PRACTICE OF TEACHING CHEMISTRY IN THE ENGLISH MEDIUM SCHOOL IN BANGLADESH

By

Nayma Momtaz
ID: 22157003

A thesis submitted to the BRAC Institute of Educational Development in partial fulfillment of the requirements for the degree of
Master of Education in Educational Leadership & School Improvement

BRAC Institute of Educational Development
BRAC University
January 2025

Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

Nayma Momtaz

Nayma Momtaz
ID 22157003

Approval

The thesis/project titled **"Exploring the Practice of Teaching Chemistry in Grades 7–9 in English Medium Schools in Bangladesh**" submitted by

Nayma Momtaz (22157003)

of Spring, 2024 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Education in Educational Leadership & School Improvement on January, 2025.

Examining Committee:

Supervisor:
(Member)

_____

Dr. Dilruba Sultana
Senior Lecturer, BRAC Institute of Educational Development

Program Coordinator:
(Member)

_____

Dr. Manjuma Akhtar Mousumi
Assistant Professor & Head of Academics, BRAC Institute of Educational Development

External Expert
Examiner:
(Member)

_____

Saraf Afra Salsabil
Senior Curriculum Developer, BRAC Institute of Educational Development

Head of the Institute:

_____

Dr. Erum Mariam
Executive Director, BRAC Institute of Educational Development

Ethics statement

This study adhered to ethical research principles to ensure the integrity and confidentiality of all participants. Prior to data collection, informed consent was obtained from all participants, including teachers and school administrators, ensuring they were fully aware of the research objectives, procedures, and their rights to withdraw at any point without consequence. Pseudonyms were used to maintain anonymity and protect the identities of participants and institutions involved in the study.

The research was conducted with the approval of relevant institutional authorities, and care was taken to minimize any disruption to regular school activities during observations and interviews. All data collected were securely stored and used solely for academic purposes.

Efforts were made to avoid bias and ensure that the findings reflect an honest and accurate representation of participants' experiences and perceptions. The research adhered to the principles of respect, integrity, and transparency to contribute positively to the field of education.

Abstract

This study investigates the strategies employed by Chemistry teachers in English medium high schools in Bangladesh, particularly in Edexcel and Cambridge curriculum-aligned institutions. Using qualitative methods, including interviews, classroom observations, and discussions, the research explores teaching practices, resources and challenges. Findings reveal that teachers rely primarily on Edexcel-certified textbooks and online resources, supplementing lessons with worksheets and handouts. Despite the use of interactive and conceptual teaching strategies, challenges such as explaining abstract concepts, maintaining student motivation, and addressing diverse learning needs persist. Teachers emphasize professional development, including lab training and workshops, to improve instructional quality. Limited lab facilities in some schools and a grade-focused system further complicate teaching effectiveness. This study underscores the need for targeted teacher training, improved resources, and inclusive strategies to enhance Chemistry education and foster equitable learning outcomes.

Dedication

This thesis is dedicated to my beloved father, whose unwavering love, guidance, and sacrifices have been the cornerstone of my life. Though you are no longer with us, your memories continue to inspire me every single day.

Every step of this journey has been taken with you in my heart, and this work is a tribute to your enduring legacy and the dreams you nurtured for me.

May you rest in eternal peace.

Acknowledgement

I would like to express my deepest gratitude to all those who have supported me in completing this thesis. I am profoundly thankful to my supervisor, **Dr. Dilruba Sultana**, for her invaluable guidance, insightful feedback, and constant encouragement throughout this journey. I also extend my sincere thanks to **Mr. Ali Karam Reza** and **Mr. A.K.M. Enayet-Ullah**, the principals of the schools whose teachers participated in this research, for their kind cooperation and support. I am particularly grateful to the dedicated teachers who shared their time and valuable insights, making this study possible. Finally, I would like to thank my family and colleagues for their unwavering encouragement, which has been my strength throughout this endeavor.

Table of Content

CHAPTER 1

1.1 Introduction:

Chemistry, a fundamental branch of science, plays a crucial role in understanding the world around us and paves the way for various technological advancements (Bakar et al., 2020). However, the teaching and learning of chemistry often pose significant challenges due to its abstract and theoretical nature (Kala et al., 2021). As Johnstone (1991) emphasized, the effectiveness of Chemistry education depends largely on the strategies employed to simplify abstract ideas and promote student engagement. This research seeks to explore and evaluate the teaching strategies used in these schools, aiming to identify practices that empower teachers and enhance student learning outcomes.

English medium schools in Bangladesh follow four main types of curricula: the National Curriculum in English Version, the British curriculum, the American curriculum, and the International Baccalaureate (IB) curriculum. The National Curriculum in English Version includes subjects such as Bangladeshi history, science, mathematics, and English, offering a blend of local and global perspectives (Islam et al., 2022). The British curriculum provides students with a wide range of subject options, enabling them to specialize in their areas of interest and prepare for higher education internationally (Cambridge Assessment International Education, 2023). It offers programs like IGCSE and A Levels. The American curriculum aims to nurture well-rounded students with an emphasis on creativity, collaboration, and leadership (Adams, 2021). It includes Advanced Placement (AP) courses, a strong focus on extracurricular activities, and the development of practical skills. The IB curriculum encourages students to think critically and develop global perspectives, preparing them for success in an interconnected world (International Baccalaureate Organization, 2023). It is structured into three levels: the Primary Years Programme (PYP), Middle Years Programme (MYP), and Diploma Programme (DP).

Effective teaching strategies are pivotal in enhancing students' understanding, engagement, and interest in chemistry (Chu & Treagust, 2014). A few important chemistry strategies include inquiry-based learning, the use of technology, contextual teaching, and collaborative learning. Inquiry-based learning encourages students to

explore, ask questions, and develop solutions through experimentation. It aligns with the scientific method, making it a natural fit for teaching chemistry (Hofstein & Lunetta, 2004). Integrating in chemistry teaching, such as simulations, animations, and virtual labs, enhances conceptual understanding. Technology also provides access to diverse resources, enabling personalized and differentiated instruction (Smetana & Bell, 2012). Contextual teaching links chemistry concepts to real-life applications, making learning more relevant and engaging. This strategy fosters motivation and aids long-term retention (Gilbert, 2006). Collaborative learning involves group activities where students work together to solve problems, conduct experiments, or discuss concepts. This approach can also address individual knowledge gaps through shared understanding (Johnson & Johnson, 2009).

However, the implementation of the strategies of teaching Chemistry in the context of English medium schools in Bangladesh may face unique challenges. Firstly, the conceptual challenges, this subject involves in explaining the abstract concepts which can hinder the teaching and engagement with the subject (Johnstone, 1991). Secondly, in explaining the mathematical problems, it could be harder for educators to assist students in bridging the knowledge gap between chemical principles and mathematical concepts (Barker & Millar, 2000). Thirdly, the safety of the laboratory, there are risks associated with executing experiments in the chemistry lab, and teachers may find it difficult to make sure students comprehend and abide by safety procedures (Nicholson, 2001). Thirdly, limitations in the resources, the efficiency of chemistry instruction can be hampered by limited access to chemicals, laboratory equipment, and other resources, especially in institutions with tight budgets (Wenzel, 2008). Fourthly, the lack of interest, some students may find chemistry boring or unimportant to their lives, which would demotivate and disengage them. Instructors might find it difficult to pique students' interest and explain how chemistry is used in everyday life (Taber, 2013). Lastly, the technical vocabulary and complicated terminology used in chemistry can be very confusing to English language learners. In order to assist these students in accessing the material, teachers might need to use various strategies (Demircioğlu, 2018).

Apart from the specialized courses required for university degrees, chemistry is also taken as a minor or subsidiary subject for many other science major courses and as a necessary prerequisite for degrees in engineering, medicine, and agriculture (Haider, n.d.). Bangladeshi AS and A Level students also rank chemistry as one of their common subjects, according to Cambridge Assessment International Education.

This research seeks to explore the teaching strategies of Chemistry used in English Medium Schools, aiming to identify practices that empower teachers and enhance student learning outcomes.

1.2 Research topic:

Practice of Teaching Chemistry in the English Medium School in Bangladesh

Research title:

Exploring the Practice of Teaching Chemistry in Grades 7–9 in English Medium Schools in Bangladesh

1.3 Statement of the problem

In Bangladesh, English medium schools follow international curricula such as the Cambridge International Examinations (CIE) and Edexcel, offering subjects like Chemistry at the high school level. However, despite the growing popularity of English medium education, there is limited research in English-Medium Science education. As, Mousumi, M. A., & Kusakabe, T. (2017) highlighted that while English-medium schools in Bangladesh are an important sector of the private education system, research on their science curriculum and teaching practices, including chemistry education, remains sparse. There are also gaps in STEM education research. For instance, Sarkar, M., & Corrigan, D. (2014) noted a significant lack of localized research on STEM education in Bangladesh, particularly in the private English-medium sector, where science teaching methodologies, including chemistry, are often overlooked in educational research. There are curriculum challenges. Rahman, M. M. (2021) found that the curriculum design and pedagogical strategies for teaching science subjects, including chemistry, in English-medium schools in Bangladesh lack a strong research base and are underexplored in academic literature.

There is a deficiency in teachers training and resources. Like, Chowdhury, T. B. M., Holbrook, J., Reis, P., & Rannikmäe, M. (2021) discuss the inadequacy of teacher training and the lack of research-based approaches for improving chemistry education, particularly in the under-researched English-medium schools.

Lastly, there is a lack of context specific research in teaching chemistry in English Medium schools. As, Hossain, M. M., & Tarmizi, R. A. (2013) argue that while STEM education is a growing field of research globally, specific studies on chemistry education in English-medium high schools in Bangladesh are nearly absent, creating a significant gap in localized educational research.

This study seeks to investigate the current strategies used by Chemistry teachers in English medium from Grade 7 to Grade 9 in Bangladesh and examine the challenges they

face. The findings will provide insights into how teaching practices can be adapted to better meet the needs of students and improve learning outcomes in Chemistry.

1.4 Research questions:

1. What is the practice of teaching chemistry by the Chemistry teachers of Grade 7 to 9 in the English medium schools in Bangladesh?
2. What are the challenges faced in teaching the subject Chemistry by the Chemistry teachers of Grade 7 to 9 in Bangladesh?

1.5 Purpose of the study

The purpose of this study is to explore the strategies employed by Chemistry teachers of grade 7 to 9 in English medium schools in Bangladesh. Teaching Chemistry in this context involves addressing the dual challenges of subject complexity and language proficiency. According to Johnstone (1991), Chemistry is inherently abstract, requiring effective pedagogical approaches to simplify complex concepts and promote student understanding. In English medium schools, the additional layer of teaching in a non-native language can impact both teaching effectiveness and student comprehension. This study seeks to explore the teaching strategies currently in use and assess their effectiveness in facilitating learning outcomes.

This research also aims to identify the challenges faced by Chemistry teachers in English medium high schools in Bangladesh. Teachers often grapple with issues such as insufficient teaching resources, students' varying language proficiency levels, and the difficulty of maintaining student engagement with abstract concepts (Gabel, 1999). By examining these challenges, this study endeavors to provide practical insights and solutions to enhance both teaching and learning experiences. Addressing these barriers is crucial for fostering a more effective Chemistry education that aligns with students' needs and the curriculum's goals.

Ultimately, this study aspires to contribute to the improvement of Chemistry education in Bangladesh's English medium schools. By exploring teaching practices and understanding the challenges faced by educators, it aims to recommend strategies that can support both teachers and students. As highlighted by Shulman (1987), the pedagogical

content knowledge of teachers plays a critical role in shaping student success. The findings of this study will benefit educators, policymakers, and curriculum developers, providing evidence-based recommendations to strengthen Chemistry teaching practices and bridge gaps in the current educational framework.

1.6 Significance of the Study:

This study is crucial for improving Chemistry education in English medium schools in Bangladesh, particularly for grades 7–9, where students encounter foundational concepts critical for higher education and future careers. Chemistry, as an abstract and experimental subject, requires innovative teaching strategies that not only clarify theoretical knowledge but also demonstrate practical applications. The insights gained from this research can be implemented to address various challenges and transform the learning experience for students.

One significant outcome of this study is its potential to enhance teaching methodologies. By identifying and recommending effective strategies, such as inquiry-based learning, technology integration, and contextual teaching, the research provides a framework for Chemistry teachers to make lessons more engaging and comprehensible. Schools can implement these strategies through regular professional development workshops, equipping teachers with modern tools and techniques to facilitate better learning outcomes.

Language barriers, a prevalent challenge in English medium classrooms, are also addressed in this study. Students often struggle with understanding technical terms and abstract concepts in a second language. The research emphasizes the need for teachers to simplify complex terminology, incorporate visual aids, and use bilingual explanations when necessary. Schools can support this effort by developing supplementary materials, such as glossaries, concept maps, and multimedia resources tailored to students' linguistic needs.

The findings of the study also have implications for curriculum development. By integrating real-world examples, contextual problems, and opportunities for hands-on experimentation, curriculum developers can make Chemistry content more relevant and engaging. This approach ensures students not only grasp theoretical concepts but also

understand their practical applications, fostering a deeper interest in the subject and its potential career pathways.

Furthermore, the findings of this study have broader implications for education policymakers, curriculum developers, and stakeholders in Bangladesh. The recommendations drawn from this research can inform policies aimed at improving STEM education, fostering a generation of students equipped with the skills and knowledge to pursue careers in science and technology. By bridging gaps in teaching practices and addressing classroom challenges, this study can contribute to the overall enhancement of the educational landscape in Bangladesh.

Collaboration among stakeholders is another critical aspect emphasized by this study. Schools, educators, policymakers, and industry professionals can work together to ensure the effective implementation of recommended strategies. Regular evaluation of teaching practices, resource-sharing among schools, and partnerships with universities or science organizations can enrich the learning experience and provide additional support for teachers and students alike.

Lastly, the study addresses disparities in resource availability, particularly in under-resourced schools. Its findings can encourage targeted investments in laboratory facilities, digital tools, and teacher training programs, ensuring equitable access to quality education. Innovative solutions like virtual labs or mobile science units can bring practical Chemistry experiences to schools lacking traditional infrastructure, bridging resource gaps and promoting inclusivity.

In conclusion, this study holds significant potential for transforming Chemistry education in English medium schools in Bangladesh. By addressing teaching challenges, improving resource allocation, and informing policy development, it can enhance students' learning experiences and prepare them for success in STEM fields. Ultimately, these efforts contribute to building a skilled and knowledge-driven workforce aligned with national development goals.

CHAPTER 2

Literature Review of the Study

2.1 Literature Review:

The literature review explores key themes central to understanding and improving teaching Chemistry, particularly in English medium schools. It begins by providing a background on English medium education, highlighting its distinctive features and challenges. The discussion then transitions to strategies for teaching Chemistry, emphasizing the importance of tailoring methods to the subject's unique demands. The role of teaching resources, including laboratory equipment, digital tools, and open educational resources, is examined to assess their impact on the quality of education. Innovative strategies for enhancing student engagement and Chemistry learning are explored alongside the interplay between teaching practices and assessment in fostering effective pedagogy. The review also highlights the role of feedback and technology in refining instructional and evaluative methods, contextualizing these insights within the practices of Chemistry teaching in Bangladesh to identify localized challenges and opportunities.

2.1.1 Background of the English Medium School

The establishment of English-medium schools in Bangladesh was largely driven by the desire of the local elite and expatriate communities to meet their educational needs through the language, given its perceived higher quality of education and global usefulness.

Primary, secondary, and upper secondary English-medium schools in Bangladesh, especially in Dhaka, offer an alternative to private education as it is undeniable, though, that these schools are typically not subject to oversight by national education boards or other oversight organizations with regard to their curriculum, hiring practices, admissions standards, or tuition pricing. Therefore, they have a degree of autonomy that is unmatched by any other Bangladeshi educational system. On the one hand, English-medium schools might be helping to raise the bar for English-medium education and the language's popularity (Milon, M. R. K., Alam, M. R., & Hossain, M. R. ,2018). This

medium is also popular among the parents since, research revealed that the supply and demand of English Medium Schools among parents are symmetrical. Parents are being encouraged to send their kids to English Medium Schools due to the strategic business planning of them and market forces that highlight the shortcomings in the supply chain of Bangla-medium schools (Mousumi, M. A., & Kusakabe, T. 2017).

