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ASSESSMENT OF HIGH SCHOOL STUDENTS' ATTITUDES TOWARDS CHEMISTRY

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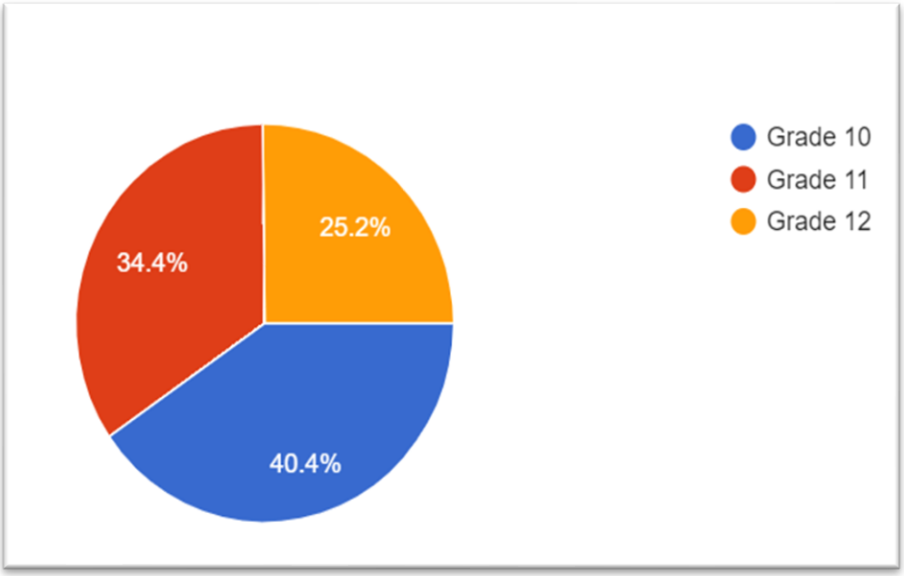

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This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Education (Curriculum and Instruction)

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Cover: The percentage of students participating in each grade level in the survey

(Screen shot: Aya Hosameldeen Sayed Mohamed Mostafa)

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Declaration of Original Work

I, Aya Hosameldeen Sayed Mohamed Mostafa, the undersigned, a graduate student at the United Arab Emirates University (UAEU), and the author of this thesis entitled "*Assessment of High School Students' Attitudes Towards Chemistry*", hereby, solemnly declare that this thesis is my own original research work that has been done and prepared by me under the supervision of Professor Hassan Tairab, in the College of Education at UAEU. This work has not previously been presented or published, or formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my thesis have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this thesis.

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Abstract

The main purpose of this study is to assess the scientific attitudes of students towards Chemistry as one of the branches of science, in the context of the UAE. These attitudes are measured using three dimensions of scientific attitudes namely; social implications, the students' Chemistry-related inquiries and their leisure interest in the subject. Additionally, this study examines the influence of categorical variables such as gender and students' grade level on the development of the students' attitudes towards the subject. An exploratory descriptive design is employed using a quantitative survey, to collect data from 192 high school students studying Chemistry in Al Ain city, UAE. Results of the study suggest that students show a positive attitude towards the subject as measured by the social implications of Chemistry, the attitude towards Chemistry inquiry and the students' leisure interest in the subject. Furthermore, the impact of gender of participants was also assessed and showed that there is no statistically significant difference was found. However, a statistically significant difference is observed between students studying in grades 10 and 11 as measured in terms of their leisure interest in Chemistry. The similarity in results for both gender is explained in terms of commonality of contexts and culture. The statistically significant differences appeared in results pertaining to grade level is explained in terms curriculum implementation and teaching approaches. Recommendations are offered to close future gaps in student attitudes.

Keywords: Attitudes, Test of Science Related Attitudes (TOSRA), social implications, scientific inquiry, leisure interest.

Title and Abstract (in Arabic)

تقييم سلوك طلاب المدارس الثانوية تجاه مادة الكيمياء

الملخص

الغرض الرئيسي من هذه الدراسة هو تقييم السلوكيات العلمية للطلاب تجاه الكيمياء كأحد فروع العلوم، في سياق دولة الإمارات العربية المتحدة .يتم قياس هذه المواقف باستخدام ثلاثة أبعاد للسلوك العلمية وهي، الآثار الاجتماعية، واستفسارات الطلاب المتعلقة بالكيمياء واهتماماتهم الترفيهية بالموضوع .بالإضافة إلى ذلك، تبحث هذه الدراسة في تأثير المتغيرات الفئوية مثل الجنس ومستوى طلاب الصف على تطور سلوك الطلاب تجاه الموضوع. تم استخدام تصميم وصفي استكشافي باستخدام المسح الكمي لجمع البيانات من 192 طالبًا في المرحلة الثانوية يدرسون الكيمياء في مدينة العين بالإمارات العربية المتحدة .تشير نتائج الدراسة إلى أن الطلاب يُظهرون موقفًا إيجابيًا تجاه الموضوع كما يُقاس بالآثار الاجتماعية للكيمياء، والسلوك تجاه استفسار الكيمياء واهتمام الطلاب بالترفيه بالموضوع .علاوة على ذلك، تم أيضًا تقييم تأثير جنس المشاركين وأظهر أنه لا يوجد فرق معتد به إحصائيًا .ومع ذلك، لوحظ فرق ذو دلالة إحصائية بين الطلاب الذين يدرسون في الصفين 10 و 11 كما تم قياسه من حيث اهتمامهم الترفيهي بالكيمياء .يتم تفسير التشابه في النتائج لكلا الجنسين من حيث القواسم المشتركة للسياقات والثقافة .وقد ظهرت الفروق ذات الدلالة الإحصائية في النتائج المتعلقة بمستوى الصف الدراسي وتم شرحها من حيث تطبيق المنهج وطرق التدريس .يتم تقديم التوصيات لسد الفجوات المستقبلية في سلوك الطلاب.

