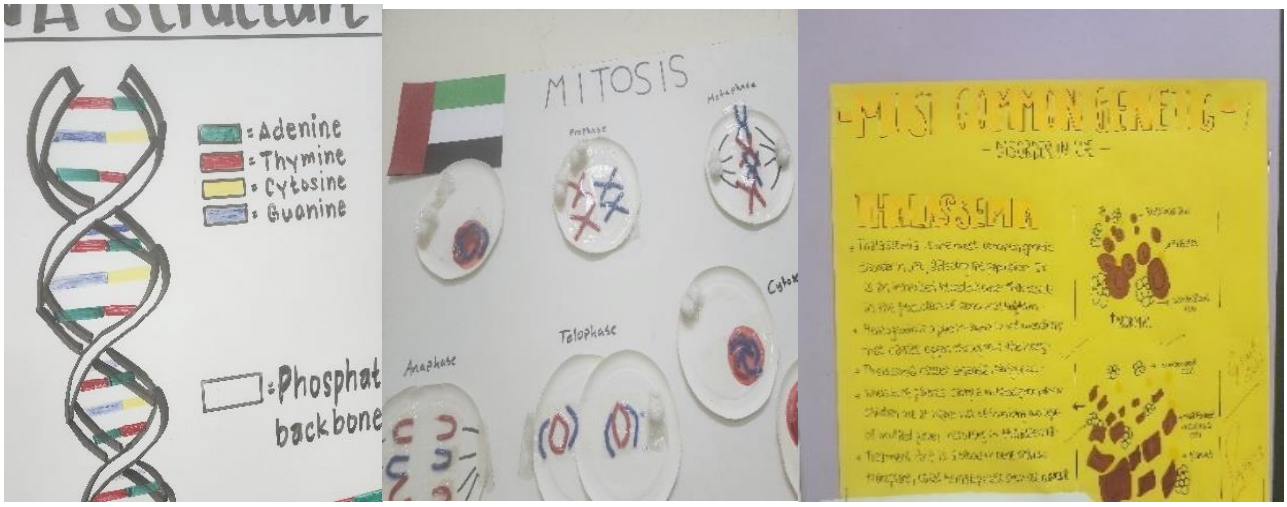

Figure 5. Rawaa's Work in Biology Project.

Expressing her dissatisfaction, Rawaa told the teacher, *"The way you speak makes it seem like you do not care about my project work" (Rawaa, personal communication, December 13th, 2023).* She also highlighted other issues she had faced, such as feeling isolated in the class with no one to talk to. Rawaa mentioned that she was the youngest student in the class and believed that her classmates bullied and made fun of her

of her, because her Arabic skills were weak, and their English proficiency was also challenging. She wondered why they attended an American school and contemplated whether she should pursue something else (Rawaa, personal communication, December 13th, 2023).

During the remaining semester subjects, Rawaa succeeded in math (pre-calculus), earning an A. She performed well in physics (General physics), ultimately receiving a B grade. Although she felt some disappointment in herself and was not entirely satisfied with the grade, she accepted it as it was. As our conversation continued about her third-semester classes, Rawaa said she had not been very involved this semester due to a loss of motivation and overwhelming exhaustion. Despite her best efforts, she felt her hard work went unappreciated, especially when working in groups where most students received similar marks.

This led her to request to work individually, but the teacher refused. Furthermore, Rawaa shared that she faced pressure from her family, who constantly pushed her to study harder. She mentioned feeling burdened by the high expectations placed upon her as the top-ranked student in the class, which sometimes made her dislike attending school and fostered negative feelings toward her teachers and colleagues.

4.7. Rawaa Challenging in School

The school has established predetermined class schedules and timings for the current semester. Due to a shortage of teachers in grade 12, Rawaa has been assigned early morning classes starting at 7:00 a.m. and late afternoon classes until 3:00 p.m. Rawaa has shared her struggles with active participation and engagement in the classroom, stemming from previous experiences of humiliation and disappointment with teachers during the first two semesters of the academic year. Moreover, she felt older students needed to value her comments and contributions. However, Rawaa occasionally enjoys lab-related classes, such as chemistry, where practical experiments are limited due to defective materials. Regrettably, the school's labs, including those for physics and biology, suffer from inadequate resources, as teachers, students, and lab technicians have voiced concerns about their poor condition and the shortage of materials and equipment.