The establishment of English-medium schools in Bangladesh was largely driven by the desire of the local elite and expatriate communities to meet their educational needs through the language, given its perceived higher quality of education and global usefulness.

Primary, secondary, and upper secondary English-medium schools in Bangladesh, especially in Dhaka, offer an alternative to private education as it is undeniable, though, that these schools are typically not subject to oversight by national education boards or other oversight organizations with regard to their curriculum, hiring practices, admissions standards, or tuition pricing. Therefore, they have a degree of autonomy that is unmatched by any other Bangladeshi educational system. On the one hand, English-medium schools might be helping to raise the bar for English-medium education and the language's popularity (Milon, M. R. K., Alam, M. R., & Hossain, M. R. ,2018). This medium is also popular among the parents since, research revealed that the supply and demand of English Medium Schools among parents are symmetrical. Parents are being encouraged to send their kids to English Medium Schools due to the strategic business planning of them and market forces that highlight the shortcomings in the supply chain of Bangla-medium schools (Mousumi, M. A., & Kusakabe, T. 2017).

2.1.1.1 Influence of the School Environment on Teaching Chemistry

The school environment plays a pivotal role in shaping students' learning experiences and outcomes in Chemistry education, particularly in grades 7 to 9. Research highlights that well-equipped laboratory facilities are essential for fostering a deep understanding of Chemistry concepts. Hofstein and Lunetta (2004) emphasize that hands-on experiments not only enhance comprehension of abstract ideas but also spark greater interest in the subject. Conversely, the absence of adequate lab resources hampers experiential learning opportunities and diminishes student engagement. Beyond physical resources, the

classroom environment significantly impacts academic achievement. Fraser and Walberg (2005) argue that positive teacher-student interactions, peer collaboration, and innovative teaching approaches create an interactive and supportive learning climate, encouraging participation and critical thinking in Chemistry. Furthermore, the role of broader school support systems, such as teacher professional development, extracurricular science activities, and access to resources, cannot be overstated. Osborne et al. (2003) point out that initiatives like science fairs, Chemistry clubs, and counseling services enhance student motivation and performance by providing avenues for exploration beyond traditional curricula. Collectively, these studies underscore the multifaceted influence of the school environment on fostering curiosity, understanding, and success in Chemistry education.

2.1.1.2 The Role of Facilities in Enhancing Teaching Chemistry

Facilities for teaching Chemistry in middle school play a critical role in shaping students' understanding, engagement, and academic achievement. Adequate laboratory facilities are fundamental to providing experiential learning opportunities that allow students to connect theoretical concepts with real-world applications. Hofstein and Lunetta (2004) emphasize that well-equipped labs enable hands-on experiments, fostering curiosity and deeper comprehension of abstract Chemistry topics. In addition to laboratories, multimedia tools and digital technologies have become vital in enhancing Chemistry education. According to Srisawasdi (2012), integrating virtual labs and simulations complements physical experiments, helping students visualize complex chemical processes more effectively. Classroom facilities, such as access to modern teaching aids like projectors and smart boards, also significantly influence Chemistry instruction. Raman and Yamat (2014) note that these tools improve teacher-student interactions and make lessons more engaging and interactive. Furthermore, the availability of instructional materials, such as textbooks, charts, and models, is crucial for effective teaching. Ayodele (2012) highlights that schools with a consistent supply of teaching resources demonstrate better student outcomes compared to those with inadequate materials. Collectively, these studies underscore the importance of well-rounded facilities in fostering an effective and stimulating Chemistry education for grades 7 to 9.

2.1.1.3 The Impact of Qualified Teachers on Effective Teaching Chemistry

In order to properly teach chemistry to pupils in grades 7 through 9, qualified and experienced teachers are essential. Studies consistently emphasize that teacher expertise directly influences students' understanding of complex Chemistry concepts. Shulman (1986) highlights that teachers' subject matter knowledge and pedagogical skills are essential for simplifying abstract concepts and fostering critical thinking. Additionally, qualified teachers are better equipped to employ innovative teaching strategies, such as inquiry-based learning and problem-solving approaches, which are particularly effective in Chemistry education (Kind, 2009). Professional development programs also play a significant role in improving teaching quality. Garet et al. (2001) argue that ongoing training enhances teachers' ability to adopt modern pedagogical techniques and integrate technology into Chemistry instruction. Furthermore, the teacher-student relationship is critical for academic success. Fraser and Walberg (2005) found that skilled teachers who establish a positive and interactive classroom environment promote better engagement and higher achievement among students. These findings underscore the importance of investing in teacher training and qualifications to ensure high-quality Chemistry education for middle school students.

2.1.2 Strategies of teaching Chemistry

Teaching Chemistry effectively often involves employing various strategies to engage students and promote deep understanding of the subject matter. The types of the important strategies in teaching Chemistry are as follows:

2.1.2.1 Laboratory Practices on Conceptual Understanding, Student Engagement, and Academic Performance in Chemistry Education

For example, hands-on laboratory experiences allow the students to actively explore chemical concepts and practical skills as by fusing theory with practical applications, laboratory work improves understanding (American Chemical Society [ACS], 2012). In order to determine whether computer modeling enhanced hands-on chemistry laboratories or computer modeling alone is more beneficial in helping high school

students grasp chemistry concepts, a study is conducted to test this hypothesis and the findings demonstrated that, in terms of fostering students' conceptual understanding, computer modeling in conjunction with hands-on laboratories was more successful than either approach alone. It was also discovered that there is a statistically significant correlation between students' conceptual understanding and their perception of scientific models as replicas (Liu, X. ,2006). Similarly, in 2007, an investigation is done to find out the relationship between demonstrations of laboratory experiments by teachers and hand-on experiments by students. The outcomes show that conceptual understanding increased in both students conducting the laboratory experiment and students watching the demonstration-laboratory. But there was no discernible difference in the conceptual understanding of the two groups (teacher's demonstrations of laboratory experiments and student's hands-on experiments), suggesting that students learn essentially the same from both approaches and that the demonstration laboratory at least has no negative conceptual effects on the students (McKee, E., Williamson, V. M., & Ruebush, L. E. ,2007).
A study was conducted by Logar, A., & Savec, V.F. (2011) which focuses on comparing the effectiveness of two types of experimental work: teacher-led lecture demonstrations and student-led hands-on work. The findings show that, when compared to students' knowledge gained through hands-on experimental work, students' content knowledge gained through the teacher's demonstration of an experiment is better and knowledge retention occurs more effectively. But according to the majority of students surveyed, doing experiments on their own was preferable to watching a teacher demonstrate (Logar, A., & Savec, V. F. 2011). Another study was done to determine how guided inquiry laboratory experiments affect students' attitudes toward Chemistry labs, their anxiety related to them, and their academic performance in the lab. The results of the paper show that the applications have significantly improved students' attitudes toward chemistry labs, their academic performance, and their anxiety related to them (Ural, E. ,2016). Current research is done with the goal of hands-on practical Chemistry activities, to examine students' Chemistry engagement, experience, and academic performance. Research design for the study was descriptive. The outcomes showed that students are interested in the practical work in Chemistry and have a good experience and perception of it (Iyamuremye, A., Nsabayez, E., Ngendabanga, C., & Hagenimana, F. ,2023).

2.1.2.2 Teaching Chemistry Through Demonstrations, Visualizations, and Virtual Laboratories

Demonstrations and visualizations can be a strategy to teach Chemistry because students can better understand abstract concepts and draw connections between various chemical phenomena by using demonstrations and visualizations, such as molecular models, animations, and videos (Talanquer, 2010). There was an investigation which looked into whether students' conceptual understanding was improved by particulate animations or video demonstrations, as well as whether there were any differences in the order in which the visualizations were presented—video or animation first. Following each visualization, the students' performance improved. Remarkably, responses improved significantly between the first and second visualization. This work does not suggest a preferred order, but rather emphasizes the value of combining the two types of visualizations (Velázquez-Marcano, A., Williamson, V. M., Ashkenazi, G., Tasker, R., & Williamson, K. C. 2004). A research project was looked at how molecular model building and multi-representation viewing using the computer-based visualizing tool eChem helped students gain an understanding of chemical representations. Over the course of six weeks, 71 eleventh graders at a small public high school participated in the collection of data from multiple sources. The analysis of the project revealed that several features in eChem helped students construct models and translate representations. Students who were highly engaged in discussions while using eChem made referential linkages between visual and conceptual aspects of representations. This in turn may have deepened their understanding of chemical representations and concepts. The findings also suggest that computerized models can serve as a vehicle for students to generate mental images (Wu, H. K., Krajcik, J. S., & Soloway, E. ,2001). The sub-microscopic level in chemistry is outside of the student’s experience level, they struggle the most to understand it. There is a study which demonstrates how to use a virtual laboratory effectively to bridge the conceptual divide between the aforementioned levels. The educational experiment's findings displayed that, when it comes to learning outcomes, virtual laboratories outperform science classrooms devoid of dynamic visual aids. The dynamic visualization

function of virtual laboratories enhances knowledge and facilitates efficient learning of chemistry (Herga, N. R., Čagran, B., & Dinevski, D., 2016).

2.1.2.3 Active Learning in Enhancing Student Engagement and Performance in Teaching Chemistry

Active Learning can be techniques to teach chemistry, since, implementing active learning techniques such as group discussions, think-pair-share activities, and problem-solving exercises encourages student engagement and promotes deeper learning by requiring students to actively participate in the learning process (Freeman et al., 2014). A study was done in Slovenia to evaluate the effectiveness of active learning with the 8^{th} grade chemistry. The findings highlight the benefits of the active learning courses over traditional chemistry classes, but they also show that students require some adjustment time to a novel teaching-learning approach (Savec, V. F., & Devetak, I. ,2013). Paulson (1999) did an investigation on his organic Chemistry classes to prove the effectiveness of the active learning and he finds out that the pass rate of the students has increased from 20% to 30% over the traditional way which he used teach before. Another research was done with the aim to offer an inventive educational tool featuring projects to promote active learning and raise students' Chemistry performance and the study's conclusions verified that the created learning tool successfully promotes active learning, which raises students' Chemistry test scores (Situmorang, M., Purba, J., & Silaban, R. 2020). An investigation was designed in the Chemistry-Biochemistry department to demonstrate the active learning technique and the results of this research unequivocally shows that the Chemistry-Biochemistry unit's active learning curriculum offered a cooperative and stimulating learning environment in which many students gained a thorough comprehension of the subject matter and the ability to express it both orally and in writing (Andrews, D. A., Sekyere, E. O., & Bugarcic, A., 2020).

2.1.2.4 Critical Thinking and Engagement Through Inquiry-Based Learning in Teaching Chemistry

Inquiry-Based Learning can be one of the strategies to teach Chemistry because in this approach students investigate scientific questions, design experiments, and analyze data foster critical thinking skills and promotes a deeper understanding of chemical principles (NRC,2012). In Jhunjhunu District, research was conducted with the urban and rural

areas students with the aim to find out the efficiency of the Inquiry-Based Learning method and he extracted that for both urban and rural students, the inquiry-based method is far more efficient than the traditional teaching approach (Singh, J. ,2020). In 2013, research was being examined to specifically looks at how implementing an inquiry-based science teaching approach could lead to meaningful science learning and the evaluations showed that students' enthusiasm for learning science could be piqued by the inquiry-based teaching techniques used (Shamsudin, N. M., Abdullah, N., & Yaamat, N. ,2013).

2.1.2.5 Teaching Chemistry Through the Integration of Technology

According to Buckley and Bretz (2012), integrating technology tools like interactive multimedia, online resources, and simulations can improve student learning and open up new ways for students to explore difficult chemical concepts. Ozo (2017) investigated a paper with the purpose of finding the importance of integrating Information Technology into commonly employed teaching method and he revealed that Information Technology has a positive on the student's learning outcomes. In Philippines, a study was conducted to investigate the teaching and learning process in Chemistry and it was discovered that there was a strong correlation between students' performance in Chemistry and how much technology they used. Additionally, it was discovered that despite the fact that technology was only occasionally employed in Chemistry classes and that it had some drawbacks, students nevertheless performed admirably in the subject (Reyes, P. B., & Silang, Z. D. ,2021).

2.1.2.6 Chemistry Teaching Through Concept Mapping Techniques

Students' comprehension of the hierarchical structure of Chemistry can be enhanced and meaningful connections between ideas can be developed by using concept mapping techniques to organize and represent chemical concepts (Novak & Gowin, 1984). A study was done to view the effect of concept maps over the traditional method and the findings provide compelling evidence that students attain the highest test scores when taught using both the traditional teaching strategy and the concept map teaching strategy. Thus, this

study presents a promising way to raise Chemistry students' performance levels (Singh, I. S., & Moono, K. 2015). Fatokun, K. V. F., & Eniayeju, P. A. (2014) did an investigation on the effects of Concept Mapping approach on the achievement and retention of the Chemistry students and they concluded that in teaching the difficult concepts the teachers should apply this method. a quantitative method on the study of the effect of the concept mapping approach regarding a periodic table concept revealed that there is a vast difference in the performance of the student when they learn the periodic table by the concept mapping technique (Francis, T. T., & Baba, S. J. ,2023).

2.1.3 The Impact of Resources on the Quality of Teaching Chemistry

The availability and effective use of teaching resources significantly influence the quality of Chemistry education. Resources such as textbooks, laboratory equipment, and technological tools provide the foundation for delivering comprehensive and engaging lessons. As Taber (2013) noted, teaching Chemistry requires resources that cater to its unique needs, including visual aids to represent molecular structures and tools for conducting experiments safely.

Laboratory resources are particularly essential in Chemistry education. Hofstein and Mamlok-Naaman (2007) emphasized the importance of practical work in helping students develop scientific skills and an appreciation for experimental science. However, challenges such as insufficient funding and poorly maintained labs often hinder the effective use of these resources, especially in schools with limited budgets (Goh et al., 2013).

Digital resources, including educational software, interactive simulations, and online databases, have revolutionized the teaching of chemistry. Hegarty-Hazel (1990) highlighted how multimedia resources could help overcome traditional teaching limitations by offering dynamic and interactive ways to explore complex chemical phenomena. Furthermore, open educational resources (OER) provide cost-effective solutions for schools, allowing teachers to access high-quality teaching materials without financial constraints (Hilton, 2016).

Finally, professional development programs are crucial for equipping teachers with the skills to effectively integrate resources into their teaching practices. Without proper

training, even the best resources may fail to achieve their intended impact on learning outcomes (Van Driel et al., 2001).

2.1.4 Innovative Strategies for Enhancing Teaching Chemistry and Student Engagement

Students can apply theoretical knowledge, gain practical skills, and comprehend basic chemical principles through direct experimentation when practical laboratory experiments are incorporated into their education (Russell & Weaver, 2018). By providing visual aids for difficult ideas and phenomena, chemical demonstrations pique students' curiosity and create a passion for the subject matter (Johnstone & Al-Shuaili, 2001). Students are given dynamic learning experiences when they use interactive multimedia resources like simulations, animations, and virtual laboratories. This helps them visualize and understand abstract chemical concepts (Adedoyin, 2019). Their problem-solving abilities and conceptual understanding are improved when problem-solving activities are integrated into the curriculum. This is because it fosters critical thinking, analytical reasoning, and the application of chemical principles to real-world scenarios (Bunce & Gabel, 2000). According to Novak and Gowin (1984), the use of concept mapping techniques aids in the visual organization and connection of chemical concepts by students, thereby promoting deeper understanding and the development of conceptual frameworks. By utilizing cooperative learning techniques like group discussions, peer teaching, and cooperative projects, teachers can encourage students' active participation, peer interaction, and idea sharing, which will improve their learning outcomes (Tanner & Allen, 2004). Adopting an inquiry-based approach fosters student-led experimentation, exploration, and curiosity about chemical phenomena, as well as a greater understanding of the scientific method (Hofstein & Mamlok-Naaman, 2007). The learners become more interested and motivated when they see the relevance and significance of chemistry in daily life, which is achieved through making connections between chemical concepts and real-life applications, environmental issues, and societal challenges (Taber, 2013). Quizzes, concept checks, and peer evaluations are examples of formative assessment strategies that can be used to identify misconceptions, give students ongoing feedback, and guide instructional decisions to support learning progression (Black & Wiliam, 1998). To ensure inclusive learning environments and to promote

equitable access to chemistry education, teaching methods, materials, and assessments should be modified to accommodate diverse learning styles, backgrounds, and abilities (Tomlinson, 2001).