مفاهيم البحث الرئيسية: السلوك، اختبار المواقف العلمية ذات الصلة ، الآثار الاجتماعية ، البحث العلمي ، الاهتمام بالترفيه.

Author Profile

Aya Mostafa is a Chemistry teacher and an Assessment Coordinator in Liwa International School following the American Curriculum in Al Ain city, UAE. She graduated from the American University of Sharjah, UAE, with a Bachelor's degree in both Chemistry and Environmental Sciences, and is currently working to complete her Master's of Education in Science Curriculum in the United Arab Emirates University in Al Ain, UAE. Aya has four years of experience in performing scientific research; two of which are during her undergraduate study and the other two are during her Master's study. She published a scientific paper titled "Chemical Modification, Characterization, and Heavy Metal Absorption of Cellulose-Based Natural Fibers" in April 2018, in one of the most reputable scientific journals. Aya is currently living in Al Ain with her husband and two boys. She is interested in completing her PhD in Education and to continue working in the field of education by conducting studies that help benefit all students in the country and across the globe.

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Dedication

To my beloved husband, sons, parents, siblings, friends and students

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List of Abbreviations

ANOVA	Analysis of Variance
NSTI	National Science Technology Innovation
ROSE	Relevance of Science Education
SAES	Science Attitudes and Engagement Survey
SALES	Science Attitudes Learning Engagement Survey
SPSS	Statistical Package for the Social Sciences
TOSRA	Test of Science Related Attitudes
UAE	United Arab Emirates

Chapter 1: Introduction

1.1 Overview

"One major challenge and task for educational researchers is to get more students interested and skilled in science" (Blankenburg, Hoffler, & Parchmann, 2016). Humans and almost all of their activities involve and require scientific discipline. Particularly Chemistry, one of the branches of science, is known to be involved in several aspects of our daily lives (Olakanmi, 2017). Chemistry is used in perfumes, batteries, medicines, foods, cleaning agents and in many other important products. Due Chemistry's importance, it is known to be one of the major subjects of studies in almost all private and public high schools in the UAE. This is due to the fact that most of the undergraduate degrees require Chemistry as one of the basic courses. Moreover, Chemistry plays a crucial role if a student is planning to major in scientifically-oriented careers such as pharmaceuticals, medicine. However, unfortunately, many students do not have positive attitudes towards Chemistry (Montes, Ferreira, & Rodiguez, 2018). Students start by having positive attitude towards sciences but unfortunately and according to Murphy and Beggs (2003) "in the case of Chemistry in particular, there is a gradual loss of interest in the subject, accompanied by feelings of boredom and rejection, and experiences of failure". This could be due to many reasons such as lack of insufficient background about Chemistry or lack of interest in it (Olakanmi, 2017). It is suggested that this lack of background and interest would have a negative influence on students' attitudes which in return might result in very low-achievement in Chemistry.

There are several factors that have direct influence on the attitude of students towards a subject. According to Davadas and Lay (2017), the attitudes of students can be affected by the Chemistry teacher, the student learning Chemistry and the learning environment provided by the educator or the educational institute at which Chemistry is being taught. Since teachers are considered the bridge between the students and the subject, they play an important role in shaping the students' attitudes towards the subject. They can either deliver the instructions in a way that builds positive attitudes for students due to their depth understanding of the subject or vice versa. The students could also have embedded love to the subjects due to achieving higher grades in the subject or due

to a deep knowledge about it from the environment surrounding the students. Similarly, the learning environment could also affect the attitudes of students. The learning environment does have a noticeable effect on the motivation of students which reflects on their attitudes. According to Radovan and Makovec (2015) “learning environments contribute to the development of self-motivation and skills”. Often some extracurricular activities are shaped in a way that pushes students to experience the scientific field, such as the International Think Science Competition or a science fair that gets organized in the school itself. On the other hand, Davadas and Lay (2017) suggested that parents also might play a crucial role in shaping their children’s attitudes towards a specific subject. This is due to the fact that parents are major influencers on the lives of their sons and daughters. Parent’s beliefs sometimes also shape the thoughts of their children (Davadas & Lay, 2017). Due to the fact that some parents acquire sciences as their paths, they influence their children unintentionally and the students have embedded positive attitudes towards sciences. While some parents maybe lack interest in sciences and therefore, they just simply push their children to study it for marks rather than for the subject itself resulting on them having negative attitudes towards the subject.

Understanding students’ attitudes, whether positive or negative, towards Chemistry is of utmost importance. The understanding of the attitudes will enable educators to gain better idea about their students’ needs and therefore tailor their delivery of instructions accordingly. It is also important for students to understand their attitudes towards science as it helps them shape their future career. Additionally, science and mathematics are of crucial importance to perform innovative and creative ideas. Moreover, it is very crucial for students to be able to understand the positiveness of science and work towards improving their attitudes towards it for future generations.