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Rawaa also explained that in grade 12, teachers strictly follow a predetermined syllabus, leaving little room for student input. This rigid curriculum minimizes student involvement. In the classroom, Rawaa only speaks when she feels confident about the topic being discussed. Unfortunately, she faced additional challenges this semester, as she got into trouble with the teachers due to inconsistent behavior and a lack of understanding of the school system, as evidenced by the chemistry teacher sending a violation through this system to her father. This has caused trouble with her father, who confiscated her phone after a chemistry teacher complained about her. As the youngest student, Rawaa needs help participating effectively and earning respect in group projects and with teachers.

Rawaa also shared her difficulties with non-class subjects, particularly in religion. Being a non-Arab student, she feels overwhelmed by the abundance of information, especially in Islamic studies. Rawaa openly acknowledges her struggles with this subject and reveals that she received low exam scores from the MOE.

4.8. Rawaa's Relationship with Her Family

Rawaa reported that she had discussed the issues of bother and humiliation with her father. Her father was willing to arrange a meeting with the principal and her teachers, but Rawaa declined the offer. She did not want to cause further stress to the teachers she might face again. Additionally, she did not want to allow the teachers to claim, "Dad had to handle the situation because I could not handle it myself" (Rawaa, personal communication, May 13, 2023). Rawaa mentioned that she gathered the courage to approach her teachers and emphasized, "I am a student at this school, just like everyone else. I deserve to be treated with respect and not be humiliated" (Rawaa, personal communication, May 13, 2023).

During the discussion about her father's involvement, Rawaa expressed that her family plays a significant role in her education. They want her to focus solely on school, not on work. Her older sister has a strong influence on her and is concerned about her well-being, both mentally and physically. Regarding school support, Rawaa remarked, *"Teachers will be teachers; some are good, and some are bad... Teachers should be passionate about what they are teaching. If they lack passion, they cannot share it positively with others. Teachers should display more compassion and interest in the students they work with" (Rawaa, personal communication, May 13, 2023).*

When asked about her progress over the past year, Rawaa mentioned that she had gained independence in her learning and how she approached education. If she is not interested in her classes, staying engaged and keeping up with assignments becomes challenging. Dealing with mistreatment, she has learned to stand up for herself early on and prevent the situation from escalating. Rawaa concluded the conversation with a couple of additional comments. She expressed her interest in possibly returning home to continue her studies in the United States. She misses her home, her mother, and her extended family. Rawaa believes that she has the right to choose her path without the pressure and expectations imposed by her father, as she will soon turn 18 and be in America. She wants to exercise her right to decide her future and major without any interference or stress from her father. She closed by saying,

"It is challenging to fit into a school or a college or major in the future if you do not match the norm, she concluded. If you do not 'Cowboy Up,' you do not receive much support at this school, according to Rawaa in a personal communication on May 13, 2023."

She giggled when I asked her about "*Cowboy Up," "You know, cowboy boots, snug jeans, button-down shirts, and either a cap not turned backward or a cowboy hat." I then pleaded with her, "Rawaa."* Please elaborate further.

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As for the phrase "Cowboy Up," Rawaa explained that it refers to a cultural expression associated with cowboys and influenced by the American West. It signifies toughness, resilience, and determination to face challenges. "Cowboy Up" encourages individuals to stay strong, persevere, and confront challenges with bravery and a positive mindset, much as cowboys did in the Old West. It emphasizes tackling obstacles head-on, displaying unwavering strength, and maintaining a determined spirit (Rawaa, personal communication, May 13, 2023)

4.9. Notes of Discovery for Rawaa

Rawaa, an 8th-grade student in the United States, faced the challenge of juggling two complex subjects —English and Chemistry —at the college level. However, adjustments had to be made to ensure she could complete her grade 12 academic year. Moving to a new country with her family gave Rawaa a sense of security, alleviating concerns about basic needs like food. Her family, especially her supportive father, provided her with the financial means to have everything she needed and more, even attending an expensive school in Alain. Despite most of the students in her school coming from affluent backgrounds, Rawaa never felt inferior; she often found herself with more than her peers.