2.1.5 The Interconnection of Teaching Practices and Assessment in Effective Pedagogy

The relationship between teaching practices and assessment is integral to effective pedagogy, as assessment informs and shapes instructional decisions while providing feedback on the success of teaching methods. According to Black and Wiliam (1998), formative assessment is central to aligning teaching practices with student needs. They argue that effective teaching involves continuously gathering information about students' learning progress and using that data to adjust instructional methods.

Teaching practices that emphasize student-centered learning often require dynamic and adaptive assessment methods. Harlen (2007) noted that formative assessments play a key role in classrooms that prioritize active engagement and inquiry-based practices. These assessments provide teachers with actionable insights into student understanding, enabling them to scaffold learning effectively.

In classrooms where differentiated instruction is practiced, assessment is crucial for tailoring teaching to meet the diverse needs of learners. Tomlinson and Moon (2013) emphasized the importance of diagnostic assessments in identifying students' readiness levels, interests, and learning preferences. This information allows educators to design lessons and activities that cater to varying abilities, ensuring that all students are appropriately challenged.

2.1.6 The Role of Feedback and Technology in Enhancing Teaching Practices and Assessment

An aspect of the relationship between teaching practices and assessment is the emphasis on feedback. Hattie and Timperley (2007) argued that high-quality feedback, an essential component of both assessment and teaching practices, significantly enhances student learning. Effective feedback should be clear, actionable, and aligned with learning objectives, ensuring that students can use it to improve their performance.

Additionally, summative assessments, though traditionally used for grading, can also provide valuable insights into the effectiveness of teaching practices. Shepard (2000)

suggested that analyzing summative assessment data allows educators to evaluate the overall impact of their instructional approaches and identify areas for improvement. Technology has further enhanced the interplay between teaching practices and assessment. Shute (2008) highlighted the use of digital assessments to provide real-time feedback and support adaptive teaching practices. For instance, online platforms that track student performance enable teachers to identify learning gaps promptly and adjust their instruction accordingly.

2.1.7 Practices of teaching Chemistry in Bangladesh

Chemistry teaching practices in Bangladesh face several challenges, particularly at the middle school level (grades 7 to 9). Rahman and Chowdhury (2018) highlight that traditional lecture-based methods dominate classrooms, limiting student engagement and hindering the development of conceptual understanding. The study emphasizes the need for interactive, student-centered approaches, such as inquiry-based learning and problem-solving activities, to improve learning outcomes. Additionally, practical laboratory work is a critical component of effective Chemistry education but is often underutilized in Bangladesh due to inadequate laboratory facilities and resources. Islam et al. (2020) note that the lack of proper infrastructure prevents students from gaining hands-on experience and applying theoretical concepts in real-world contexts. To address these issues, the study recommends enhancing laboratory setups and providing specialized training for teachers in lab management and experimental techniques. Another significant factor influencing Chemistry education is teacher pedagogy. Hossain and Kamal (2016) reveal that teacher-centered methods predominate, with limited opportunities for active student participation. This disengagement negatively affects students' interest and understanding of Chemistry. The authors suggest adopting more participatory strategies, including group discussions, multimedia resources, and demonstrations, to foster student engagement and improve academic performance. Collectively, these studies underline the importance of modernizing teaching methods, improving infrastructure, and investing in teacher training to enhance Chemistry education in Bangladesh.

2.1.7.1 Challenges in Promoting Scientific Literacy Among Bangladeshi Science Educators

Regarding the advancement of scientific literacy, an article describes the viewpoints and methods of Bangladeshi science instructors. The results of this study show that the teachers who took part in the study had a variety of viewpoints on scientific literacy, some of which were naive. Moreover, their viewpoints were frequently not seen to be realized in the classroom since professors placed a more traditional emphasis on teaching science. Students struggled to make links between the science they studied in school and their daily lives since many of their instructional methods fostered an academic science culture. This study also revealed the conflict that educators had when attempting to reconcile the principles of science and religion when instructing science in a religiously conservative society (Sarkar, M., & Corrigan, D., 2014).

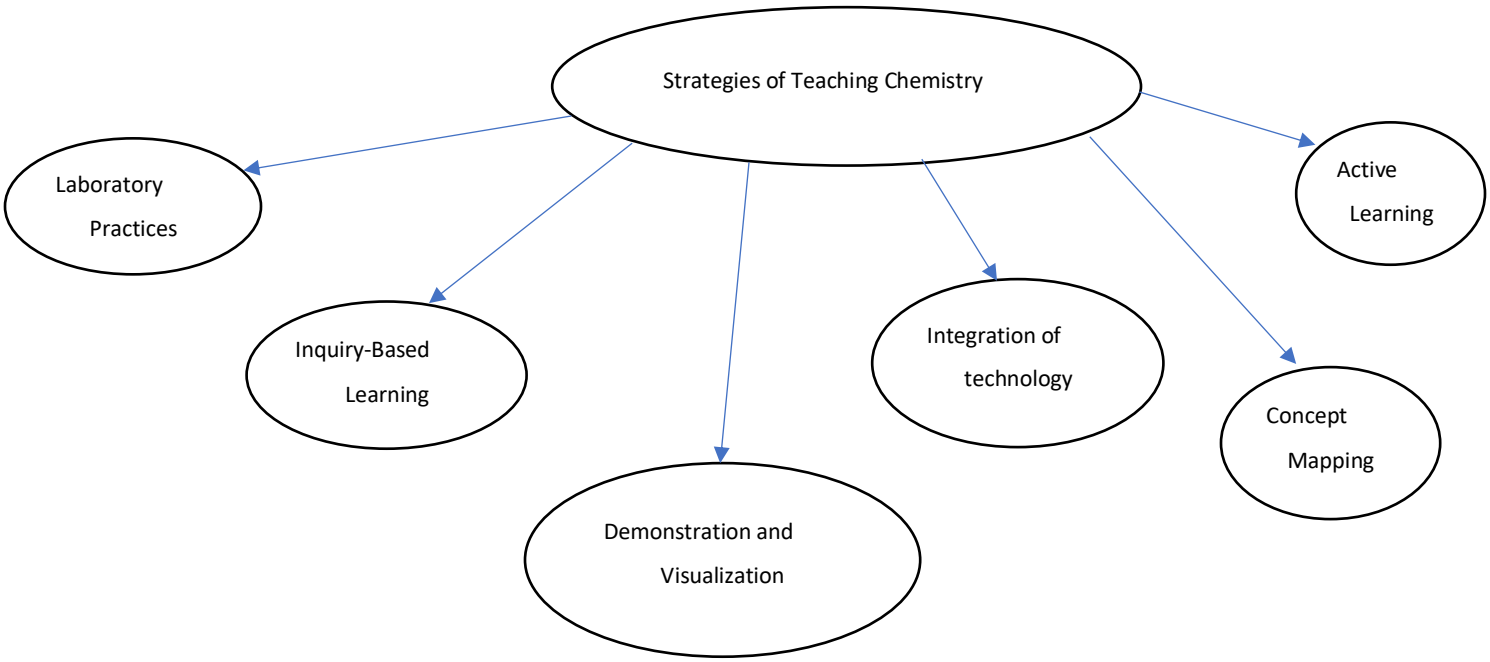
2.1.7.2 Exploring Teaching Practices and Approaches in Secondary Science Education in Bangladesh

A Case of Secondary School Science Teachers in Bangladesh was written by Nur-e-Alam, S. M. (2014). His findings about teaching methods showed that, in the secondary schools, science instructors mostly used teacher-centered, or didactic, instruction, with very little student involvement. It appears that professors mostly use lectures to communicate with students. They also ask a lot of simple questions that prompt students to respond with words or phrases, good students' incorrect responses, and commend students for their correct responses in a noninteractive, monologic discourse style. He discovered that there was a clear reflection of views in the ways that were taught. It has been discovered that educators use facilitative teaching strategies and hold contemporary views on teaching and learning. They ask a variety of questions, listen intently to students' thoughts, give very little lecture time, use a variety of teaching techniques, and provide much more unbiased feedback to students' answers. Teachers with conventional views, on the other hand, use didactic teaching methods. They mostly lecture, give students very little opportunity to speak, critique and defend authority, essentially use lower-order questions to test students' content understanding, provide students with evaluative feedback on their answers, and use a few numbers of teaching strategies. However, transitional teachers engage in two distinct roles in the classroom.

In order to investigate two fundamental facets of secondary scientific education in Bangladesh, Rahman, S. H. (2011) conducted a study. One goal was to utilize a real-world example of a novel teaching strategy to assist participating teachers in modifying their conventional methods of instruction. Helping participating science instructors transform the culture of their present professional practice was the second goal. According to this thesis' findings, teachers should be encouraged to use teaching aids as a deliberate tool, help students understand science material instead of just relying on memory and recognition of facts, find ways to connect science to real-world situations, move away from rote learning and theoretical exercises, and spark students' interest and enthusiasm in the classroom. Furthermore, the teachers' practices of the participants were impacted by the cooperative exercises conducted during the intervention phase. As a result of this job-embedded learning process, they committed to identifying any gaps or mismatches between their teaching and their students' learning.

The literature concludes by highlighting the vital role that good teaching methods, materials, and evaluations play in improving chemistry instruction, especially in English-medium schools. Important elements for raising student engagement and learning outcomes include incorporating a variety of teaching pedagogies, utilizing both traditional and digital resources, and supporting teachers' ongoing professional development. Furthermore, a thorough framework for developing effective pedagogy is provided by the connections between technology, assessment, feedback, and teaching practices. The literature also emphasizes the special difficulties faced by Bangladeshi chemistry teachers, especially with regard to the availability of resources and the modification of instructional strategies to accommodate students' individual needs. Improving the standard of chemistry instruction in these settings will require addressing these issues with creative solutions and focused assistance.

2.2 Conceptual Framework



The conceptual framework for teaching Chemistry combines various strategies to enhance students' understanding, engagement, and academic performance. Laboratory practices, such as hands-on experiments and teacher-led demonstrations, integrate theory with practical applications, helping students build conceptual understanding and improve engagement. For example, research has shown that combining hands-on experiments with computer modeling leads to better conceptual understanding compared to using either method alone (Liu, 2006). Similarly, teacher demonstrations and student-led experiments both effectively increase conceptual understanding, with demonstrations showing slightly better knowledge retention (Logar & Savec, 2011). Guided inquiry in laboratory

activities has also been shown to improve students' attitudes toward Chemistry labs, academic performance, and reduce anxiety (Ural, 2016).

Demonstrations, visualizations, and virtual laboratories aid students in understanding abstract and sub-microscopic chemical concepts. Studies reveal that combining particulate animations with video demonstrations enhances students' conceptual understanding (Velázquez-Marcano et al., 2004). Moreover, virtual laboratories that incorporate dynamic visualizations outperform traditional classrooms by facilitating efficient learning and bridging the gap between conceptual levels (Herga et al., 2016).

Active learning techniques, such as group discussions, problem-solving activities, and think-pair-share exercises, promote deeper learning and engagement. For instance, active learning has been shown to significantly improve Chemistry test scores and create a stimulating learning environment (Andrews et al., 2020; Situmorang et al., 2020).

Inquiry-Based Learning (IBL) focuses on the investigation of scientific questions, experiment design, and data analysis, fostering critical thinking and a deeper understanding of chemical principles. Research demonstrates that IBL is more effective than traditional teaching approaches in both urban and rural contexts and sparks enthusiasm for learning Chemistry (Singh, 2020; Shamsudin et al., 2013). Integrating technology, such as simulations, multimedia tools, and online resources, enhances student learning by enabling the exploration of complex chemical concepts. For example, the use of technology in Chemistry classrooms has been strongly correlated with improved academic performance despite occasional challenges in implementation (Reyes & Silang, 2021).

Finally, concept mapping techniques help students organize and represent chemical concepts hierarchically, promoting better comprehension and retention. For example, using concept mapping to teach the periodic table led to improved performance compared to traditional teaching methods (Francis & Baba, 2023). Together, these strategies form a cohesive framework, connecting effective teaching practices with the desired outcomes of fostering student engagement, critical thinking, and academic success in Chemistry education.

CHAPTER 3

Methodology of the Study

This section depicts, the methodology for exploring the practice of teaching Chemistry of Grade 7 to 9 teachers in English Medium Schools in Bangladesh, along with the challenges they face, will be outlined. The qualitative approach has been chosen to delve deeply into the experiences, perceptions, and practices of these educators, aiming to provide rich insights into the dynamics of chemistry education within this context.

3.1 Research Approach

Qualitative research approach employed to explore the practice of teaching chemistry and the challenges faced by high school chemistry teachers in Bangladesh. This approach was well-suited for investigating teaching strategies and challenges in chemistry education. Since, this research method explore in-depth investigation which prioritized over numerical information in order to better understand the experiences, viewpoints, and methods of high school chemistry teachers. This qualitative method will assist in collecting comprehensive, contextual data that elucidates the varied experiences of Chemistry teachers in Bangladeshi high schools that use English as a medium of instruction.

Numerous factors, including student demographics, institutional policies, and cultural contexts, impact teaching strategies and challenges. The researcher can investigate these factors in greater detail by using a qualitative approach. The open-ended and flexible nature of qualitative methods (such as interviews, observations) offers opportunities for finding new insights and emerging themes that might not have been anticipated, especially since the goal of this study was to investigate current practices and challenges. It is more likely that chemistry teachers' experiences involved intricated, multifaceted

facets of instruction, which were best represented by narrative data as opposed to numerical data. A more thorough examination of the classroom setting, pedagogical strategies, and teacher-student interactions was made possible by this method. In sum, a qualitative approach is the best method for investigating the individualized experiences and methods of educators, offering a thorough grasp of Chemistry education and the difficulties encountered by Bangladeshi English-medium schools.

Qualitative tools such as classroom observations and interviews enable a detailed examination of the pedagogical strategies and techniques employed by teachers, as the study aimed to investigate current teaching methods. The subtleties of classroom dynamics and instructional choices, which are essential to comprehending teaching practices, were captured with the aid of this method. The goal of the study was to identify obstacles that educators encounter, which can vary depending on the situation. A comprehensive evaluation of the personal and professional challenges teachers face—from language hurdles to curricular issues—was made easier by qualitative methods. This makes it possible to comprehend the difficulties in depth and moves beyond cursory observations. Unique cultural, institutional, and linguistic contexts influence teaching strategies in Bangladesh's English-medium schools. These contextual factors are important for understanding how and why certain practices are adopted or challenged, and a qualitative approach allows the researcher to collect insights directly from teachers. As a result, the qualitative approach supports the goals of the study by offering rich, comprehensive data that is critical for comprehending both the complex issues faced in Bangladeshi English-medium schools and the teaching practices that are employed there.

3.2 Research site:

Two English Medium Schools are selected School-A and School-B. Since, English medium schools in Bangladesh typically follow standardized international curricula, ensuring uniformity in syllabi, teaching methods, and assessment practices across institutions (Oates, 2010). Teachers in these schools often undergo similar training aligned with international standards, leading to comparable pedagogical approaches (Shamim, 2008). Additionally, centralized examination systems like IGCSE and A-Level further standardize educational objectives and outcomes (Cambridge Assessment International Education, 2020). By strategically selecting two schools- diverse

perspectives are captured while ensuring generalizability due to this shared framework (Yin, 2018). Therefore, studying two schools can effectively provide a representative image of English Medium Schools in Bangladesh.

School-A is located in Dhanmondi which is established in 1972. School-B is located in Mohammadpur and its establishment is in the year 2000.

School-A is among Bangladesh's most esteemed English-medium schools and it adheres to the British Curriculum, which leads to International Advanced Level, GCE "A" Levels, and IGCSE. The Government of Bangladesh, Edexcel, and CIE, UK have all accredited the institution. The school consists of around 8000 students and it has eight campuses.

School-B has established few years ago with 200 students and it follows the same British curriculum of GCE and IGCSE.

School-A is selected because having been established in 1973, provides insights into how teaching strategies have evolved over time. Its long history allows for an examination of whether and how traditional methods have adapted to modern educational needs, particularly in Chemistry education. A school with a long-standing reputation is likely to have more experienced teachers and established teaching practices. This makes it ideal for investigating strategies that have been refined over decades. A large student population likely means a diverse range of learners in terms of abilities, backgrounds, and learning styles. This diversity offers the opportunity to study how teaching strategies are tailored to meet the needs of a wide variety of students. Older and larger schools often have more established infrastructures and resources, such as labs, equipment, and teaching materials, which can impact the way Chemistry is taught.