1.2 Statement of the Problem

Attitudes of high school students towards a subject usually differ from one student to another and can develop from one stage to another (Syyeda, 2016). Some students tend to have positive attitudes towards science-related subjects while others show negative attitude to them, depending on the fact that such subjects are not quite relevant to their future career. The positive attitudes towards science could be a result of

students having their career already shaped in their minds and that they are willing to acquire sciences while performing their future studies (Badri, et al., 2016). It could also be related to their complete understanding of the subject or due to their interest in the subject. On the other hands, the negative attitude could be related to misunderstanding in the concepts, finding scientific concepts harder to study (Tairab, Al Arabi, Rabbani, & Hamad, 2020) or to the fact of them not being able to achieve the required grades in (Tairab, et al., 2020) science-related subjects (Mazana, Suero Montero, & Olifage, 2019). Some research studies also showed that male and female may have different attitudes towards science which has always been linked to the achievement in the subject (Can, 2012). Additionally, other studies suggested that other factors, such as grade level and learning environment do influence the students' attitudes towards a subject (Montes, et al., 2018). Therefore, this study investigated Al Ain high school students' attitudes towards Chemistry. In the UAE, science; such as Chemistry, is highly regarded as a key to many scientific careers. Unfortunately, no studies on students' attitude towards Chemistry have been conducted in the UAE context. However, results of comparative international studies suggest that students in that region do not have that attitudes that match the high regards of science given by the country. Specifically, the study documents student attitudes towards Chemistry as measured by students' social implications towards Chemistry, the leisure interest in Chemistry and their attitude towards Chemistry inquiry. Additionally, the study assessed the impact of student gender and grade level on the formation of these attitudes. Specifically, it questioned whether there are any statistically significant differences between males and females in terms of their attitude towards the Chemistry subject and the difference between each grade level in terms of the attitude of students. This is because interest and enjoyment play a very important role in facilitating the teaching and learning process and that in order to solve any scientific problem, students need to acquire love and passion for science.

1.3 Purpose of the Study

This study aimed to

1. Assess high school students' overall attitudes towards Chemistry as measured by three scales of TOSRA namely; Social implications of Chemistry, Attitude towards Chemistry inquiry and Leisure interest in Chemistry.

2. Examine the impact of gender and grade level on the development of attitudes towards science generally and Chemistry specifically as measured by three scales of TOSRA namely; Social implications of Chemistry, Attitude towards Chemistry inquiry and Leisure interest in Chemistry.

1.4 Research Questions

In order to achieve the stated purpose, the following questions were raised:

1. What level of scientific attitudes do grades 10 to 12 have towards Chemistry?

2. Are there any statistically significant differences in the level of attitudes in relation to gender as measured by the Social implications of Chemistry, Attitude of Chemistry inquiry and Leisure interest in Chemistry?

3. Are there any statistically significant differences in the level of attitudes in relation to grade level as measured by the Social implications of Chemistry, Attitude of Chemistry inquiry and Leisure interest in Chemistry?

1.5 Significance of the Study

This study contributed to Chemistry educators' awareness about student attitudes towards Chemistry. It aimed to build upon to educator's understanding of the feelings of high school students build while learning Chemistry. The study is expected to help educators understand the impact of attitudes in learning of Chemistry. Additionally, identifying the level of attitudes may assist Chemistry teachers to make decisions on ways through which they can best promote teaching strategies that may help students to become more engaged with Chemistry and hence develop positive attitudes towards science in general and Chemistry in particular. It will help educators motivate students, if needed, towards Chemistry since "the most important influence on learning is motivation" (Radovan & Makovec, 2015). Furthermore, educators may be able to work

on developing and adjusting the curriculum the subject based on the understood attitudes of students.

From an educator's perspective, understanding the attitudes of students towards Chemistry is important to students. Helping students understanding their attitudes towards Chemistry will enable them to work accordingly in terms of the subject. They will be able to work more in-depth to satisfy their future career if it is related to the subject, since attitudes is directly related to the achievement of goals (Montes, et al., 2018). Additionally, it will help them to work more to be able to act accordingly to understand the subject. It will help them to identify their position in the subject and whether or not they need to change any of their activities to enhance their achievements and therefore the process of learning.

The findings of this study may also be significant to parents. Findings are expected to provide parents with knowledge of the level of attitudes of their children. Parents would be in a better position to support their children and assist them to succeed in their selected scientific career. Moreover, parents would be more aware of the determinants of positive attitudes and will work collaboratively with their children to improve their attitudes towards Chemistry and as a result improve their achievement in it. This could be by providing all kinds of support in terms of motivating their children to participate in competitions, attend workshops and even seminars that enhances the knowledge of the subject and therefore benefit their future career.

1.6 Definition of Terms

Attitude: is defined as "The tendency to think, feel, or act positively or negatively toward objects in our environment" (Eagly & Chaiken, 1993) cited by Salta and zougrake (2004). Attitudes are different from beliefs and interests. According to the online dictionary (2020) a belief is "confidence in the truth or existence of something not immediately susceptible to rigorous proof", whereas interest: is "something that concerns, involves, draws the attention of, or arouses the curiosity of a person". This study does not look into existing truth neither into what draws student's attention but rather it is looking at the attitude of high school students in terms of their personal

feelings to Chemistry as a subject. The feeling can be quantified as positive or negative level of liking or disliking of Chemistry as a discipline.

Test of Science Related Attitudes (TOSRA): It is a standardized instrument developed by Fraser (1981) to measure student science related attitudes. The instrument consisted of the following scales:

- Social Implications of Science
    - This scale measures attitude of students towards the conducted scientific research and their benefits socially (Welch, 2010).
- Attitude of Scientific Inquiry
    - This scale measures the attitude towards scientific experimentations and inquiring science to gain deeper understanding of the surrounding world (Welch, 2010).
- Leisure interest in science
    - This scale measures the interest of students in attending lectures or participating in events that would require scientific investigation or background. In other word, enjoying the addition of science to other activities rather than restricting it to attending science classes (Welch, 2010).
- Normality of Scientists
    - This scale measures the normal attitude of normal people with normal lifestyles towards science (Welch, 2010).
- Adoption of Scientific Attitudes
    - This scale measures the effectiveness of science in the ability of changing perspectives of people based on a researchable scientific evidence or theory (Welch, 2010).
- Enjoyment of Science Lessons
    - This scale measures the degree of enjoyment of students to the science-learning process (Welch, 2010).
- Career interest in science
    - This scale measures the degree of interest of students in pursuing careers related to sciences (Welch, 2010).