Nevertheless, Rawaa encountered difficulties with some teachers who humiliated her. Although she never sought school resources or services to guide her through her rights during the grade 12 academic year, her stress and frustration were evident. She received advice from various teachers, each with their own agenda and approach. The teachers should cooperate with Rawaa, who is preparing for grade 12, and provide her with the necessary guidance. To illustrate, registration for a Chemistry class required a minimum level of mathematical competency, which she had not yet met. Nowadays, Rawaa's intelligence and cheerful disposition, along with sufficient guidance, advice, and assistance from her school, teachers, and fellow family members, can help her become a successful student and enjoy her grade 12 experience thoroughly.

This chapter presents data from interviews with 12 Grade 12 students as part of the research project on the OQA of chemistry students in the UAE. This study applied methods such as observation and recording of students' work, teachers' interactions, and non-verbal cues. The subjects were students from an American school in Al Ain, which I selected because of my familiarity with the school as a former head of the department for 10 years. Additionally, school systems, lab records, student work, and teacher plans were re-examined. The interviews aimed to explore the challenges students meet in grasping organic quantitative analysis, one of the most important topics in a chemistry course.

The motive for organizing these interviews was to gain a clearer understanding of the challenges grade 12 students may face in their final high school years. Reflective observations and documentation captured personal thoughts, experiences, and unspoken reactions to the interview questions. A triangulation approach was employed to analyze the data, utilizing three methods:

I. Observation of the eight student participants

II. One focused interview with a unique student case study telling her story, and an interview with eight students

III. Review of teacher and student documents

Through repeated readings and content analysis, 15 nodes and three emergent themes were identified. The nodes were automatically gathered and organized into a hierarchical structure for in-depth analytical coding aligned with the research questions. The final structure and scaffold of the hierarchical layout for all nodes were generated.

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Apart from the interviews with students, additional information was gathered from two chemistry teachers in an informal setting, treating them as colleagues and friends rather than following a formal interview format. The interviews with students were transcribed, and the data were analysed using NVivo 12 software to identify patterns and themes.

4.10. Case Study Findings

This section presents the key findings from Rawaa's case study, focusing on the challenges she faced in learning Organic Qualitative Analysis (OQA) and the factors that influenced her learning experience.

4.10.1. Language Barriers and Academic Performance

Rawaa's language proficiency, particularly in Arabic, is a critical factor in her learning experience. The literature review supports this observation, emphasizing the role of language in science education (Alieto, 2018; Beka, 2016). Rawaa's struggles with her chemistry teacher, who predominantly uses Arabic, underscore the importance of effective communication in the classroom. Moreover, Rawaa's plea for the teacher to explain in English, her preferred language, and the teacher's subsequent negative response align with studies on teacher-student communication and its impact on student engagement and motivation (Wentzel, 2002; Pianta et al., 2003). According to Varga (2017), previous research has reported a positive association between instructors and learners, which serves as a critical predictor of academic progression and engagement. In developing a conducive learning environment, a positive relationship between teachers and students emerges as a potent medium. Students who perceive greater support from their teachers tend to attain improved academic outcomes

Consequently, teacher education students should receive explicit instruction on academic language, coupled with ample opportunities to enhance their proficiency in its usage (Vander Merwe, 2018). As investigated by Beka (2016) and Alieto (2018), the impact of language competencies on understanding is particularly relevant in the Emirati context, where diverse linguistic backgrounds may influence students' development of science concepts.

4.10.2. Teacher-Student Relationships

The dynamics between Rawaa and her teachers play a pivotal role in shaping her academic experience. The challenges she faces with her chemistry teacher, including feelings of humiliation and a lack of understanding regarding her unique needs, resonate with the broader literature on teacher-student relationships (Roorda et al., 2011; Hughes et al., 2012). According to Roorda et al. (2011), significant attention has been given to TSRs (affective teacher-student relationships) to facilitate students' adjustment in schools. The quality of the TSRs is positively correlated with reduced behavioral problems, improved social functioning, higher academic achievement, and greater engagement in learning activities. Similarly, Hughes et al. (2012) cite longitudinal research indicating that teachers who create a supportive relationship with their learners have a positive impact on academic and behavioral pursuits. The absence of adequate support systems within the school, as evidenced by the inadequate resources in the labs and the rigidity of the curriculum, further compounds Rawaa's difficulties. This aligns with studies emphasizing the significance of supportive environments for student success (Deci et al., 1991; Eccles & Roeser, 2015).