School-B is selected because a school established more recently may employ newer, more innovative teaching strategies compared to older institutions. This makes it ideal for examining how modern educational trends are incorporated into Chemistry teaching. A smaller student population allows for more personalized and interactive teaching methods. Studying a school with fewer students offers insights into the effectiveness of individualized instruction in Chemistry. Smaller, newer schools may face challenges related to limited resources, such as fewer laboratory facilities or less experienced

teachers. This allows for a closer look at how Chemistry is taught in schools with fewer advantages, providing a contrast to the larger, more established school. More compact educational institutions may be more adaptable and quicker to implement new technologies or pedagogies, providing a chance to explore alternative approaches than more conventional, larger institutions.

Therefore, selecting one school established in 1973 with a large student population and another established in 2000 with a smaller number of students provides a rich comparative framework for the research. The choice of these two disparate educational institutions allows the research to examine a variety of pedagogical approaches, from traditional to contemporary, as well as the effects of resource availability and school size on Chemistry instruction.

3.3 Research participants

There was total six teachers selected from the School-A and School-B by purposely sampling method in order to get data for this paper. They all were interviewed individually.

Participant-1, Participant-2 and Participant-3 were selected from School-A. Whereas, Participant-4, Participant-5 and Participant-6 were selected from School-B.

Participant-1 teaches in class-7 and she has done MSc in microbiology. Whereas, Participant-2 last educational qualification is BSc in Electronic and Telecommunication Engineering who teaches in class-8. Participant-3 did her graduation in BSc in Leather Products Engineering and teaches in class-9. Participant-4 and Participant-5 have their graduation in BBA and BSc in Microbiology respectively where, Participant-4 teaches in class-7 and Parcipant-5 teaches in classes 8. Participant-6 take classes in class-9 and she has a BSc degree in Biochemistry. They all were female Chemistry teachers and their ages were between 30 to 45.

Chemistry teachers from classes 7 to 9 were selected as research participants because these grades are crucial in building foundational knowledge of chemistry, which prepares students for more advanced topics in high school. Teachers at this level play a key role in shaping students' understanding of core concepts and scientific thinking. By examining the strategies they use, the research can gain insights into the pedagogical approaches, challenges, and effectiveness of teaching chemistry in English medium schools in

Bangladesh. Their experiences were directly related to the research topic, as they provide a practical understanding of how chemistry is taught and what methods are employed to engage students in a non-native language environment.

3.4 Sampling procedure

The primary targeted population for my research was high school Chemistry teachers in English medium schools in Bangladesh. These teachers were crucial participants as they directly engage in teaching Chemistry to students. High school Chemistry teachers can provide detailed information on the teaching methods, strategies, and resources they use to explain complex Chemistry concepts in English. This includes lesson planning, use of teaching aids, technology, laboratory sessions, and assessment methods. These teachers can also highlight the difficulties they encounter. They can offer personal experiences that reveal the systemic and day-to-day hurdles in teaching Chemistry effectively in an English medium environment. Therefore, these teachers helped to identify the gap between teaching practices and desired educational outcomes in Chemistry within the context of Bangladesh's English medium schools.

The participants were selected by the purposive sampling method. This method allows to intentionally select individuals who are most knowledgeable and experienced with the topic of interest (Patton, 2015). In this method, researchers intentionally choose individuals who were most likely to provide valuable insights into the subject of study. This approach was particularly useful when the research focuses on a specific phenomenon, and the goal was to gather in-depth, qualitative data rather than generalize findings to a broader population.

The criteria used to choose the participants were that they all were chemistry teachers who had a minimum experience of 2-3 years. They are currently employer in an English medium school in Bangladesh and they were familiar with the teaching in the international curricula. They all were willing to participate in the study and they are chosen from different schools. Only six participants were chosen for the time and resources constrain.

3.5 Data collection method

Two methods were used to collect the data. They were interviews and classroom observation. The interviews were designed with the semi-structured questions with the title resources, strategy, assessment and challenges. There were six to seven questions for each title. Two checklists were developed for the observation, one for each research questions. One checklist contained the items: lesson plan and preparation, use of teaching aids, content delivery, student engagement, teaching methods, practical work, classroom management, assessment techniques, feedback to students and adaptability. The other checklist contained the following items: resource availability, laboratory facilities, student preparedness, curriculum constraints, time management, professional development, classroom size, student motivation and language barriers.

Three interviews were taken from the School-A with the Participant-1, Participant-2 and Participant-3, while, three interviews were taken from the school-B with the Participant-4, Participant-6 and Participant-5. Therefore, total six interviews were taken to collect the data and each interview lasted for 40 to 60 minutes. Twelve classroom observations were (two class observation of each teacher) conducted of the Chemistry lessons from the same teachers who were being interviewed. Since, the purpose was to complement the interview data by directly observing how these teachers applied their teaching strategies in practice. The duration of each observation was one full Chemistry class session (40 minutes).

Semi-structured interviews allow for an open-ended discussion, capturing teachers' pedagogical decisions and rationale, leading to insights on instructional practices (Bryman, 2016). According to Kvale (2007), semi-structured interviews are helpful for comprehending individual experiences and environmental elements that affect instruction. Through interviews, the teaching methods can be explored that Chemistry teachers currently use. Teachers can share details on how they plan lessons, interact with students, and integrate practicals, while also discussing how they address the specific learning needs of students in an English medium context. They can also share personal experiences and challenges, such as difficulties with resources, time constraints, language barriers (if students struggle with English), or the adaptation of the curriculum to meet student needs. These interviews encourage teachers to express these challenges candidly, providing rich qualitative data.

Classroom observations provide objective data that can be compared with teachers' reported practices, allowing for triangulation of data (Cohen et al., 2018). This method provides a more objective view of the actual classroom environment, interactions, and the effectiveness of teaching methods. Observations will help identify common practices, such as how teachers scaffold student learning or differentiate instruction for students with varying English proficiencies (Cohen, Manion, & Morrison, 2018). It also helps in identifying real-world challenges that may go unnoticed or unreported by participants in interviews (Creswell & Poth, 2017).

Cross-checking data is possible when semi-structured interviews and classroom observations are used where interviews offer depth in understanding personal perspectives, observations provide a broad view of the actual teaching environment and student-teacher dynamics, giving you a comprehensive understanding of the research questions. This combination of qualitative methods will provide a robust and detailed understanding of the current practices and challenges in teaching Chemistry in English medium schools in Bangladesh.

3.6 Role of the Researcher

As a researcher conducting qualitative analysis on the practice of teaching Chemistry in English medium schools in Bangladesh, my role involved directly engaging with Chemistry teachers through interviews and classroom observations. During interviews, I sought to understand their teaching strategies, how they approached complex concepts, and the pedagogical methods they used to make Chemistry accessible to students. I designed semi-structured interview questions to encourage teachers to share their experiences with lesson planning, use of practical experiments, and the integration of technology in their teaching. I ensured that my questions were open-ended, allowing teachers to freely discuss their methods, challenges, and successes.

In addition to interviews, I observed classroom interactions to gain firsthand insights into the teaching practices of Chemistry teachers. My role as a non-participant observer allowed me to focus on how teachers delivered lessons, engaged students, and explained difficult concepts in real-time. I paid close attention to how they structured lessons, used visual aids, conducted experiments, and encouraged student participation. I also noted the

learning environment and the level of student engagement during the lessons, which helped me see the practical implementation of the strategies discussed in interviews. Finally, my role extended to analyzing the data collected through these interviews and observations. I transcribed the interview responses and coded the data to identify recurring themes and patterns. By comparing the data from interviews and classroom observations, I was able to triangulate the findings, providing a well-rounded understanding of the current teaching practices and challenges in Chemistry education in Bangladesh's English medium high schools.

3.7 Data analysis

To analyze the data for the research questions on Chemistry teaching practices and challenges in English medium high schools in Bangladesh, thematic analysis was employed as a qualitative method. Thematic analysis allows for identifying, analyzing, and reporting patterns or themes within the data (Braun & Clarke, 2006). The process began by familiarizing myself with the interview transcripts and observation data, followed by generating initial codes that reflected specific teaching practices and challenges encountered by the teachers. These codes were systematically organized into themes based on recurring patterns. The themes were then reviewed and refined to ensure they accurately captured the essence of the data, with constant comparison between the themes and raw data to maintain validity. Lastly, the themes were interpreted in relation to the research questions, providing a structured understanding of the practices and challenges in Chemistry education (Nowell, Norris, White, & Moules, 2017). This approach allowed for a rich, detailed interpretation of the teachers' experiences in the classroom.

In this paper thematic analysis is involved by systematically coding the data from interviews and classroom observations, followed by categorizing these codes into meaningful themes. The themes can be divided as follows

- Resources: The availability and the use of the teaching aids with the laboratory facilities are explored.
- Strategy: Lesson plan, preparation, content delivery, practical work and teaching methods of the teachers are identified.

- Classroom management: Adaptability of the student, student engagement, student preparedness, time management and classroom size are explained.
- Challenges: Resources availability, curriculum constraints, professional development of the teachers, language barriers, student motivation and language barriers are discussed.

3.8 Ethical Issues and Concerns

I ensured all research participants, specifically Chemistry teachers, provided informed consent before participating in the study. Each participant was given detailed information about the study's purpose, the nature of the data being collected, and how it would be used. Participation was entirely voluntary, with assurances of confidentiality. Only after obtaining verbal consent did, I proceed with interviews.

To maintain confidentiality, I anonymized all data by using pseudonyms, ensuring no identifying information appeared in research documentation or analysis. Interview recordings and transcripts were stored securely in password-protected files accessible only to me. Quotes and findings in the final report were carefully presented to protect participants' identities.

To minimize bias, I used open-ended, neutral questions during interviews and refrained from sharing my opinions to avoid influencing responses. Classroom observations followed a structured framework to focus on objective behaviors and interactions. I validated findings by cross-checking data from interviews and observations, employing peer reviews and self-reflection to maintain objectivity and integrity throughout the research process.

3.9 Credibility and Rigor

As a Chemistry teacher with 10 years of experience in English medium schools, my personal and professional characteristics could influence various stages of data collection, analysis, and interpretation. Personally, my familiarity with the educational environment and my rapport with fellow teachers might create a level of comfort and trust during interviews and classroom observations, potentially leading participants to share more openly. However, this familiarity could also introduce bias, as my own experiences and

preconceptions about effective teaching practices might unintentionally influence how I perceive and interpret the data.

Professionally, my in-depth knowledge of Chemistry teaching strategies equips me with the ability to ask relevant, targeted questions during interviews and observe subtle classroom dynamics. However, this same expertise could affect how I analyze the data, as I may give more weight to certain methods or challenges based on my own experiences. To mitigate these influences, I will need to remain aware of potential biases and ensure I approach the data with objectivity, using clear, systematic methods for analysis and interpretation to maintain the validity of the study.

3.10 Limitations of the study

A key limitation of this study is the constraint of time and funding, which restricted the scope of data collection. While I initially planned to visit more research sites to gather data from a wider variety of schools, these constraints confined the study to a smaller sample. This limited scope may affect the diversity of perspectives and the generalizability of the findings, as the data reflects a focused group of participants rather than a broader range of schools.

Another significant limitation is the inability to observe teacher training sessions due to scheduling gaps, with no sessions planned during the research period. This prevented me from gathering first-hand insights into how Chemistry teachers are trained in Bangladesh, limiting the study's exploration of the role of professional development in addressing teaching challenges. Additionally, the geographic scope of the study was restricted to a specific region, which may overlook regional variations in resources, infrastructure, and teaching practices across different parts of the country.

Lastly, the study faces potential researcher bias due to my extensive experience as a Chemistry teacher in English medium schools. While my background allows me to provide valuable insights, it could inadvertently influence how I collect, analyze, and interpret data. To address this, I have employed systematic methods for data analysis and remained critically reflective throughout the research process to ensure the findings accurately represent participants' perspectives without being shaped by my own experiences.

Chapter 4
Results of the Study

This study explores the teaching strategies, resources, assessment practices, and challenges faced by Chemistry teachers of class 7-9 in English medium high schools in Bangladesh, with a focus on Edexcel and Cambridge curriculum-aligned institutions. Through interviews, observations, and discussions with participants, the study highlights the reliance on school-selected, Edexcel-certified textbooks as the primary resource, supplemented by online platforms for updated information and student engagement. Teachers utilize a blend of structured syllabi, supplementary materials, and interactive strategies to cater to varying student needs, with assessment practices carefully aligned to prepare students for O-level examinations. The findings also reveal significant challenges in explaining abstract concepts, maintaining student motivation, and managing diverse learning needs within a grade-focused framework. The teachers emphasized the importance of professional development opportunities, such as lab training and workshops, to enhance Chemistry instruction quality and address persistent challenges in the field.

The findings of the study are categorized into following themes.

4.1. How the Availability and Quality of Resources Shape Chemistry Teaching

The availability and quality of resources significantly impact the effectiveness of Chemistry teaching, affecting both instructional methods and student outcomes. Well-equipped laboratories, access to advanced technology, and high-quality teaching materials foster active learning and enhance students' conceptual understanding (Hofstein & Lunetta, 2004; Prensky, 2001). However, resource constraints can limit hands-on

experiences, compelling teachers to rely heavily on theoretical approaches, which may hinder students' grasp of complex chemical concepts (Harrison & Treagust, 2000).

4.1.1. Use of Textbooks by the Teachers

All the Participants responded that they use the textbooks as their main resources which is assigned by the school that they selected by taking the recommendation from the Ed excel and Cambridge Curriculum. The criteria the schools implemented to select the textbooks are that the books must be certified by the Edexcel Board which contains the topics suggested by the exam board and it is being designed from basic to advanced level. As one of the participants utter, "We primarily rely on the textbook provided by the school. It is selected based on the Edexcel or Cambridge curriculum recommendations, ensuring it aligns with the syllabus and exam requirement." (Interview 1, 1st September2024). While other one also said, "The textbooks we use are certified by the Edexcel Board and are designed to cover all the necessary topics, starting with the basics and progressing to advanced concepts. This helps us follow a structured teaching approach." (Interview 3, 3rd September 2024). Another one said, "At the beginning of each academic session, the school provides us with textbooks and a detailed syllabus. This makes it easier to plan lessons and ensure that we cover everything required for the exams." (Interview 4, 15th September 2024). One participant responded "The school emphasizes using Edexcel-certified textbooks because they are designed according to the exam board's recommendations. This ensures that we stay on track with international standards and prepare students effectively." (Interview 6, 17th September 2024).

"During classroom observations, it was noted that at the start of the academic session, teachers were provided with textbooks and a detailed syllabus outlining weekly teaching plans."

"In all 12 observed classrooms, the assigned textbooks were used as the primary instructional material, with teachers frequently referencing them during lessons."

The analysis of the findings suggests that the schools placed significant importance on the use of standardized textbooks as the primary teaching resource for Chemistry instruction. All participants indicated reliance on textbooks that were pre-selected by the schools based on recommendations from the Edexcel and Cambridge curricula. This demonstrates that the schools aimed to ensure alignment with the curriculum standards

and examination requirements, as the selected textbooks were certified by the Edexcel Board. The certification process ensured that the books covered the necessary topics in a structured progression from basic to advanced levels, catering to the diverse needs of students across grades.

Additionally, observations revealed that the schools actively facilitated the use of these textbooks by providing them to teachers and establishing a well-defined syllabus at the start of each academic session. This approach highlighted a systematic effort by the schools to create consistency in teaching practices and curriculum delivery. By equipping teachers with curriculum-aligned resources and a predefined syllabus, the schools aimed to streamline the teaching process and ensure that educational goals were met effectively. These findings indicate that the schools prioritized structured and standardized resources to maintain quality and consistency in Chemistry education while adhering to international curriculum standards. However, it also underscores a dependency on textbooks, which might limit the flexibility of teaching approaches if not supplemented with additional resources or innovative methodologies.