However, only the Social Implications of Science, Attitudes of Scientific Inquiry and Leisure Interest in Science Scales were in this study and were slightly adjusted to fit the purpose of the study, which is to study Chemistry rather than sciences.

1.7 Limitations/Delimitations

The study was conducted only in a single location in Al Ain, therefore, generalizability of the findings should be taken with good care. This is due to the fact that one school in Al Ain cannot reflect the whole community of Al Ain neither all the schools in the United Arab Emirates, UAE. Moreover, due to a desire from students to satisfy the researcher's aims and expectations, students might have not honestly reflected their real attitudes (Salta & Tzougrake, 2004), which in return might result in an untruthful data. Finally, students might have not reflected their actual feelings and therefore the results will be opinionative. Moreover, the findings of the study were interpreted from the view of the researcher which is definitely affected by the researcher's philosophical and theoretical background. This, in return, might result in the interpretation of survey results to be subjective.

Delimitation:

The study was limited to one school in Al Ain, and for students in grades 10 to 12 of both genders. The school selected follows the American Curriculum and the Next Generation Science Standards (NGSS). Data was collected in the beginning of term 1 of the academic year 2021-2022 and was analyzed shortly after collection using the SPSS program.

1.8 Organization of the Study

This study was divided into six major sections. Section I, the introduction, will introduce the reader to the main topic of the research. Section II, literature review, which will shed light on previous studies related to the attitudes of the students towards science and Chemistry. Section III, where the methods used, participants chosen and procedures used to assess the issue were presented and described. Section IV, where the data collected was analyzed statistically. This is followed by section V which discussed the

findings globally and nationally to answer research questions stated above. Finally, Section VI concluded all the findings with recommendation for further research in the same scope.

Chapter 2: Literature Review

2.1 Chapter Overview:

Students attitude towards science subjects has been of utmost importance for a long time. Larger body of literature investigated students' attitudes to better understand their impact on the learning process as well as on the cognitive understanding and the academic progress of students (Mujtaba, Sheldrake, Reiss, & Simon, 2018). In this section of the study, relevant past studies on students' attitudes are examined and analyzed to conceptualize the term attitudes, particularly in the context of their impact on the development of scientific attitudes. First, the theoretical framework underpinning the study is presented. Then, prior work on students' attitudes towards sciences and its implication on their learning are critically examined. This is followed by a discussion of the impact of gender and grade level as variables on scientific attitudes. Finally, several tools and instruments that were previously used to address attitude are presented with their pros and cons. The chapter concludes with a short summary of the literature findings and then a short statement that introduces the next chapter.

2.2 Theoretical Framework

In order to critically examine the term attitudes psychological theories are used as a conceptual framework to better conceptualize attitudes as a construct. The attitude of humans, in general, is explained by an important psychological theory called the Affective cognitive consistency theory. This theory uses the consistency and the inconsistency factors to understand the cognitive outcome from a person towards new information. Kruglanski, et al. (2018) argues that the expectancy is directly related to the affective reaction of an individual. He adds that the expectancy and belief in a desirable outcome positively affects one's affective reaction and if such expectancy is in an undesirable outcome causes one's affective reaction to be, on the contrary, negative. Humans in general feel ambivalent towards a subject or a product due to inconsistency, if these inconsistencies were reduced, they show positive attitude towards it (Jiang, Liang, Wang, & Sun, 2016). Since students always believe that scientific concepts are hard to be studied (Tairab, et al., 2020), their cognitive consistency could affect their

attitude towards studying science due to such a belief. Studying attitudes, therefore, would give an insight understanding if whether a specific attitude is shaped because of a belief or due to other factors such as gender or understanding of the subject knowledge.

Additionally, Sherif's Social Judgment Theory explains how attitudes of humans in general gets affected by one's own experiences and knowledge. In general, people's different attitudes will affect their judgements towards the same message or same subject (Xiao-Yun, 2021). The theory clearly indicates that the ego-involvement plays an important role in shaping one's attitude towards an object or a subject. This means that the acceptance or rejection or noncommitment of a human to a certain idea or subject is related to the importance of that subject to the person (Lim, Mohamed, Hamsah, & Tan, 2019). For instance, if a person believes that a certain subject is important to him/her, they will more willing to accept it and therefore develop a positive attitude towards it. On the other hand, if a person does not have such a belief, that person might prejudge the subject and therefore a negative attitude towards the subject might develop resulting in an act of rejection or neither acceptance nor rejection (Meade, 2021). This theory helps in prediction one's attitudes towards a particular issue or subject and therefore would help in targeting students whom we understand their judgement towards a subject.

2.3 Defining Attitude and How it is Shaped

There is a clear distinction between attitude, interest and behavior. Attitudes tend to differ in terms of definition from a researcher to another. Attitudes are considered as "The tendency to think, feel, or act positively or negatively toward objects in our environment" (Eagly & Chaiken, 1993) cited by Salta and Tzougrake (2004). Moreover, Davadas & Lay (2017) defined attitude as a mental state or disposition to an event or object. This was also reported by Albarracín, Johnson, Zanna, and Kumkale (2005) who mentioned that attitudes are one's "relatively enduring evaluation of something, where the something is called the attitude object". Even though attitude is different from behavior, still some researchers did conclude that they are directly related. According to Fishbein, Jaccard, Davidson, Ajzen, and Loken (1980), "Behavior is seen as being determined by intention", which is considered as a product of attitude. Similarly, Glasman and Albarracín (2006) argued that attitudes sometimes get reflected in one's

own behavior. Therefore, regardless of the difference, still they show some definite relationship.