4.10.3. Limited Laboratory Resources and Practical Learning

Another significant challenge for Rawaa was the lack of access to adequate laboratory resources. The absence of adequate support systems within the school, as evidenced by the limited lab resources and the rigidity of the curriculum, further compounds Rawaa's difficulties. This aligns with

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studies emphasizing the significance of supportive environments for student success (Deci et al., 1991; Eccles & Roeser, 2015).

4.10.4. Academic Support and Coping Strategies

Despite these limitations, Rawaa sought other solutions to her problems. She approached another chemistry teacher, who was more open to communicating with her in English. This shift in support enabled Rawaa to enhance her performance in the second semester. The teacher provided her with the direction and resources she needed to catch up on missed material and prepare for her examinations. As per the analysis by Deci et al. (1991), teachers fostering students' autonomy lead to an understanding of students' cognitive standpoint and elevate motivation. The recommended support for self-determination comprises teachers offering students choices, minimizing constraints, validating their academic pursuits and emotions, and providing them with the necessary knowledge to execute tasks. Similarly, Eccles and Roeser (2015) explain that schools, as intricate multi-level entities, impact the social-emotional, academic, and behavioral development of students through 103 diverse mechanisms. In such a context, teachers directly affect student achievement, which is linked to motivation and instructional quality. According to Boesdorfer (2019), chemistry educators at different educational levels play a critical role in shaping students' futures, as they may pursue careers as STEM professionals, chemical engineers, and chemists. The inclusivity and effectiveness of their teaching substantially impact the students' interests and success in chemistry. However, teaching chemistry is a multi-faceted process that mandates an in-depth understanding of the chemistry content, student dynamics, assessment approaches, and instructional methodologies.

4.10.5. Themes Identified in the Case Study

Through Rawaa's case study, several themes emerged that highlight the broader challenges students face in learning OQA:

- Language Proficiency: Language barriers significantly impact students' ability to understand and engage with complex scientific material.
- Teacher-Student Relationships: Supportive teacher-student dynamics are crucial for student success, while strained relationships can lead to disengagement and poor performance.
- Practical Learning Opportunities: The lack of laboratory resources and practical-based instruction limits students' ability to grasp abstract concepts in OQA.
- Academic Support Systems: Access to additional support from teachers and resources can help students overcome challenges and improve their academic outcomes

5. Discussion

5.1. Interpretation of Findings

The findings of Rawaa's case study reveal numerous major aspects that influenced her comprehension of Organic Qualitative Analysis (OQA). Language obstacles, her relationship with her chemistry teacher, and a lack of hands-on learning opportunities surfaced as major themes throughout her experience. These findings are consistent with the research goals that guided this study, specifically the obstacles students have when learned OQA and the tactics that can be used to improve comprehension.

5.1.1. Language Proficiency and Classroom Communication

Language proficiency was identified as one of the most important influences on Rawaa's learning experience. Rawaa, a transfer student with low Arabic ability, struggled to keep up with chemistry lectures that were mostly taught in Arabic. This not only hampered her capacity to grasp essential

OQA ideas but also caused irritation and disengagement. Research indicates that language barriers can significantly affect students' academic performance, especially in complex subjects such as chemistry (Alieto, 2018; García, 2009).

Rawaa's experience underscores the importance of effective communication in school. When teachers fail to meet students' linguistic demands, the teacher-student relationship can deteriorate, as Rawaa's tense interactions with her chemistry teacher show. This finding is consistent with previous research highlighting the importance of supportive teacher-student connections in boosting academic success and student engagement (Wentzel, 2002; Roorda et al., 2011).

5.1.2. Teacher-Student Relationships

Rawaa's strained relationship with her chemistry teacher persisted throughout the case study. The teacher's refusal to provide explanations in English, combined with a general lack of support, contributed to Rawaa's disinterest in the subject. This tense connection had a significant impact on her academic performance, leading to a hatred for both the topic and her teacher. The literature on teacher-student interactions highlights the importance of positive connections in increasing student engagement, motivation, and academic accomplishment (Hughes et al., 2012). When teachers fail to foster supportive

In contrast, when Rawaa received assistance from another chemistry teacher who interacted with her in English, her performance and confidence improved, demonstrating the value of tailored help and positive teacher relationships. This outcome reinforces prior studies on the relevance of teacher autonomy and flexibility in satisfying students' needs (Deci et al., 1991).