4.1.2. Use of Research Papers and Websites by the Teachers

The Participants informed that they use research papers or websites to stay updated with the latest developments and resources in the field of chemistry education. The online platforms or websites they frequently use for supplementing their chemistry lessons are Google, save my exam.com and Pearson website

As, one of the participants said "I often use websites like Save My Exams and the Pearson website to find additional resources and stay updated with the latest teaching materials." (Interview 2, 2nd September 2024). Another participant quoted "Google is my go-to platform for searching for recent research papers or supplementary materials to enhance my Chemistry lessons." (Interview 3, 3rd September 2024). One interviewer responded "To stay updated with current developments in Chemistry education, I regularly browse research articles online and look for verified sources through Google Scholar or the Pearson site."(Interview 5, 16th September 2024). One of the participants stated, "I supplement my teaching with resources from Save My Exams, as it offers concise and exam-focused materials that are very effective for student practice."(Interview 6, 17th September 2024).

The findings reveal that teachers actively supplement their Chemistry lessons with up-to-date resources from online platforms such as Google, Save My Exams, and the Pearson website, demonstrating their commitment to staying informed about recent developments in the field and enhancing their teaching practices. These platforms provide a variety of materials, including research papers, practice exams, and curriculum-aligned resources, which help teachers enrich their lessons and better meet students' needs. While this approach reflects a shift towards blended learning by combining traditional and digital resources, it also highlights a potential limitation in resource diversity, as teachers tend to rely on a few specific websites. To maximize the benefits of these tools, schools could support teachers by offering training on how to effectively evaluate and integrate digital resources, ensuring that a broader range of materials is used to enhance teaching and learning.

4.1.3. Status of Laboratory in the Selected Schools

When Observations are done it had been seen that School-A has well-equipped laboratory with all the available apparatus but School-B does not have any laboratory but they have the basic equipment like beaker, funnels and test-tubes where the teachers can demonstrate the simple experiments in the classroom. The teachers did not allow the students to perform any experiments but they did hand-on experiments related to their topics.

(Observation 1, 9th September 2024) “In School-A, it was observed that the laboratory was fully equipped with all the necessary apparatus, allowing for a wide range of experiments to be conducted. The lab included advanced equipment like Bunsen burners, glassware, and other specialized apparatus, which supported comprehensive practical lessons."

(Observation 7, 22nd September 2024) "School-B, however, lacked a dedicated laboratory space. Teachers in this school used classroom environment to demonstrate simple experiments, relying on basic equipment such as beakers, funnels, and test tubes. These materials allowed them to perform some basic demonstrations, though students were not allowed to carry out hands-on experiments themselves”. (Observation 8, 22nd September 2024) "Teachers in both schools ensured that students engaged with the subject matter through practical demonstrations. In School-B, although students were not directly

involved in performing the experiments, they were able to observe the procedures and discuss the scientific principles behind them."

(Observation 10, 23rd September 2024) "In School-A, the use of a fully equipped laboratory enabled teachers to offer a more interactive and hands-on learning experience, whereas in School-B, due to the lack of proper facilities, teachers had to rely on demonstration-based teaching methods, restricting student participation in practical experiments."

The observations highlight significant disparities in laboratory resources between the two schools and their impact on teaching practices. School-A's well-equipped laboratory enabled teachers to conduct a wide range of experiments, creating opportunities for an interactive and hands-on learning experience. However, despite these facilities, teachers still limited student participation in experiments, possibly due to concerns over time, safety, or curriculum constraints. In contrast, School-B lacked a dedicated laboratory but provided basic equipment like beakers, funnels, and test tubes for classroom demonstrations. This approach allowed teachers to showcase simple experiments, but the absence of a proper lab restricted the depth and scope of practical activities, preventing students from engaging directly in experimental work. These findings suggest that while resources play a critical role in shaping the practical aspects of Chemistry education, their effective utilization is equally important. Teachers in both schools could benefit from professional development to optimize the use of available resources and encourage more active student participation in experiments, regardless of resource limitations.

4.1.4 Guiding Students in Accessing Reliable Chemistry Resources

The interviews revealed that the Participants guided the students in finding reliable chemistry resources by sending them links, site address or you tube videos regarding the topics.

As, one of the participants cited, "I often share links to reliable websites or YouTube videos with my students to help them understand topics better. For example, if we're covering chemical bonding, I might send them a tutorial video that explains it visually." (Interview 1, 1st September 2024). While, one of the participants uttered, "Whenever students struggle with a concept, I guide them to useful resources by sending YouTube video links or articles that simplify the subject and make it easier to grasp."(Interview 2,

2nd September 2024) and other participant, consented, "I believe in teaching students how to find reliable information, so I send them references to trusted educational platforms and explain why these resources are credible."(Interview 4, 15th September 2024). Another one also said, “When students need additional help, I direct them to specific online resources, such as tutorials or practice problems, ensuring they have trustworthy materials to study from." (Interview 5, 16th September 2024).

The analysis indicates that teachers play a proactive role in guiding students to access reliable Chemistry resources, leveraging digital platforms to enhance learning. By sharing links, site addresses, and YouTube videos, teachers help students bridge gaps in understanding and explore topics in greater depth. This practice not only ensures that students use credible materials but also fosters independent learning skills, as students are encouraged to seek additional information beyond the classroom. Moreover, the use of varied digital resources caters to different learning styles, particularly for visual and self-paced learners. However, the effectiveness of this guidance may depend on the students' ability to critically evaluate and effectively utilize the resources provided. Teachers might further strengthen this approach by incorporating training on how to discern credible sources and optimize the use of online materials.

4.2. The Role of Teaching Approaches in Enhancing Student Engagement and Understanding

The practice of the teachers in School-A highlights the importance of proactive lesson planning in maintaining instructional quality, even in larger classrooms. Effective time management allowed teachers to balance content delivery with the necessary focus on maintaining classroom discipline.

(Observation 2, 9th September 2024) "In School-A, teachers were observed submitting their lesson plans one week in advance, ensuring they were well-prepared for their classes. Despite the larger class size of approximately 30 students, teachers effectively managed their time, delivering their planned lessons within the allocated period, although some time was spent addressing classroom management."

There is proactive planning approach of the teachers in School-B ensured that lessons were delivered seamlessly, with minimal disruptions throughout the term. Additionally,

the smaller class sizes fostered a more focused learning environment, enabling teachers to provide targeted support and foster meaningful student engagement.

"In School-B, teachers planned their lessons for the entire term before it began, which contributed to a smooth flow of classroom activities. The smaller class sizes, with 10 to 15 students, allowed for better class management and more personalized interactions during lessons." (Observation 7, 22nd September 2024)

There is consistency in both the schools which highlights the teachers' dedication to maintaining high teaching standards and implementing effective strategies in real classroom settings. Moreover, it reflects a strong alignment between their pedagogical planning and practical execution, fostering an optimal learning environment for students.

(Observation 9, 23rd September2024) "Across both schools, all Chemistry teachers appeared well-prepared for their lessons, with teaching strategies and content delivery aligning closely with the approaches described during interviews. This alignment demonstrated consistency between the teachers' stated methods and their classroom practices."

The teachers made efforts to create an engaging classroom environment, additional methods may be required to fully capture students' attention and curiosity. Implementing innovative teaching strategies, such as inquiry-based learning or real-life applications of Chemistry, could help boost student interest and motivation.

(Observation 11, 24th September 2024) "The classrooms in both schools were fairly interactive, with teachers engaging students through questions and discussions. However, students in both schools displayed moderate levels of interest and motivation in learning Chemistry, indicating room for strategies to enhance student engagement."

The analysis reveals that structured lesson planning and classroom management strategies significantly influence the effectiveness of Chemistry teaching in both schools. In Schools, the requirement to submit lesson plans a week in advance ensured preparedness, even in larger class sizes, though managing a bigger group required additional time, slightly impacting lesson delivery. While both schools maintained fairly interactive classrooms, the moderate levels of student interest and motivation highlight a potential

area for improvement, suggesting a need for more engaging and innovative teaching methods.

4.2.1 Key Teaching Strategies Employed by Participants

When the Participants were asked for the response about their key teaching strategies. In that time, one of the participants exclaimed that at first, she explained the main concept about the topic and then she explains from the book in details (Interview-1,1st September2024). Another participant said that she tries to give easy examples while describing the chapters (Interview-2,2nd September2024). Some participants responded that they give focus on the main concepts (Interviews-3 and 4, 3rd and 15th September2024). Whereas, one participant disclosed that she does continuous repetitions of her work and emphasize on the basic key details (Interview-5,16th September2024). Some of the participants illustrated that they define their topic by relating to everyday life to make a balance of theoretical concepts with the practical applications (Interviews-3 and 6, 3rd and 17th September 2024). While, some of the participants said that they explain the topic through examples and by demonstrating them in diagrams (Interviews-1,2 and 5, 1st,2nd and 16th September 2024).

The analysis indicates that the teaching strategies employed by the participants reflect a diverse range of approaches aimed at making Chemistry concepts understandable and relatable for students. The emphasis on explaining main concepts, as highlighted by some of the participants, demonstrates a focus on building a strong foundational understanding, while the use of easy examples and continuous repetitions by some participants show a commitment to reinforcing learning and ensuring retention. The effort of some participants to connect theoretical concepts with everyday life underscores the importance of making lessons relevant and practical, which can enhance student engagement and comprehension. Additionally, the use of diagrams and demonstrations, as noted by many of the participants, highlights the value of visual aids in simplifying complex ideas. Together, these strategies reflect a balanced approach to teaching that combines conceptual clarity, practical relevance, and varied instructional techniques to cater to diverse learning needs.

4.2.2 Techniques Used by the Teachers to make Chemistry Interesting

The Participants uttered that the techniques they use to engage students who might find chemistry challenging or uninteresting are that they told them about the scope of possible careers if they learn this subject or by offering them extra classes. (Interview 1,3,5, 1st ,3rd and 15th September 2024). As, one participant responded that "I take extra classes after the school timing for the students whose performance is not good in the classes or not attentive in the class" (Interview-5, 16th September 2024). Some interviewers revealed that they allow some time for the students so that they can discuss their queries or they repeat their work and in this way the teachers will able to meet the diverse learning needs of their students (Interviews-2,4 and 6, 2nd ,15th and 17th September 2024).

The analysis reveals that teachers employ supportive and adaptive strategies to engage students who find Chemistry challenging or uninteresting, demonstrating a commitment to addressing diverse learning needs. Highlighting the career prospects associated with studying Chemistry serves as a motivational tool, helping students see the subject's relevance to their future goals. Providing extra classes, as noted by Participant 5, reflects a proactive effort to offer personalized attention to struggling students, ensuring they have additional time to grasp complex concepts. Similarly, Participants 2, 4, and 6's approach of allocating time for students to ask questions and repeating key lessons fosters an inclusive learning environment that accommodates different paces of learning. These strategies underline the importance of teacher-student interaction and tailored interventions in building students' interest and confidence in Chemistry. By combining motivational techniques with practical support, the participants demonstrate effective ways to enhance student engagement and performance.

4.2.3 Ensuring Safety and Educational Value in Lab Activities

The strategies implemented by the Participants to ensure that the lab activities are both safe and educational by allowing the students to observe the experiments from some safe distances.

"During the lab session in School-A, the teacher demonstrated an experiment involving a chemical reaction. The students were instructed to stand at a safe distance from the setup while the teacher explained each step in detail, ensuring that students could observe the process without being exposed to any potential risks." (Observation 4,5 and 6, 10th and 11th September2024)

"In School-B, the teacher conducted a demonstration of the experiment in the front of the classroom. Students were seated at their desks, maintaining a safe distance from the experimental setup, while the teacher emphasized safety precautions and explained the scientific principles involved." (Observation 10,11 and 12, 23rd and 24th September 2024)
"Before starting the experiment, the teacher in School-A provided clear instructions about safety protocols, such as not touching the equipment or chemicals. Students were positioned strategically around the demonstration table to ensure they could see the experiment while staying at a safe distance." (Observation 4,5 and 6, 10th and 11th September 2024)
"In both schools, teachers were observed prioritizing safety by using protective equipment such as gloves and goggles during demonstrations. Students were not directly involved in handling the materials but were engaged through questions and discussions as they observed from their designated positions."(Observations 4,5,6,10,11 and 12, 10th, 11th ,23rd and 24th September 2024)
The analysis highlights that the teachers prioritize safety while conducting laboratory activities, ensuring that students can observe experiments in a secure and controlled environment. By positioning students at a safe distance and adhering to strict safety protocols, such as using protective equipment and providing clear instructions, teachers minimize risks associated with handling chemicals and equipment. This approach not only safeguards students but also creates an opportunity for effective learning, as students can focus on understanding the experimental process without distractions or safety concerns. Additionally, engaging students through explanations and discussions during the demonstrations enhances their conceptual understanding and fosters curiosity about practical applications of Chemistry. The findings reflect a balance between safety and educational value in laboratory activities, ensuring that students gain observational and theoretical insights while adhering to necessary precautions.

4.2.4 The Role of Technology in Chemistry Teaching Strategies

Most of the participants (Interviews-1,3,4,5 and 6, 1st ,3rd, 15th, 16th and 17th September 2024) shared that the technology plays an important role in their chemistry teaching

strategies because it helps them a lot in better understanding of the subject and it also aid them in gathering information or making worksheets.

The analysis suggests that technology plays a pivotal role in enhancing Chemistry teaching strategies by supporting both instructional delivery and resource preparation. According to the participants, technology aids in simplifying complex concepts, enabling students to achieve a better understanding of the subject through visualizations, simulations, and multimedia tools. Additionally, it empowers teachers to gather diverse resources, design engaging worksheets, and create more dynamic lesson plans, thereby enriching the learning experience. This integration of technology not only enhances the accessibility and quality of educational materials but also reflects an adaptive teaching approach that aligns with modern educational practices. By leveraging technology effectively, teachers can bridge gaps in student comprehension and foster a more interactive and engaging classroom environment.

4.2.5 Reflecting on and Improving Teaching Practices

The participants were asked about their opinion on how they reflect on and improve their teaching strategies over time. In that moment some of the participants (Interviews- 2,3 and 4, 2nd,3rd and 15th September 2024) replied that by taking feedback from the students. While, others (Interviews 1,5 and 6, 1st ,15th and 16th September 2024) replied, by gaining more experiences by teaching the subjects or by keeping updated from the research findings.

The analysis indicates that the participants employ reflective practices to continuously improve their teaching strategies, highlighting a commitment to professional growth and adapting to student needs. Participants feedback reveals that the teachers actively seek insights from learners to identify areas for improvement and adjust their methods accordingly. This strategy fosters a collaborative learning environment and ensures teaching approaches remain relevant and effective. Conversely, some participants focus on gaining experience through teaching and staying updated with research findings, demonstrating a long-term commitment to their professional development. By integrating practical teaching experience with the latest educational advancements, these teachers ensure their strategies evolve with changing curriculum demands and pedagogical trends. Together, these approaches underscore the participants' dedication to reflective and

informed teaching practices, balancing immediate classroom dynamics with broader professional growth.

4.3 Factors Affecting the Effectiveness of Chemistry Teaching

According to the participants in the interview, the most difficult aspects of teaching chemistry are the abstract ideas because the subject includes a lot of abstract theories and concepts that can be difficult for students to visualize and comprehend, like quantum mechanics and atomic structure (Interview-1, 1st September 2024). Secondly, they stated that mathematical skills are necessary for calculations involving molarity, stoichiometry, thermodynamics, and kinetics, which can be challenging for certain students (Interview-3 and 4, 3rd and 15th September 2024). Thirdly, maintaining laboratory safety can be very difficult, particularly when dealing with younger students who might not understand the significance of following lab procedures, which could result in mishaps (Interview-5 and 2, 2nd and 16th September 2024). Lastly, it can be hard to keep students interested and motivated to learn chemistry, and it can occasionally feel dry or difficult (Interview-6, 17th September 2024).

The analysis reveals several key challenges that teachers face when teaching Chemistry, particularly in making the subject accessible and engaging for students. First, the abstract nature of many Chemistry concepts. This challenge highlights the need for innovative teaching strategies, such as visual aids or interactive models, to help bridge the gap between theory and student comprehension. Second, the necessity for mathematical skills in topics further complicates learning. This suggests that a stronger emphasis on integrating mathematical skills into the Chemistry curriculum could help students feel more confident in tackling these calculations. Additionally, laboratory safety emerges as an ongoing concern, especially with younger students who may not fully appreciate the risks of not adhering to safety protocols. This requires teachers to balance instructional time with constant reinforcement of safety procedures to ensure a secure learning environment. Finally, maintaining student interest and motivation is a recurring challenge, particularly when dealing with abstract or seemingly disconnected material. Teachers must find ways to make Chemistry relevant and engaging, possibly by connecting lessons to real-world applications or using hands-on activities to foster curiosity and excitement. Overall, these challenges highlight the complexity of teaching

Chemistry and the need for adaptive strategies that address both the intellectual and motivational needs of students.