Even though they are different constructs, yet, attitudes do diverge a person's choice towards them and have a direct effect on the career one aims for (Gonçalves, et al., 2011). One's thoughts and actions are usually deviated towards a content or a fact that he/she has a positive attitude towards. Whereas, doubt its importance, no matter how crucial is that fact, they might still have a negative attitude towards that content or that fact. Hence, attitudes can be, in certain situations, a reflection of people's stereotypes about the content or the object. On the other hand, social pressure does have a clear influence on a person's attitude. This is mostly evident with most of the students, as they tend to follow their peers in their preferences towards a particular activity or subject (Osborne, Simon, & Collins, 2003). This is usually due to students' fear of being left behind or neglected by their peers. Additionally, teachers, methods of delivering and parents can have a noticeable effect on students' attitudes towards a subject (Davadas & Lay, 2017). Therefore, it would be beneficial to look for the underlying reason of their occurrence in order to be able to address them accordingly.

2.4 Students Attitudes Toward Science and the Influencing Factors

Osborne, et al. (2003) defined the attitude toward science as "the feelings, beliefs and values held about an object that may be the enterprise of science". Since, according to them, attitudes is considered as "a measure of the subject's expressed preferences and feelings towards an object". It is important to understand the attitude of students towards science. Many researchers had studied the attitude towards science-related subjects (Salta & Tzougrake, 2004). The main reason underlies in the fact that science-related subjects are commonly known as being difficult and/or demanding. Additionally, very few students tend to pursue science-related careers or fields regardless of their demand (Hillman, Zeeman, Tilburg, & List, 2016). However, several studies reveal that students actually develop a preference for science subjects particularly as they grow older, since these subjects become more relatable to students' everyday lives (Badri, et al., 2016). However, students' preferences usually vary across the spectrum of science subjects taught, which includes earth science, biology, physics, Chemistry, environmental

sciences, etc. Regardless of the spectrum of science subject, Badri, et al. (2016) elaborates on the importance for students 'engagement in issues related to science to help students become reflective citizens.

Looking deeper into Chemistry as one of the branches of science, it is one branch that relates and plays important role mostly to human activities. However, the attitudes towards Chemistry still differ between high school students. In purpose of understanding the students' attitudes towards Chemistry in Greece, Salta and Tzougrake (2004) addressed attitudes of 576 high school students. Their study tends to measure the attitudes of students using four different variables; interest, difficulty, usefulness and importance. The results of their study suggested that students show neutral attitudes in terms of interest towards Chemistry and towards its difficulty. Additionally, the results suggested that students believe that Chemistry is important to their daily activities, however, majority of the students do not see it beneficial for their future careers. In contrary, the international Relevance of Science Education (ROSE) study that was held in 34 different countries for 15-years old learners by Sjøberg and Schreiner (2005) aiming to assess the attitudes of those learners towards both science and technology. The findings of the study suggested that attitudes of students towards science are generally positive rather than neutral. This was also supported by Mujtaba, et al. (2018) in their study that investigated the attitudes, beliefs and context of 4780 students in England towards both science and Chemistry. The results of their study suggested that confidence play an important role in shaping the attitudes of students towards science generally and Chemistry specifically. Students tend to show positive attitudes towards science-related subjects in situations where they are more confident in understanding and applying scientific concepts. Additionally, their study highlighted several factors that has direct influence on students' attitudes as the motivation of the students, the teaching techniques used to deliver instructions, in addition to the encouragement of their family members and their science educators.

2.5 Impact of Attitudes on Student's Learning

Attitude is one of the "essential components of scientific literacy (Said, Summers, Abd-El-Khalick, & Wang, 2016). The study of attitudes is crucial to educators in order

to be able to understand the students' reactions towards specific subjects and therefore work on preparing the best classroom environment and activities that are "tailored to students' attitudes and expectations" (Holden, 2012). The reason highlighted earlier by researchers is that attitudes towards and interests in a subject tend to directly affect the students' achievement in that subject (Bybee & McCrae, 2011). Guido (2018) mentioned clearly that there is a high correlation between the positive attitude of students towards science and their achievement in science. In contrast, students' achievements tend to have direct influence on students' attitudes towards a subject. Guido (2018), in his study of attitudes of students towards physics clearly argued that better understanding of the subject matter and higher achievements could positively influence the students' attitudes towards the subject. Regardless of which is affected by the other, there is a clear relation between attitude towards a subject and the achievement in this subject. This opens an eye on the importance of assessing attitude, the factors that affect it and ways that could result in improving it in order to enhance the process of students' learning of the subject and to improve their progress in it.