5.1.3. Practical Learning Opportunities

Rawaa's restricted access to laboratory resources posed another important hurdle in her efforts to understand OQA. Practical learning is necessary for students to gain a better knowledge of chemical principles. Unfortunately, Rawaa's school was unable to provide adequate laboratory experiences due to outdated equipment and a lack of chemicals. This lack of hands-on learning experiences hampered her capacity to apply theoretical information, a finding consistent with the larger literature on science education, which emphasizes the significance of practical-based training (Hofstein, 2005; Russell & Weaver, 2011).

The inadequacy of laboratory equipment in Rawaa's case reflects a broader issue in UAE scientific education, where limited resources often prevent students from participating in meaningful, hands-on learning opportunities. Previous research has underlined the importance of educational reforms to bridge these resource disparities, as practical learning environments are crucial for student achievement in science disciplines such as OQA (Abd-El-Khalick & Lederman, 2000).

5.1.4. Unexpected Results and New Insights

Rawaa's example revealed an unexpected finding: cultural and contextual factors had a substantial impact on her academic experience. Rawaa, a transfer student from an American school, encountered additional challenges in adjusting to the cultural and educational environment at her new school in the UAE. Her struggle to manage her school's cultural norms, particularly language difficulties and instructor expectations, highlights the larger challenge of cultural adaptation in educational contexts (Ward & Kennedy, 1993; Berry, 2006).

Rawaa's experience underscores the importance of schools providing more comprehensive support to kids from diverse educational and cultural backgrounds. This conclusion implies that, in addition to addressing language barriers and resource constraints, schools should also evaluate the cultural and social factors that influence students' academic achievement.

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5.2. Summary of Key Points

- Language Barriers: Rawaa struggled to understand chemistry lectures provided in Arabic, a language she could not speak fluently. This language barrier, combined with her teacher's lack of support, made it difficult for her to understand crucial ideas in OQA.

- Teacher-Student Dynamics: Rawaa's experience emphasized the significance of strong teacher-student interactions. Her bad encounters with her chemistry teacher aggravated her difficulties, whereas the assistance she received from another teacher who spoke English greatly improved her understanding and confidence.

- Practical Learning Limitations: Rawaa faced major challenges due to limited access to well-equipped laboratory resources. Without real, hands-on experience, her understanding of OQA was mostly theoretical, limiting her ability to fully learn and apply the principles.

5.3. Relation to Existing Literature

The findings of this case study corroborate much of the existing literature on the difficulties of studying OQA and the factors that determine students' success in scientific education. Previous studies have shown that practical-based learning and teacher-student connections are important (Boesdorfer, 2019; Roorda et al., 2011). However, this case study offers new insights by highlighting the specific problems students face in the UAE, where language barriers and cultural adaptation play a significant role in shaping the educational experience.

Furthermore, this study emphasizes the need for tailored support and instructor autonomy to meet students' specific learning requirements. This case study examines Rawaa's experience in depth, offering a nuanced view of how factors such as language proficiency, teacher relationships, and practical learning opportunities interact to shape students' success in OQA. These findings have important implications for educators and policymakers seeking to improve scientific education in the UAE.

5.4. Significance of the Findings

This case study emphasizes the need for a comprehensive strategy to address the obstacles high school students in the UAE encounter when learning OQA. It emphasizes the need to address language barriers in multilingual classrooms, provide instructors with the necessary tools and professional development, and increase access to practical laboratory experiences. These findings have important implications for educators, policymakers, and curriculum developers seeking to improve chemistry instruction in resource-constrained settings.

6. Conclusion, Recommendations, and Limitations

6.1. Conclusion

The findings from Rawaa's case study shed light on the elements that influence high school students' knowledge of Organic Qualitative Analysis (OQA) in the UAE. Throughout her journey, language barriers, insufficient instructor support, and a lack of practical learning opportunities emerged as major challenges to her academic achievement. These findings are relevant because they illustrate broader challenges students face in similar circumstances, particularly in environments with substantial language diversity and limited resources.