The Participants noted that they faced numerous difficulties in maintaining students' interest and engagement in chemistry. Firstly, students frequently find it difficult to understand how chemistry relates to their personal lives or potential careers, which lowers their motivation to study the subject thoroughly (Interview-2,4,6, 2nd ,15th ,17th September 2024). Secondly, chemistry requires students to memorize intricate terms, formulas, and reaction mechanisms, which can make learning tiresome and intimidating (Interview-1,3,5 1st ,3rd ,16th September 2024). Thirdly, the reputation of chemistry as a difficult subject can demotivate students right away and establish a psychological barrier to participation (Interview-3,2,5. 3rd, 2nd, 16th September 2024). Lastly, students' intrinsic interest in chemistry may be weakened by frequent testing and a grade-focused approach that makes chemistry seem like something to be endured rather than enjoyed (Interview-1,4, 6, 1st ,15th ,16th September 2024)

The findings reveal significant challenges in maintaining student interest and engagement in Chemistry, stemming from a combination of factors. A lack of perceived relevance makes it difficult for students to connect Chemistry to their personal lives or future careers, diminishing motivation. The subject's reliance on memorization of intricate terms, formulas, and reaction mechanisms further exacerbates this issue, making it appear daunting and tedious. Additionally, Chemistry's reputation as a difficult subject creates a psychological barrier, discouraging active participation and fostering apprehension among students. The frequent emphasis on testing and a grade-driven approach further detracts from intrinsic interest, as students perceive Chemistry as a chore to endure rather than a field to explore. Addressing these challenges requires educators to make Chemistry relatable through real-world applications, reduce its intimidation factor by building student confidence, and foster curiosity with engaging, exploratory, and less grade-centric learning experiences.

The participants pointed out that evaluating students' performance and comprehension in chemistry presents many difficulties. Firstly, assessments in chemistry frequently require striking a balance between theoretical understanding and practical application so, it can

be challenging to make sure that tests are fair and thorough while still covering both factors (Interview-1,2,6, 1st ,2nd ,17th September 2024). Secondly, teachers may not have enough time to perform comprehensive assessments due to the restrictive nature of high school schedules (Interview-3,4,5, 3rd ,15th ,16th September 2024). Thirdly, different learning styles and speeds can be found among students in the same classroom because of this diversity, developing tests that are suitable for every student is difficult (Interview-1,4, 1st, 15th September 2024). Lastly, due to the proliferation of online resources, students may copy their answers, particularly for homework assignments, which makes it difficult for teachers to assess their true comprehension (Interview-2, 5, 2nd ,16th September 2024).

The findings concentrate on the multifaceted challenges teachers face in evaluating students' performance and comprehension in Chemistry. Designing assessments that balance theoretical understanding with practical application is particularly demanding, as it requires careful planning to ensure fairness and thoroughness. Time constraints within high school schedules exacerbate this issue, limiting opportunities for comprehensive evaluations and detailed feedback. Additionally, the diversity in students' learning styles and speeds complicates the development of assessments that are both inclusive and academically rigorous. The reliance on memorization by some students further undermines the ability to gauge true understanding, as rote learning often masks gaps in conceptual knowledge. Moreover, the ease of access to online resources has led to increased instances of copied assignments, making it difficult for teachers to accurately assess students' genuine comprehension. These challenges emphasize the need for innovative, flexible, and integrity-focused assessment strategies that prioritize deep learning over superficial performance.

The participants highlighted several changes and forms of assistance they believe would improve the quality of Chemistry instruction in Bangladeshi high schools. As, one of the participants (Interview-2, 2nd September 2024) suggested that "training on how to effectively use laboratory equipment would significantly enhance teaching practices." Similarly, another participant (Interview-4, 15th September 2024) emphasized the importance of "regular teacher training programs to keep teachers updated with modern pedagogical methods." One participant (Interview-5, 16th September 2024) added that

"workshops focusing on innovative teaching strategies and hands-on activities would help make Chemistry more engaging and accessible for students". These responses underscore the participants' belief that structured training and professional development opportunities are critical for enhancing Chemistry education.

The findings suggest that the participants recognize the need for professional development and resources to improve the quality of Chemistry instruction in Bangladeshi high schools. They identified laboratory training, teacher development programs, and workshops as essential tools for enhancing teaching practices. Laboratory training, in particular, is seen as crucial for equipping teachers with the skills to use laboratory equipment effectively and to create more hands-on, practical learning experiences. Furthermore, ongoing teacher training and workshops would enable educators to stay updated with modern teaching methods and innovative approaches, which are important for engaging students and fostering a deeper understanding of Chemistry. This indicates a clear need for systemic support that focuses not only on theoretical knowledge but also on practical teaching skills and effective classroom management. The emphasis on workshops and safe lab practices highlights the importance of improving the physical and pedagogical resources available to teachers, ultimately enhancing the overall quality of Chemistry education.

Chapter 5
Discussion and Conclusion of the Study

The discussion aims to explore the various factors affecting the effectiveness of Chemistry teaching in Bangladeshi high schools, based on the perspectives and practices of Chemistry teachers. Through interviews and classroom observations, key challenges, strategies, and improvements in the teaching of Chemistry are examined. Additionally, the discussion highlights the teachers' reflective practices and the need for professional development for enhancing the quality of Chemistry instruction. The analysis emphasizes the importance of addressing both intellectual and motivational aspects of teaching to create a more engaging and effective learning environment for students. It is being divided into two sections according to the research questions.

Section 1: Teaching Practices of Chemistry by High School Chemistry Teachers (Grades 7 to 9) in English Medium Schools in Bangladesh.

1.1 Role and Utilization of Textbooks in Chemistry Teaching Practices

The findings reveal a strong reliance on standardized textbooks in Chemistry teaching practices in English medium schools following the Edexcel and Cambridge curricula. The schools' emphasis on selecting certified textbooks ensures alignment with international curriculum standards, catering to the progression from basic to advanced topics. According to Savage and Savage (2010), textbooks play a crucial role in ensuring curriculum fidelity, providing teachers with a structured resource that aligns with examination requirements. This structured approach was evident in both the interviews and classroom observations, where textbooks served as the primary instructional tool.

Such reliance reflects the schools' commitment to maintaining high educational standards and ensuring students are well-prepared for their examinations.

However, while the use of standardized textbooks provides consistency and alignment, it may also limit teachers' flexibility to adapt their methods to students' diverse learning needs. Teachers' reliance on predefined textbooks might discourage the incorporation of supplementary resources or innovative pedagogies that could enhance student engagement and understanding. As Vavrus, Thomas, and Bartlett (2011) suggest, while textbooks provide essential structure, effective teaching also requires adapting resources to contextual needs. The analysis underscores the need for schools to encourage teachers to supplement textbooks with additional materials and strategies that foster critical thinking and problem-solving skills, key components of effective Chemistry education. Furthermore, the provision of textbooks and detailed syllabi at the beginning of the academic session supports a systematic approach to curriculum delivery, reducing the workload of teachers in planning lessons. However, this standardized approach might lead to over-dependence on textbooks as the sole resource, potentially stifling creativity in teaching. As highlighted by Ball and Cohen (1996), textbooks should be used as a guide rather than a prescription, allowing teachers to adapt and innovate based on students' needs and classroom dynamics. Future research could explore how supplementary resources and teacher autonomy can be integrated with the use of standardized textbooks to create a more holistic and dynamic learning environment in Chemistry classrooms.

1.1.1 Integration of Research Papers and Online Resources in Teaching Practices

The findings illustrate that Chemistry teachers in English medium schools are leveraging online platforms and research papers to supplement their lessons and remain updated with the latest developments in their field. Teachers frequently utilize websites such as Save My Exams, Google, and the Pearson website to access exam-focused materials, curriculum-aligned resources, and research articles. This reflects their dedication to enhancing the quality of instruction and providing students with diverse and relevant learning materials. According to Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework, integrating technology into teaching requires not only subject knowledge but also the ability to use digital resources effectively to

enhance pedagogy. The participants' reliance on these platforms demonstrates an emerging practice of blended learning, combining traditional and digital resources to enrich the classroom experience.

However, the findings also point to a potential limitation in the diversity of resources used, as teachers rely on a narrow set of websites. This limited scope may reduce the variety of teaching methodologies and materials available to students. Research by Reimers and Schleicher (2020) emphasizes the importance of equipping teachers with skills to critically evaluate and diversify digital resources to meet students' evolving needs. To address this, schools could provide professional development programs focused on resource evaluation and integration. By broadening their repertoire of online tools and research-based materials, teachers could further enhance their instructional strategies, promoting critical thinking and problem-solving skills in students. This would help create a more dynamic and effective learning environment, aligning with 21st-century educational goals.

1.1.2 Analysis of Laboratory Resources and Their Impact on Chemistry Teaching

The observations reveal a stark contrast in laboratory resources between School-A and School-B, significantly influencing the nature of Chemistry instruction. School-A's well-equipped laboratory provided the infrastructure for conducting comprehensive experiments, fostering opportunities for hands-on learning. However, despite the availability of advanced equipment, teachers limited student participation, potentially due to safety concerns, time constraints, or rigid curriculum guidelines. This aligns with Hofstein and Lunetta's (2004) findings, which emphasize that the mere presence of laboratory resources does not guarantee effective student engagement. Educators must integrate practical work into lessons thoughtfully, ensuring that it aligns with learning objectives and actively involves students to develop their experimental skills and scientific inquiry.

In contrast, School-B, which lacked a dedicated laboratory, relied on basic equipment for demonstration-based teaching, limiting students' opportunities for direct involvement in experiments. While such demonstrations help convey scientific principles, the absence of hands-on activities reduces the depth of students' experiential learning. Research by Abrahams and Reiss (2012) underscores the importance of active student participation in

laboratory activities, noting that it enhances their understanding of scientific concepts and nurtures critical thinking. These findings highlight the need for targeted professional development programs for teachers in both schools to maximize the impact of available resources. For School-A, this involves fostering strategies to increase student participation in practical work, while for School-B, teachers could explore innovative, low-cost methods to involve students in experiments despite limited resources, ensuring equitable learning opportunities.

1.1.3 Strategies for Guiding Students Toward Reliable Chemistry Teaching Resources

The findings highlight that teachers actively guide students in accessing reliable Chemistry resources by sharing links to trusted websites, YouTube videos, and other digital materials. This practice aligns with the increasing use of technology in education, which allows teachers to supplement traditional instruction with diverse, accessible resources that enhance students' understanding of complex topics. Research by Ertmer and Ottenbreit-Leftwich (2010) underscores the value of integrating technology into teaching practices, emphasizing that it fosters deeper learning and improves student engagement. By providing curated resources, teachers help students explore topics in depth, address conceptual gaps, and cater to varied learning styles, such as visual or self-directed learners. This approach also supports students in developing independent learning skills, preparing them for lifelong learning.

However, the effectiveness of this guidance depends on students' ability to critically evaluate and effectively use the resources provided. As McGrew, Breakstone, Ortega, Smith, and Wineburg (2018) note, the prevalence of online information necessitates the ability to discern credible from unreliable sources. Teachers could enhance this practice by incorporating lessons on evaluating the credibility of online materials, such as recognizing authoritative sources or understanding bias in digital content. Additionally, introducing structured assignments that require students to use the shared resources effectively could further solidify their skills in navigating and applying online materials. By combining guidance with critical evaluation training, teachers can ensure that students not only access reliable resources but also maximize their potential in enriching their Chemistry education.

1.2 Impact of Teaching Approaches on Student Engagement and Conceptual Understanding in Chemistry

The findings underscore the pivotal role of structured lesson planning and effective classroom management in enhancing the quality of Chemistry instruction in both schools. In School-A, teachers submitted weekly lesson plans, demonstrating a proactive approach to preparedness, even with larger class sizes. Research by Marzano et al. (2003) highlights that well-structured lesson planning improves classroom management, ensuring that content delivery is systematic and aligned with learning objectives. However, larger class sizes in School-A presented challenges, as teachers had to allocate additional time for maintaining discipline, which slightly impacted lesson delivery. Despite these challenges, teachers maintained instructional quality, reflecting their dedication to effective teaching practices.

In contrast, the smaller class sizes in School-B allowed teachers to engage more personally with students, fostering a focused and interactive learning environment. This supports the findings of Blatchford, Bassett, and Brown (2011), who argue that smaller classes enable more targeted support and better student-teacher interactions, enhancing learning outcomes. The proactive term-wise lesson planning observed in School-B further streamlined classroom activities, contributing to uninterrupted teaching and a cohesive flow of lessons. While both schools demonstrated consistency in aligning pedagogical planning with classroom execution, the smaller class sizes in School-B provided a distinct advantage in managing student engagement and ensuring personalized attention.

Despite the strengths observed in lesson planning and classroom management, moderate levels of student interest and motivation in both schools indicate an area for improvement. Incorporating innovative teaching methods, such as inquiry-based learning or real-life applications of Chemistry, could stimulate curiosity and deepen students' understanding of the subject. According to Prince and Felder (2006), active learning strategies, including problem-solving tasks and real-world applications, enhance student engagement and promote critical thinking. By integrating such approaches, teachers could further enrich the learning environment, fostering greater enthusiasm and

participation among students. This highlights the need for professional development programs to equip teachers with skills to implement innovative methodologies, ensuring a balance between traditional and modern pedagogical practices.

1.2.1 Effective Teaching Strategies Adopted by Chemistry Educators

The teaching strategies employed by the participants reveal a multifaceted approach to making Chemistry accessible and engaging for students. A strong emphasis on explaining main concepts, as reported by several participants, aligns with constructivist theories of learning, which highlight the importance of building a robust foundational understanding before progressing to advanced topics (Vygotsky, 1978). Furthermore, the use of relatable examples and continuous repetitions demonstrates an effort to reinforce learning and promote retention, which aligns with Bloom's Taxonomy's principles of ensuring comprehension and recall through repetition and application (Krathwohl, 2002). These approaches not only address cognitive learning objectives but also cater to the varying levels of prior knowledge among students, fostering inclusivity and adaptability in teaching practices.

In addition to foundational strategies, some participants employed methods to bridge theoretical concepts with practical applications, making Chemistry more relatable to everyday life. Research by Gilbert (2006) supports this approach, emphasizing that connecting scientific concepts to real-world scenarios enhances student engagement and understanding. The use of diagrams and demonstrations further reinforces this idea, as visual aids are particularly effective in clarifying abstract concepts and catering to diverse learning styles (Mayer, 2009). Together, these strategies demonstrate a comprehensive teaching methodology that balances conceptual clarity, practical relevance, and diverse instructional techniques, reflecting an effort to address the holistic needs of students. However, there is potential for further enhancement by incorporating more interactive and inquiry-based learning methods to deepen student involvement and critical thinking.

1.2.2 Strategies for Enhancing Student Engagement

The strategies employed by teachers to make Chemistry engaging and accessible for students reflect a thoughtful and adaptive approach to addressing diverse learning needs. One effective technique involves highlighting the career opportunities associated with Chemistry, as mentioned by several participants. Research indicates that connecting

academic subjects to real-world applications and future careers can significantly increase student motivation and interest (Eccles & Wigfield, 2002). By illustrating the subject's practical value, teachers help students perceive Chemistry not merely as a challenging academic discipline but as a pathway to potential professional success. Additionally, the provision of extra classes for struggling students, as observed in this study, aligns with differentiated instruction strategies that aim to provide personalized support to ensure no learner is left behind (Tomlinson, 2001).

Moreover, allocating time for addressing student queries and repeating lessons fosters a supportive classroom environment where learners feel comfortable seeking help. These practices align with the principles of inclusive education, emphasizing the importance of adapting teaching methods to cater to diverse learning styles and paces (UNESCO, 2017). Additionally, ensuring safety during laboratory activities by allowing students to observe from a safe distance demonstrates a balance between practical learning and student welfare, reinforcing the importance of structured yet engaging teaching practices. Together, these techniques highlight the role of teacher initiative in creating an interactive and supportive educational environment, which is crucial for maintaining student interest and enhancing learning outcomes in Chemistry.