2.6 The Impact of Gender and Grade Level Variable on Student's Attitudes

Can (2012), in her study that assessed the interaction between gender and grade level as constructs affecting attitude of students towards Chemistry, both genders showed low attitudes towards Chemistry. However, the male students showed more positive attitudes in Grade 9 that declined towards Grade 11. In contrary, the female students showed opposite results. The results showed that female students had initially low attitude towards Chemistry that increased towards grade 11. Overall, her study suggested that there is a statistically significant difference between the male and female students' attitudes towards Chemistry, however, they were both below the average mean score value, which meant that science teachers should take this into consideration when planning for Chemistry lessons. Dorman and Fraser (2009), however, specified in their study about students' attitude towards science subject considering the learning environment, gender and the grade level, that that difference is not in the gender construct but rather the classroom learning environment. They both clearly conclude from their studies that students do have more positive attitude towards the subject if the

classroom learning environment is positive, regardless of their gender difference. This finding was also supported by Said, et al. (2016) who concluded from his study in Qatar on students in grades 3 to 12 that there are no statistically significant differences between genders in terms of the students' attitudes towards science. The authors of this study also figured out that the attitudes of students towards science tend to decrease for both genders as they go to higher grade levels. Since there are some contradictions between the literacy studying gender and attitudes towards science earlier, it would be very important to gain insight understanding of whether or not there is a statistically significant difference between students' gender as well as their grade level and their attitudes towards Chemistry.

2.7 Assessment of Scientific Attitudes

Three major approaches were adapted for assessment of attitudes; the qualitative, the quantitative and mixed methods analyses aimed to students and teachers in order to gain in-depth understanding of the attitudes as well as gain rich clarifications of the view (Almalki, 2016). Quantitative data collection tools, such as questionnaires were used in order to gain more numerical information as well as predicting trends. Moreover, a combination of both quantitative and qualitative instruments was used in order to help the researcher to better understand the construct.

There are several instruments that were quantitatively used in order to assess students' attitudes towards science; 1) Relevance of Science Education Project (ROSE), 2) Students Attitudes Towards Science (SATS) and 3) Test of Science Related Attitudes (TOSRA) (Aydeniz & Kotowski, 2014).

ROSE is an instrument that is used to gather information about "students' experiences, interests, priorities, images, perception" and attitude towards science subjects using 245 items (Aydeniz & Kotowski, 2014). ROSE cannot be used at once due to the high number of questions that it contains. Therefore, it is recommended by researchers to administer only parts of this survey based on the need of the study.

SATS is an instrument that consists of 5 constructs that are aiming to understand the attitudes of students toward science and the behaviors related to the process of

learning science (Aydeniz & Kotowski, 2014). The five constructs studied by SATS are the motivation of students to learn science subjects, their perceptions of the utility of science, their self-efficacy beliefs for the learning of sciences, their subjective norms towards science and their intentions to be involved in science-related activities.

Finally, TOSRA, a standardized instrument developed by Fraser (1981) to measure student science related attitudes, was used to assess high school students' attitudes towards Chemistry. The instrument is consisting of seven scales that study the students' attitude quantitively; 1) Social implications of science, 2) attitude of scientific inquiry, 3) Leisure of interest in science, 4) Normality of scientists, 5) Adoption of scientific attitudes, 6) Enjoyment of Science Lessons and 7) Career Interest in Science (Welch, 2010). The instrument aims to study the degree of agreement of students using a five-point scale for each of the above-mentioned seven scales and 10 items per scale which results in total of 70 items (Fraser B. J., 1981). Since it is a Likert type scale, the possibility of students faking their results is a bit high, therefore, it is suggested by Fraser (1981) that teacher should make it very clear to students that the results would not be used for grading and that the results are anonymous. Another challenge that is faced by such a 5-point scale is that students at this age tend to usually choose an option that is "socially accepted or more desirable" (Chyung, Roberts, Swanson, & Hankinson, 2017). In this research paper, 3 scales from TOSRA instruments were adjusted to fit Chemistry rather than Science in general and were used to assess the students' attitudes towards Chemistry.

2.8 Student's Attitudes Toward Science in the UAE Context

There are several studies in the Arab countries, specifically in the UAE, that has been conducted tackling the study of students' attitude towards science. One of the following studies was conducted by (Balfakih, 2003) aimed to identify whether or not the methods of teaching have a direct effect on the attitude and achievement of high school students in Chemistry in the United Arab Emirates. The author of the study used 23 items in a questionnaire that was addressed to students in the 10^{th} grade in different regions of the country. Based on the finding of the study, the teaching methods do have a direct effect on the attitude of students towards Chemistry and their achievements. Even

though this was clearly mentioned in the literature review of the author, the author mainly concentrated on the achievements rather than the attitude. His findings, however, showed that the teaching methods, students' understanding and students' achievements do directly affect students' attitude towards Chemistry. Therefore, these factors should be taken into consideration when proving positive or negative attitudes towards the subject in the UAE.

Badri, et al. (2016) conducted a study to investigate student attitudes in Abu Dhabi. The study's main purpose was to identify the different and the most significant constructs that affect students' expectations of their future job. The attitude of students towards science was one of those constructs that were measured in the study. The authors used Relevance of Science Education (ROSE) instrument in order to assess the attitude of students towards science and to student the construct. The participants were a total of 5650 students from different schools in Abu Dhabi city, the United Arab Emirates. The authors managed to include both public and private school in their studies. Based on the findings of this study, the attitudes of students about science "have significant influence on what students like to study, his/her future job expectations and what he/she likes to do as out-of-school experiences". This proves that attitude is an important construct that needs to be studied and investigated further in order to be able to improve students' attitude towards sciences generally and Chemistry specifically.

Moreover, Khalil and Aldridge (2019) added to the above studies by examining the relationship between students' attitudes and the learning environment in science classes in Abu Dhabi, UAE. Her sample participants included 784 students from 34 different classes from 8 different schools present in the emirate. The author used the Science Attitudes and Engagement Survey (SAES) in order to assess the students' attitudes towards science. This instrument used by the author was initiated based on two valid and reliable instruments Test of Science Related attitudes (TOSRA) and Science Attitudes Learning Engagement Survey (SALES). The findings of her study suggested that attitudes of students towards science is directly affected by the learning environment. The attitudes of students were found by the researcher to be more positive when cooperative learning strategies are being implemented in class.