6.2. Recommendations

6.2.1. Recommendations for Practice

1. Enhancing Teacher Support: Teachers should receive continual professional development geared toward fostering inclusive and supportive classroom environments. Training programs should

emphasize the importance of linguistic accommodations and the building of healthy teacher-student connections to achieve higher academic achievement.

2. Enhanced Practical Learning Opportunities: Schools should prioritize the availability of well-equipped laboratories and incorporate hands-on experimentation into their curricula. Where physical resources are limited, virtual labs and simulations can help bridge the gap between theory and practice.

3. Language Support in Multilingual Classrooms: To alleviate the language obstacles experienced by children like Rawaa, schools should create bilingual or language-support programs that allow students to access chemistry information in their preferred language. Teachers should be educated to present content in their students' native and secondary languages.

6.2.2. Recommendations for Further Research

Future research may delve deeper into specific interventions and their impact on students' conceptual understanding of OQA. Hence, it can be concluded that addressing the identified challenges in teaching OQA requires a comprehensive and collaborative approach. This includes professional development for teachers, resource allocation, language support for students, and thoughtful curriculum design. Theoretical frameworks and insights from educational scholars can guide the development of interventions and strategies to enhance the teaching and learning of OQA in high school chemistry classes. Rawaa's journey provides valuable insights into the multifaceted nature of students' experiences in the academic realm. By critically examining her case in the context of existing literature, we gain a deeper understanding of the challenges she faces and the broader implications for educational practices

6.3. Limitations

While this study sheds light on students' experiences with OQA learning in the UAE, it also acknowledges its limitations. Firstly, the research focuses on a single international school in Al Ain. This limits the generalizability of findings to the broader UAE educational landscape with its diverse range of schools and curricula. Secondly, the study relies on 106 students self-reported experiences through interviews and observations. While valuable, this approach can introduce bias as students may not always accurately reflect on their learning or challenges. Finally, the chosen qualitative case study methods, while insightful, don't directly assess students' actual understanding of OQA concepts. This limits the ability to measure the effectiveness of teaching approaches or identify specific knowledge gaps.

Declarations

Author Contributions. Manal Almahdawi: Corresponding author, methodology, data curation, formal analysis, writing – original draft, review and editing; Ahmad Qablan: Editing, manuscript preparation, methodology, critical revisions, and supervision; Fatema Alyammahi: Conceptualization, methodology, data analysis, validation. review, editing, and formal analysis. All authors agreed with the results and conclusions

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Appendix I.

Appendix A: Interview Questions for Rawaa

1. Can you describe your overall experience learning Organic Qualitative Analysis (OQA)?
2. What specific challenges did you face in understanding the concepts in OQA?
3. How did language impact your ability to follow the chemistry lessons?
4. How would you describe your relationship with your chemistry teacher? Did this relationship affect your learning?
5. Were there any specific resources (textbooks, lab materials) that you felt were lacking or inadequate?
6. What strategies did you use to overcome these challenges?
7. Was there any additional support that helped you improve your performance in chemistry, particularly in OQA?

Appendix B: Observation Checklist

Classroom Observation for Rawaa

- Teacher-student interactions:
  - Did the teacher provide explanations in multiple languages?
  - How did the teacher respond to student questions?
- Student engagement:
  - Was Rawaa actively engaged in the lesson?
  - Did she ask questions or request clarification?
- Practical activities:
  - Was there any hands-on lab work during the session?
  - Were the necessary materials (chemicals, reagents) available for the practical tasks?

Appendix C: Document Analysis

Documents Reviewed

- Rawaa's class notes: Handwritten notes on Organic Qualitative Analysis concepts, including functional group identification.
- Teacher feedback: Comments provided by the chemistry teacher on Rawaa's assignments and quizzes.
- Lab report: Rawaa's submitted lab report on OQA practical experiments.

Appendix D: Consent Form for Case Study Participation

Consent to Participate in Research

Participant Name: _____
Date: _____

I, [Participant's Name], voluntarily agree to participate in the research study titled *"A Case Study on the Challenges and Strategies in Learning Organic Qualitative Analysis: The Story of Rawaa."* I

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understand the purpose of this study and the data collection methods, which include interviews, classroom observations, and document analysis. I am aware that my identity will be kept confidential, and I have the right to withdraw from the study at any time without consequence.

Signature: _____

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