1.2.3 Balancing Safety and Educational Effectiveness in Laboratory Practices

Ensuring safety in laboratory settings is a critical component of effective Chemistry education, as it fosters a secure learning environment while promoting the understanding of scientific concepts. Observations from both School-A and School-B indicate that teachers prioritize safety by maintaining strict protocols, such as positioning students at a safe distance from the experimental setup and using protective equipment like gloves and goggles. These practices align with findings by Scherz and Schorr (2019), who emphasized that incorporating safety measures during laboratory activities not only prevents accidents but also instills a culture of safety in students, preparing them for future scientific endeavors. By providing clear instructions on safety protocols and demonstrating experiments with precision, teachers ensure that students remain engaged while observing the experimental process without being exposed to risks. This approach helps students focus on the scientific principles underlying the experiments, fostering a deeper understanding of the subject matter.

Additionally, the integration of safety measures with interactive teaching strategies enhances the educational value of laboratory activities. Teachers in both schools were observed engaging students through detailed explanations and discussions during demonstrations, which aligns with Vavrus et al.'s (2018) assertion that interactive learning enhances student engagement and critical thinking. While students were not directly involved in conducting experiments, their active participation in discussions allowed them to connect theoretical knowledge with practical applications. This method reflects the importance of balancing observational learning with hands-on experiences to ensure safety while maintaining the educational integrity of laboratory sessions. Such strategies underscore the significance of well-structured and safety-oriented laboratory practices in fostering curiosity, enhancing comprehension, and building students' confidence in applying Chemistry concepts effectively.

1.2.4 Evaluating and Enhancing Teaching Practices for Effective Learning

The findings reveal that participants employ a combination of reflective practices and professional development strategies to improve their teaching methods, highlighting their dedication to continuous growth. The participants' relying on student feedback, aligns with the principles of student-centered learning. According to Hattie (2009), feedback is a powerful tool for improving teaching effectiveness, as it provides insights into how students perceive and engage with the material. By seeking feedback, teachers can identify gaps in their strategies and make informed adjustments to meet learners' needs. This practice not only enhances instructional quality but also fosters a collaborative learning environment where students feel their voices contribute to shaping the teaching process. Moreover, incorporating student feedback ensures that teaching strategies remain adaptive and relevant, catering to the diverse and evolving needs of learners (Brookfield, 2017).

On the other hand, the participants emphasized professional growth through teaching experience and staying updated with research findings. This aligns with the concept of lifelong learning, where educators actively seek to refine their skills and knowledge over time. Research by Guskey (2002) highlights the importance of professional development in enhancing teacher effectiveness, emphasizing that staying informed about current educational research enables teachers to adopt evidence-based practices. Additionally,

practical teaching experience provides opportunities for reflection, allowing educators to evaluate the success of their methods and incorporate lessons learned into future practices (Schön, 1983). Together, these reflective and developmental approaches underscore the importance of blending immediate classroom experiences with ongoing professional learning to create dynamic and effective teaching strategies that benefit both educators and students.

SECTION 2: CHALLENGES FACED BY THE TEACHERS

Analyzing Challenges in the Effectiveness of Chemistry Teaching

The analysis highlights several challenges faced by Chemistry teachers in Bangladeshi high schools, which significantly affect the effectiveness of instruction.

2.1 Abstract Nature of Chemistry

Teachers reported that the abstract nature of Chemistry concepts, such as quantum mechanics and atomic structure, posed significant challenges. Research by Johnstone (2000) highlights that such abstract topics in science demand high cognitive engagement, making visualization particularly difficult for students. Studies also suggest that employing visualization techniques, such as diagrams, molecular models, or computer simulations, can significantly aid in bridging the gap between abstract theory and comprehension (Harrison & Treagust, 2000). These methods can play a critical role in reducing the cognitive load associated with learning abstract concepts. Studies indicate that abstract topics in science often demand high cognitive engagement, making them difficult for students to visualize (Johnstone, 2000). This finding underscores the importance of employing models, diagrams, and simulations to make abstract concepts more accessible and the Chemistry teachers can use techniques to encounter these challenges.

2.2 Mathematical Requirements

Chemistry's reliance on mathematical skills, especially in areas like stoichiometry, thermodynamics, and kinetics, was highlighted as a challenge. Research supports that students often struggle with the integration of math in science subjects, which can hinder

their overall comprehension (Beerenwinkel & von Arx, 2017). Teachers suggested additional training and resources to address these gaps.

2.3 Laboratory Safety and Resources

The disparity between schools in terms of laboratory resources and safety practices was evident. While one school had a well-equipped lab, the other lacked sufficient facilities, requiring teachers to conduct simple demonstrations in classrooms. The literature emphasizes that hands-on laboratory experiences are essential for fostering scientific inquiry and understanding (Hofstein & Lunetta, 2004). Limited resources, however, constrain the ability to offer such experiences, potentially affecting students' learning outcomes.

2.4 Student Motivation and Engagement

Maintaining students' interest and motivation in Chemistry was identified as another challenge. Studies have shown that incorporating gamification and relevance-based instruction can enhance student engagement and make the learning experience more interactive and enjoyable (Barata, Gama, Jorge, & Gonçalves, 2015). This approach aligns with the observation that connecting Chemistry to real-life contexts or career pathways may help mitigate the perceived difficulty of the subject and sustain interest (Holbrook & Rannikmae, 2009). Factors such as the perceived difficulty of the subject, the memorization required, and a grade-focused approach contribute to this issue. Research suggests that fostering a growth mindset and highlighting the relevance of Chemistry in real-world contexts can help improve student engagement (Dweck, 2006).

2.5 Assessment Challenges

Teachers faced difficulties in developing assessments that balance theoretical knowledge and practical skills, cater to diverse learning styles, and discourage rote memorization. The time constraints imposed by school schedules further complicated this process. Literature highlights the importance of formative assessments and alternative evaluation methods to support diverse learners (Heritage, 2010).

5.2 Conclusion

This study investigated the teaching practices and challenges faced by high school Chemistry teachers of Grades 7 to 9 in English medium schools in Bangladesh. The

findings revealed that teachers employ a range of strategies, including conceptual explanations, real-life applications, and interactive teaching methods, to facilitate student engagement and understanding. The use of standardized curricula, supported by textbooks aligned with international examination boards, ensures consistency and adherence to global benchmarks in Chemistry education. Teachers also leverage digital tools and platforms to enhance their instructional strategies, aligning with modern pedagogical practices.

A clear framework for enhancing chemistry instruction in Bangladeshi English-medium high schools is provided by the discussions. First, digital platforms and interactive tools, which assist students in making the connection between abstract concepts and real-world applications, can enhance the use of textbooks, even though they are necessary for standardized learning. The educational process can be improved by teachers using a variety of online resources and supplemental materials, which can make learning more engaging and approachable.

The unequal availability of laboratory resources among schools emphasizes the necessity of expanding students' access to practical experiences, which are essential for enhancing their comprehension of chemistry. Alternative approaches like virtual simulations or portable lab kits could fill the gap when schools don't have fully furnished labs, enabling students to interact with chemistry in meaningful ways. For younger students in particular, improving lab safety procedures is essential to establishing a safe learning environment.

The results also highlight the importance of formative and summative evaluations in effectively monitoring students' development. Continuous feedback from formative assessments integrated into grading systems can help teachers modify their teaching strategies and students identify and close learning gaps.

Furthermore, it is clear that continuing professional development is crucial for supporting teachers. Opportunities for training in laboratory safety, technology integration, and modern teaching techniques can enable educators to better manage a variety of classroom issues. Finally, by demystifying difficult ideas and demonstrating the subject's relevance to real-world situations, incorporating career relevance and real-world examples into chemistry lessons can boost student motivation and engagement.

In conclusion, these discussions suggest a more comprehensive and encouraging method of teaching chemistry—one that prioritizes constant professional development for educators, strikes a balance between supplemental and standardized resources, and stresses experiential learning. By putting these tactics into practice, educators can establish a classroom setting that improves students' understanding of chemistry and science in general while also preparing them academically.

References

Abrahams, I., & Reiss, M. J. (2012). Practical work: Its effectiveness in primary and secondary schools in England. *Journal of Research in Science Teaching, 49*(8), 1035–10

Adams, R. (2021). American curriculum: Key features and benefits. *Education Today.*

Akram, T. M., Ijaz, A., & Ikram, H. (2019). Exploring chemistry teachers' perception of inquiry-based learning approach in developing students' problem-solving skills. *Journal of Research in Science Teaching, 56*(8), 1071-1094.

Al Amin, M., & Hamid, M. O. (2023). English as a medium of instruction and inequality: Exploring private sector higher education in Bangladesh. In P. H. Bharati & B. R. Sahu (Eds.), *Policies, Politics, and Ideologies of English-Medium Instruction in Asian Universities* (pp. 167-183). Routledge.

American Chemical Society. (2012). *Chemistry in the National Science Education Standards: Models for meaningful learning in the high school chemistry classroom.* ACS Publications.

Andrews, D. A., Sekyere, E. O., & Bugarcic, A. (2020). Collaborative active learning activities promote deep learning in a chemistry-biochemistry course. *Medical Science Educator, 30*, 801-810.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10-20. https://doi.org/10.1016/j.tate.2010.08.007

Ayodele, J. B. (2012). The impact of school facilities on the teaching and learning of Chemistry in secondary schools. *Journal of Education and Practice, 3*(1), 13-21.

Barkar, N. A., Saat, R. M., & Noorzaei, J. (2020). Chemistry and its importance in everyday life. *International Journal of Chemistry Education Research, 4*(2), 113-121. https://doi.org/10.20885/ijcer.vol4.iss2.art4

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6-8.

Barker, V., & Millar, R. (2000). Students' reasoning about basic chemical thermodynamics and chemical bonding: What changes occur during a context-based post-16 chemistry course? *International Journal of Science Education, 22*(11), 1171-1200. https://doi.org/10.1080/095006900750048648

Beerenwinkel, A., & von Arx, M. (2017). The role of mathematical competence in science education. *International Journal of Science Education, 39*(4), 467-482.

Biggs, J. (2003). *Teaching for quality learning at university.* McGraw-Hill Education.

Blaschke, L. M., & Hase, S. (2016). Heutagogy: A holistic framework for creating twenty-first-century self-determined learners. In S. Hase & C. Kenyon (Eds.), *Self-determined learning: Heutagogy in action* (pp. 25-40). Bloomsbury Academic.

Blatchford, P., Bassett, P., & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher-pupil interaction: Differences in relation to pupil prior attainment and primary vs. secondary schools. *Learning and Instruction, 21*(6), 715-730.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice, 5*(1), 7-74.

Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan, 80*(2), 139-148.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5-31. https://doi.org/10.1007/s11092-008-9068-5

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Brookfield, S. D. (2017). *Becoming a critically reflective teacher.* Jossey-Bass.

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Bunce, D. M., & Gabel, D. L. (2000). Enhancing chemistry problem-solving achievement using problem categorization. *Journal of Research in Science Teaching, 37*(7), 769-792.

Buckley, M., & Bretz, S. L. (2012). Using technology to support inquiry-based learning in large undergraduate chemistry classes. *Chemistry Education Research and Practice, 13*(3), 205-212.

Cambridge Assessment International Education. (2020). The Cambridge approach to assessment. *Cambridge University Press.* Retrieved from https://www.cambridgeinternational.org

Cambridge Assessment International Education. (2023). About the Cambridge curriculum. *Cambridge University Press.* Retrieved from https://www.cambridgeinternational.org

Chowdhury, A. M. R., & Nath, S. R. (2016). English medium education in Bangladesh: A historical overview. *The Journal of English Language Teaching and Learning, 6*(13), 1-14.

Chowdhury, T. B. M., Holbrook, J., Reis, P., & Rannikmäe, M. (2021). Bangladeshi science teachers' perceived importance and perceived current practices in promoting science education through a context-based, socio-scientific framework. *Science & Education,* 1-37.

Chu, H. E., & Treagust, D. F. (2014). Secondary students' stable and unstable optics conceptions using contextualized questions. *Journal of Science Education and Technology, 23*(2), 249-263. https://doi.org/10.1007/s10956-013-9471-9

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Darling-Hammond, L. (2017). Teacher education around the world: What can we learn from international practice? *European Journal of Teacher Education, 40*(3), 291-309.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional learning in the learning profession: A status report on teacher development in the United States and abroad. *National Staff Development Council.*

Darling-Hammond, L., Flook, L., Cook-Harvey, Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97-140. https://doi.org/10.1080/10888691.2018.1537791

Demircioğlu, G. (2018). Teaching chemistry to English language learners: An inquiry-based approach. *Journal of Chemical Education, 95*(8), 1290–1295. https://doi.org/10.1021/acs.jchemed.8b00097

Dr Md. Mahmudul, H. (2019). English medium education system in Bangladesh.

Dweck, C. S. (2006). *Mindset: The new psychology of success.* Random House.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*(1), 109-132.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3), 255-284

Fatokun, K. V. F., & Eniayeju, P. A. (2014). The effect of concept mapping-guided discovery integrated teaching approach on Chemistry students' achievement and retention. *Educational Research and Reviews, 9*(22), 1218–1223.

Francis, T. T., & Baba, S. J. (2023). Effect of concept mapping teaching approach on students' academic performance in chemistry in senior secondary schools. *Indonesian Journal of Educational Research and Technology, 3*(1), 69–78.

Fraser, B. J., & Walberg, H. J. (2005). Research on teacher-student relationships and learning environments: Context, content, and analysis. *International Journal of Educational Research, 43*(1–2), 27–50. https://doi.org/10.1016/j.ijer.2006.03.002

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415.

Gabel, D. L. (1999). Improving teaching and learning through Chemistry education research: A look to the future. *Journal of Chemical Education, 76*(4), 548. https://doi.org/10.1021/ed076p548

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education, 28*(9), 957–976.

Goh, N. K., Toh, K. A., & Chia, L. S. (2013). Developing creative thinking skills in science students through a simulation-based learning environment. *Instructional Science, 41*(5), 957–972.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice, 8*(3), 381–391.

Haque, M. R. (n.d.). Infusing scaffolding, Zone of Proximal Development, and formative assessment to improve chemistry teaching at Chittagong College, Bangladesh. *Chittagong College, 1716*, 75.

Haider, S. Z. (n.d.). Chemical education in Bangladesh. *Department of Chemistry, Dhaka University, Dhaka – 1000, Bangladesh.*

Harlen, W. (2007). *Assessment of learning.* SAGE Publications.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–112.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* Routledge.

Heritage, M. (2010). *Formative assessment: Making it happen in the classroom.* Corwin Press.

Herga, N. R., Čagran, B., & Dinevski, D. (2016). Virtual laboratory in the role of dynamic visualization for better understanding of chemistry in primary school. *Eurasia Journal of Mathematics, Science and Technology Education, 12*(3), 593–608.

Hegarty-Hazel, E. (1990). *The student laboratory and the science curriculum.* Routledge.

Hilton, J. (2016). Open educational resources and college textbook choices: A review of research on efficacy and perceptions. *Educational Technology Research and Development, 64*(4), 573–590.

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education, 88*(1), 28–54.

Hofstein, A., & Mamlok-Naaman, R. (2007). The laboratory in science education: The state of the art. *Chemistry Education Research and Practice, 8*(2), 105–107.

Hofstein, A., & Kind, P. M. (2012). Learning in and from science laboratories. *Chemistry Education Research and Practice, 13*(1), 59–68. https://doi.org/10.1039/C1RP90032A

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental and Science Education, 4*(3), 275–288.

Hossain, S. M., & Kamal, M. M. (2016). Teacher pedagogy and student engagement in Chemistry classrooms in Bangladesh. *Asian Journal of Education and Social Studies, 1*(4), 1–10. https://doi.org/10.9734/AJESS/2016/26656

International Baccalaureate Organization. (2023). What is the IB? Retrieved from https://www.ibo.org

Islam, M. R., Rahman, T., & Sultana, S. (2022). The impact of English version education on academic performance in Bangladesh. *Asian Education Review, 10*(3), 45–55.