2.9 Summary

The above review of previous studies on the attitudes of students towards sciences and Chemistry opened the eye of the researcher to the true definition of attitude and to some of the factors that helps in building it. It was important to understand that attitude is usually reflected in the behavior of the students and that it directly affects the achievement in the subject. Additionally, and since according to some previous research, attitude differs with gender (Can, 2012), it would be very important to understand the students' attitude towards Chemistry considering the gender as a construct as well as the change of attitude through the academic years. The review also exposed the researcher of this paper to different instruments that could be used to investigate attitudes, and TOSRA was chosen as the main instrument for the study.

Considering all the above-mentioned studies, the review showed that very little studies have been conducted in the UAE context. Additionally, the gender and the grade level, as variables, were not assessed in the context of the UAE. Moreover, previous studies that studied attitudes of students towards science, such as the one conducted by Balfakih (2003), are relatively old. Due to current gaps in previous research studies conducted about attitudes in the UAE and the intense studies about attitudes in different regions of the world opened the door for further investigations in the country. Hence, this research paper targeted high school students in United Arab Emirates, specifically in Al Ain, to investigate their attitudes towards Chemistry and examine the impact of gender as well as grade level on the development of attitude towards Chemistry.

Chapter 3: Methodology

3.1 Overview of the Chapter:

As described by Almalki (2016), research methodologies are of paramount importance. Researchers must therefore describe clearly and explain thoroughly research methods they employ. This chapter describes fully the methodologies that were employed. The chapter consists of 7 sections, each shows a clear description of steps in the methodology that were used to conduct the research.

The chapter starts with the context at which the research took place. This is to provide insights about the environment at which the research was conducted. The environment is but not limited to; the school, the curriculum taught, the qualifications and the background of teachers, the teaching methods and the grades tackled.

The second section of this chapter focuses on the design that was employed by the research, it shows the approach by which the research was conducted and a clear description of design employed from this approach, descriptive design. It also clarifies the reason behind the choice of that design and justify from literature the reason why this was the best design employed to answer the research questions.

Section three of the chapter presents a fulfilling description of the participants who participated in the study. In the section, the number of schools chosen, their category, the grade levels selected, the background of the students and their approximate age are described.

The participant's section is followed with a section that describe in details the Test of Science Related Attitudes, TOSRA, instrument that was used in the study. It shows all the different scales of the instrument with a clear description of the ones that were chosen in this research.

The sixth section of the chapter shows a detailed step-by-step procedure of how the research was conducted. It shows how logistics took place, such as seeking approvals from the authorities to conduct the research. Additionally, it presents all the required meetings with teachers and students. It presents also how a pilot study was conducted to

establish the psychometric properties of the instrument followed by the main study's conduction.

Lastly, the data analysis section, the last section, gives a clear insight of different statistical procedures that took place to analyze the collected results. It clearly shows the descriptive statistics that was used. Moreover, it will present how t-test and ANOVA are used to find statistical differences between males, females and students in different grade levels.

3.2 Research Design

A quantitative approach was be used in order to address the attitudes of students towards Chemistry in Al Ain, United Arab Emirates "in a systematic and structured manner" (Farghaly, 2018). Exploratory descriptive design was employed and conducted in order to describe the level of attitudes students have toward science generally and Chemistry specifically. The descriptive design was employed because it is suggested to describe the existing phenomena in real-life setting (Burns & Grove, 2010). In other words, it is aimed to describe the kinds of attitudes that students have towards Chemistry rather than justify the reasons behind those attitudes. This gives an insight understanding of the problem in order to later perform research about reasons and suggested solutions. Moreover, this research design was used to quantify the level of attitude high school students have towards Chemistry.

3.3 Participants

Five schools were randomly chosen from the list of targeted schools. The initial target of the research was to include five different schools that were selected randomly using cluster sampling. Due to the Covid-19 pandemic, the schools were conducted using a unified email that got sent to all schools simultaneously. However, unfortunately, only one school responded back with the approval for the study to take place at, regardless of the reminders that were sent once again to all schools.

Once the school confirmed its approval, this was followed by randomly selecting two classes, one from each gender for the pilot study and the rest for the main study. The

students' sample used for the pilot study consisted of 41 participants whereas the main study consisted of 192 students studying in grades 10, 11 and 12 of both genders as per Table 1 below. There are two purposes for selecting these specific grade levels; first them studying the three branches of sciences. Moreover, the sample was chosen with the purpose of having students who have quite enough Chemistry background

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Table 1: Summary of participants

	Grade 10	Grade 11	Grade 12	Total
Male	34	31	32	97
Female	39	29	27	95
Total	73	60	59	192

3.4 Instrument

To better assess the attitudes of students towards Chemistry, Test of Science Related Attitudes (TOSRA) questionnaire, that was developed by Fraser in 1978, was used. This instrument uses seven different scales in order to assess the attitudes of high school students towards science. Out of these seven scales only three were used, this is due to the fact that those scales are closer to the teaching and learning of science. Particularly, reflecting the current approaches and methodologies used in the process of teaching and learning. The three chosen scales are described below.

- Social Implications of Science
    - This scale measures attitude of students towards the conducted scientific research and their benefits socially (Welch, 2010).
- Attitude of Scientific Inquiry
    - This scale measures the attitude towards scientific experimentations and inquiring science to gain deeper understanding of the surrounding world (Welch, 2010).
- Leisure interest in science
    - This scale measures the interest of students in attending lectures or participating in events that would require scientific investigation or

background. In other word, enjoying the addition of science to other activities rather than restricting it to attending science classes (Welch, 2010).