Islam, M. R., Ahmed, K., & Rahman, M. F. (2020). Enhancing Chemistry education through laboratory-based learning in Bangladesh. *Journal of Science Education and Technology, 29*(2), 123–133. https://doi.org/10.1007/s10956-019-09894-4

Iyamuremye, A., Nsabayez, E., Ngendabanga, C., & Hagenimana, F. (2023). Effectiveness of hands-on practical activities in teaching and learning Chemistry: An exploration of students' engagement, experience, and academic performance. *African Journal of Educational Studies in Mathematics and Sciences, 19*(1), 97–107.

Johnstone, A. H. (2000). Teaching of chemistry—Logical or psychological? *Chemistry Education Research and Practice, 1*(1), 9–15.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365–379.

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning, 7*(2), 75–83. https://doi.org/10.1111/j.1365-2729.1991.tb00210.x

Johnstone, A. H., & Al-Shuaili, A. (2001). Learning in chemistry: What should we be teaching? *Chemistry Education: Research and Practice in Europe, 2*(2), 123–158.

Kala, S., Yaman, M., & Alyuz, N. (2021). Investigating students' difficulties in learning chemistry concepts: A case study in Indonesia. *International Journal of Instruction, 14*(4), 567–586. https://doi.org/10.29333/iji.2021.14433a

Krathwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice, 41*(4), 212–218.

Kvale, S. (2007). *Doing interviews.* SAGE Publications.

Liu, X. (2006). Effects of combined hands-on laboratory and computer modeling on student learning of gas laws: A quasi-experimental study. *Journal of Science Education and Technology, 15*, 89–100.

Logar, A., & Savec, V. F. (2011). Students' hands-on experimental work vs lecture demonstration in teaching elementary school chemistry. *Acta Chimica Slovenica, 58*(4).

Lucas, S., & Wright, P. (2014). Safety in the science classroom: A review of laboratory safety practices and their implications for Chemistry teaching. *Journal of Chemical Education, 91*(2), 222–228. https://doi.org/10.1021/ed400535x

Marzano, R. J., Marzano, J. S., & Pickering, D. J. (2003). *Classroom management that works: Research-based strategies for every teacher.* ASCD.

Mayer, R. E. (2009). *Multimedia learning.* Cambridge University Press.

McGrew, S., Breakstone, J., Ortega, T., Smith, M., & Wineburg, S. (2018). Can students evaluate online sources? Learning from assessments of civic online reasoning. *Theory & Research in Social Education, 46*(2), 165–193.

McKee, E., Williamson, V. M., & Ruebush, L. E. (2007). Effects of a demonstration laboratory on student learning. *Journal of Science Education and Technology, 16*, 395–400.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record, 108*(6), 1017–1054.

Meyer, J. H. F., & Land, R. (2005). Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education, 49*(3), 373–388. https://doi.org/10.1007/s10734-004-6779-5

Milon, M. R. K., Alam, M. R., & Hossain, M. R. (2018). A comparative study on the methods and practices of English language teaching in Bangla and English medium schools in Bangladesh. *Australasian Journal of Business, Social Science and Information Technology (AJBSSIT, 4*(3), 118–125.

Mousumi, M. A., & Kusakabe, T. (2017). The dynamics of supply and demand chain of English-medium schools in Bangladesh. *Globalisation, Societies and Education, 15*(5), 679–693.

National Research Council (NRC). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* The National Academies Press.

Nicholson, B. (2001). Safety in the school laboratory—Dispelling the myths. *Journal of Chemical Education, 78*(2), 143–145.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1–13.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* Cambridge University Press.

Nur-e-alam, S. M. (2014). Exploring beliefs on teaching-learning and actual practices: A case of secondary school science teachers in Bangladesh. *Hiroshima University.*

Nuruzzaman, M., Hossain, M. K., Islam, M. S., & Rahman, M. M. (2021). Exploring the status of implementing multimedia in teaching chemistry at higher secondary level in Bangladesh. *International Journal of Instruction, 14*(4), 261–282. https://doi.org/10.29333/iji.2021.14415a

Oates, T. (2010). Could do better: Using international comparisons to refine the National Curriculum in England. *Cambridge Assessment.* Retrieved from https://www.cambridgeassessment.org.uk

Ojo, O. T. (2017). Effects of information technology-integrated teaching strategies on secondary school Chemistry students' learning outcomes in Lagos State, Nigeria [Doctoral dissertation, University of Lagos (Nigeria)].

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079. https://doi.org/10.1080/0950069032000032199

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Sage Publications.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon, 9*(5), 1-6.

Prince, M., & Felder, R. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education, 95*(2), 123–138.

Raman, A., & Yamat, H. (2014). The use of technology in Chemistry classrooms: Its impact on teaching and learning. *Asian Social Science, 10*(4), 59-65. https://doi.org/10.5539/ass.v10n4p59

Rahman, S. H. (2011). Professional learning of secondary science teachers in Bangladesh (Doctoral dissertation, Monash University).

Rahman, M. M., & Chowdhury, S. A. (2018). Teaching practices in chemistry education: Challenges and strategies for improvement in Bangladesh. *International Journal of Educational Development, 62,* 12-22. https://doi.org/10.1016/j.ijedudev.2018.02.003

Reimers, F. M., & Schleicher, A. (2020). A framework to guide an education response to the COVID-19 pandemic of 2020. OECD Publishing.

Reyes, P. B., & Silang, Z. D. (2021). Integration of technology in the teaching and learning process in Chemistry. *Asia Pacific Journal of Educational Perspectives, 8*(2).

Russell, J. B., & Weaver, G. C. (2018). A review of laboratory instruction styles. *Journal of Chemical Education, 95*(2), 199-210.

Sarkar, M., & Corrigan, D. (2014). Promotion of scientific literacy: Bangladeshi teachers' perspectives and practices. *Research in Science & Technological Education, 32*(2), 162-181.

Sarker, M. A. H. (2019). English-medium schools in Bangladesh: An analysis of educational equity and language marginalization. *International Journal of English Language Teaching, 7*(3), 71-80.

Savage, T. V., & Savage, M. K. (2010). *Successful classroom management and discipline: Teaching self-control and responsibility*. SAGE Publications.

Savec, V. F., & Devetak, I. (2013). Evaluating the effectiveness of students' active learning in Chemistry. *Procedia-Social and Behavioral Sciences, 106,* 1113-1121.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.

Scherz, Z., & Schorr, Y. (2019). The role of safety awareness in science education: Implications for laboratory teaching. *Journal of Science Education and Safety, 28*(3), 345–358.

Shamim, F. (2008). Trends, issues, and challenges in English language education in Bangladesh. *Asia Pacific Journal of Education, 28*(3), 227–240. https://doi.org/10.1080/02188790802236005

Shamsudin, N. M., Abdullah, N., & Yaamat, N. (2013). Strategies of teaching science using an inquiry-based science education (IBSE) by novice Chemistry teachers. *Procedia-Social and Behavioral Sciences, 90,* 583-592.

Sharda, Z. (2023). Education: Weighing the odds between English medium and English version.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher, 29*(7), 4–14.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*(1), 153–189.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–22. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Simpson, R. D., & Oliver, J. S. (1990). A summary of research on the teaching and learning of Chemistry. *Journal of Chemical Education, 67*(9), 753-758. https://doi.org/10.1021/ed067p753

Singh, I. S., & Moono, K. (2015). The effect of using concept maps on student achievement in selected topics in Chemistry at tertiary level. *Journal of Education and Practice, 6*(15), 106-116.

Singh, J. (2020). The study of the effectiveness of the inquiry-based learning method in the Chemistry teaching learning process. *Turkish Journal of Computer and Mathematics Education (TURCOMAT, 11*(3), 867-875.

Situmorang, M., Purba, J., & Silaban, R. (2020). Implementation of an innovative learning resource with a project to facilitate active learning to improve students' performance on Chemistry. *Indian Journal of Pharmaceutical Education and Research, 54*(4), 905-914.

Smetana, L. K., & Bell, R. L. (2012). Computer simulations to support science instruction and learning: A critical review. *International Journal of Science Education, 34*(9), 1337-1370.

Srisawasdi, N. (2012). The role of simulation-based learning in improving students' understanding of Chemistry. *International Journal of Science Education, 34*(7), 1073-1090. https://doi.org/10.1080/09500693.2012.667581

Taber, K. S. (2013). Revisiting the Chemistry triplet: Drawing upon the nature of chemical knowledge and the psychology of learning to inform Chemistry education. *Chemistry Education Research and Practice, 14*(2), 156-168.

Talanquer, V. (2010). Visual representations in Chemistry education: The role of external, spatial, and internal representations. *Chemistry Education Research and Practice, 11*(1), 5-16.

Tanner, K. D., & Allen, D. (2004). Approaches to biology teaching and learning: Learning styles and the problem of instructional selection—Engaging all students in science courses. *Cell Biology Education, 3*(4), 197-201.

Tiberghien, A., Jossem, E. L., & Barojas, J. (2013). Connecting research in physics education with teacher education. International Commission on Physics Education.

Tomlinson, C. A., & Allan, S. D. (2000). *Leadership for differentiating schools & classrooms*. Association for Supervision and Curriculum Development.

Tomlinson, C. A., & Moon, T. R. (2013). *Assessment and student success in a differentiated classroom*. ASCD.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). ASCD.

Tomlinson, C. A. (1999). Mapping a route toward differentiated instruction. *Educational Leadership, 57*(1), 12-16.

Ural, E. (2016). The effect of guided-inquiry laboratory experiments on science education students' Chemistry laboratory attitudes, anxiety, and achievement. *Journal of Education and Training Studies, 4*(4), 217-227.

UNESCO. (2017). *A guide for ensuring inclusion and equity in education*. UNESCO Publishing.

Vavrus, F., Thomas, M., & Bartlett, L. (2018). Ensuring effective classroom discussions: A guide for teachers. *Pedagogy and Practice, 15*(2), 120–136.

Vavrus, F., Thomas, M., & Bartlett, L. (2011). Ensuring quality by attending to inquiry: Learner-centered pedagogy in sub-Saharan Africa. UNESCO.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. *Journal of Research in Science Teaching, 38*(2), 137–158.

Velázquez-Marcano, A., Williamson, V. M., Ashkenazi, G., Tasker, R., & Williamson, K. C. (2004). The use of video demonstrations and particulate animation in general Chemistry. *Journal of Science Education and Technology, 13,* 315-323.

Wenzel, T. J. (2008). Teaching high school Chemistry in the era of standards-based education: A qualitative study of teacher beliefs and classroom practices. *Journal of Research in Science Teaching, 45*(7), 802–824.

Wiggins, G., & McTighe, J. (2005). *Understanding by design*. ASCD.

Williamson, V. M., & Ruebush, L. E. (2007). Effects of a demonstration laboratory on student learning. *Journal of Science Education and Technology, 16,* 395-400.

Wu, H. K., Krajcik, J. S., & Soloway, E. (2001). Promoting understanding of chemical representations: Students' use of a visualization tool in the classroom. *Journal of Research in Science Teaching, 38*(7), 821-842.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

Yore, L. D., Pimm, D., & Tuan, H. L. (2007). The literacy component of mathematical and scientific literacy. *International Journal of Science and Mathematics Education, 5*(4), 559-589

APPENDIX A

Consent Letter

Nayma Momtaz
Master's student of Educational Leadership and School Improvement at the BRAC Institute of Educational Development
BRAC University
Contact Number: 01794273741

Subject: Consent for Participation in Research Study

Dear Yesmin Habiba,
I am a master's student at BRAC University conducting research on **"Exploring the Strategy of Teaching Chemistry in the Grade-7 to 9 in the English Medium Schools in Bangladesh."** This study aims to explore current teaching practices and the challenges faced by Chemistry teachers in English medium high schools.
As part of my research, I would like to request your participation in an interview and permission to observe two of your Chemistry classes. The interview will focus on your teaching methods, classroom experiences, and any difficulties you encounter while teaching Chemistry. The class observations will help me gain a deeper understanding of the strategies used in real classroom settings.
Your participation in this study is completely voluntary, and you may withdraw at any time without any consequences. All information provided will be kept confidential, and your identity will not be disclosed in the research findings. The data collected will be used solely for academic purposes.
If you agree to participate, please sign the consent form below. Should you have any questions or require further clarification, feel free to contact me at any time.
Thank you for your time and cooperation.
Sincerely,
Nayma Momtaz

Consent Form
I, agree to participate in the research study conducted by **Nayma Momtaz** from BRAC University. I understand that my participation involves an interview and class observations. I acknowledge that my participation is voluntary and that I can withdraw at any time. I also understand that my responses and class activities will be kept confidential.

Signature: Habiba
Date: 3.09.24

APPENDIX B

Data collection tools

Semi-structured interviews guidelines for the chemistry teachers:

Resources

1. What are some of the most valuable resources you use for teaching chemistry?
2. How do you stay updated with the latest developments and resources in the field of chemistry education?
3. How do you select textbooks for your chemistry classes?
4. What criteria do you consider?
5. What online platforms or websites do you frequently use for supplementing your chemistry lessons?
6. What type of laboratory equipment and resources do you have available in your school?
7. What supplementary materials, such as workbooks or practice problem sets, do you provide to your students?
8. How do you guide students in finding reliable chemistry resources for self-study?

Strategies

1. What are some of the key teaching strategies you use in your chemistry classes?
2. How do you balance theoretical concepts with practical applications in your lessons?
3. What techniques do you use to engage students who might find chemistry challenging or uninteresting?
4. How do you differentiate your instruction to meet the diverse learning needs of your students?
5. What strategies do you use to ensure that lab activities are both safe and educational?
6. What role does technology play in your chemistry teaching strategies?
7. How do you reflect on and improve your teaching strategies over time?

Assessments

1. What types of assessments do you use to evaluate student understanding in chemistry?
2. Can you describe how you balance formative and summative assessments in your teaching?
3. How do you design your exams and quizzes to accurately measure student learning?
4. How do you ensure that your grading criteria are clear and fair to all students?
5. How do you provide feedback to students on their assessments?
6. How do you use assessment data to inform and adjust your teaching strategies?

Challenges

1. What are some of the biggest challenges you face in teaching chemistry?
2. What challenges do you encounter in keeping students engaged and interested in chemistry?
3. How do you handle the diverse learning styles and abilities of students in your chemistry classes?
4. Do you face any challenges related to limited resources or materials for teaching chemistry?
5. What are the challenges associated with ensuring safety in the chemistry laboratory?
6. What challenges do you face in assessing student understanding and performance in chemistry?
7. Do you face any challenges related to parental involvement or support in your chemistry classes?
8. What challenges do you face in balancing theoretical instruction with practical laboratory work?
9. From your perspective, what improvements or support would be most beneficial for high school chemistry teachers in Bangladesh to enhance the quality of chemistry education?

APPENDIX C

Observation Checklist for Teaching Chemistry in English Medium Schools in Bangladesh
Research Question 1: What is the practice of teaching chemistry by the Grade 7 to 9 Chemistry teachers in the English medium schools in Bangladesh?
Classroom Practices Observation Checklist

Item	Observed Behavior	Comments
Lesson plan and preparation	Clear objectives and lesson plans	
Use of teaching Aids	Utilization of visual aids, models, and lab equipment	
Content Delivery	Clear explanation of concepts	
Student Engagement	Interaction and engagement with students	
Teaching Methods	Use of diverse teaching methods (lectures, discussions, experiments)	
Practical Work	Hands-on lab activities and experiments	
Classroom Management	Ability to maintain discipline and order	
Assessment Techniques	Use of formative and summative assessments	
Feedback to Students	Providing constructive feedback	
Adaptability	Adapting lessons to students' needs and levels	

Research Question 2: What are the challenges faced in teaching the subject Chemistry by the Grade 7 to 9 Chemistry teachers in Bangladesh?

Challenges Faced in Teaching Observation Checklist

Item	Observed challenge	Comments
Resource Availability	Adequate of teaching materials and resources	
Laboratory Facilities	Quality and availability of lab facilities	
Student Preparedness	Students' readiness and background knowledge	
Curriculum Constraints	Flexibility and comprehensiveness of the curriculum	
Time Management	Sufficiency of time allocated for chemistry classes	
Professional Development	Opportunities for teacher training and development	
Classroom Size	Manageability of class size	
Student Motivation	Students' interest and motivation in learning chemistry	
Language Barriers	Issues with language comprehension and usage in English	