The chosen scales are likely to reflect the attitudes of students towards the subject. Furthermore, the UAE recently encourage teaching and learning philosophy that match the meaning and philosophy of these scales employed in the current study. Each of the chosen scales were edited to better fit the aim of the research which targets Chemistry, one of the branches of science, specifically. Each of the scales included 10 different items, five of which are positives while the other five are negatives. This resulted in developing a 30-items version of the TOSRA questionnaire. The questionnaire uses five-point Likert Scale starting with (5) that represents "Strongly Agree" and ending with (1) that represents "Strongly Disagree" (Welch, 2010). Even though the instrument was used earlier by several researchers in many different countries over the past years, performing a pilot study was of utmost importance (Kim, 2011). The main aim of the pilot study was to ensure that the instrument is suitable in terms of understanding by high school students studying Chemistry in Al Ain. The pilot study targeted 41 students from grades 10-12 from the same region in Al Ain. However, this pilot study was conducted using sample other than the main sample used in the main study.

Although the TOSRA instrument was developed in 1978, yet, it is still being effectively used by several researchers to date. This guarantees the validity and reliability of each item in the instrument and ensures that they can be used to address attitudes of high school students towards any of the branches of science. According to Fraser (1981), "The reliability coefficient ranges between 0.67 to 0.93 with a mean of 0.84 for year 10 sample". The intercorrelation was low and ranged from 0.10 to 0.59 with mean of 0.33 (Fraser, 1981) as cited by Welch (2010).

The items of the instrument were all taken from a standardized instrument that was used by several researchers in different countries earlier. Yet, in order to check for the validity of the items in this specific region, the three scales with all the thirty items were provided to three professors from the education department for feedback. The three professors agreed that simple terminologies could be used in some items to make it easier for students from the Arabic region to understand it fully. Additionally, they

suggested substituting the term “science” with “Chemistry” to better fit the objectives of the study.

To examine the reliability of the instrument, a pilot study was conducted in order for the researcher to gain better understanding of the setup needed and the time that should be allocated for the main study. Moreover, the pilot study aimed to calculate the reliability of the three scales and their items in order to compare it with previous research and ensure that the instrument could be reliably used in this region. The study was performed on a sample of 41 participants. The participants were chosen randomly from different classes from one school in Al Ain. The students were given 40minutes to complete the questionnaire and were observed during that time to ensure their understanding of the items and to observe the time they took to complete the questionnaire. Data was then collected and item total correlation was performed on all items taking into consideration the effect if an item is deleted. The total correlation for all items was reported to be 0.802. The value being close to 1 suggested high correlation between the variables (Khatoon, 2021). Additionally, this value reflected the fact that instrument would be less reliable if an item got deleted, therefore, a decision was taken to keep all items. Additionally, correlation was performed per scale, 10 items at a time, and it was concluded that the item total correlation for social implications towards Chemistry to be 0.571, for leisure interest in Chemistry 0.812 and attitude of chemical inquiry 0.757. The correlation for the items representing social implications towards Chemistry was found to be relatively low, this could be due to the small size of the sample chosen and it is expected not to have a drastic effect on the test results.

3.5 Procedure

After randomly choosing the participating schools, the school that responded was contacted by the researcher to go through procedures that include logistics such as obtaining the necessary approvals to access the school and consent participants. Following the logistics, meeting sessions with school principal, targeted heads of departments and teachers were planned and conducted to provide an overview of the research and explain the main purposes and objectives of it. To help ensure face and content validation of the instrument, the researcher gave a short session for Chemistry

teachers teaching the chosen classes. Additionally, Chemistry teachers were also given an idea on ways through which they can introduce the questionnaire and encourage students to give their consent to participate in the research. However, selected students were still given the right to refuse participating in the current research study or to consider their result as anonymous.

3.6 Data Analysis

Once this was approved by the school and the participating students, a pilot study was conducted in order to establish the psychometric properties of the instrument, TOSRA, being used and to ensure the validity and the reliability of the instrument in this region with these participants. Additionally, the pilot study was a good chance to be able to develop or introduce any more aspects to the main study (Kim, 2011). Finally, the main study was conducted to collect the needed data. The questionnaire was conducted in the first term of the new academic year, 2020-2021, to give the chance for the researcher to get back to participants if the researcher needed to do so, or interview some if the results require further depth understanding. Additionally, based on researcher's experience, students are known to be more energetic during the beginning of the year than the end. Therefore, providing it in the beginning of the year provided more reliable data for the research. Students were given time during one of their Chemistry sessions to complete the questionnaire to give them the chance to raise any questions or concerns about the questionnaire to their Chemistry teachers.

Due to the classification of the collected data as ratio data, the researcher performed descriptive statistical analysis using SPSS (Statistical Package for the social Science) in order to answer research question #1, what level of scientific attitudes do grades 10 to 12 have towards Chemistry? The main aim of performing the descriptive statistical analysis is to give the researcher room to compare data and observe deviations of the results from one another. Additionally, it supports the reader in understanding and visualizing the data. Moreover, inferential data analysis was used to provide the researcher a wider room for assessing the data and to test for possible statistically significant difference between the sample's categorical variables.

3.7 Context

Five different secondary schools in Al Ain were targeted and selected for the research to be performed, United Arab Emirates. This is due to proximity and standards of these schools. The research targeted only schools which are adopting the American Curriculum to prevent having curriculum as a factor influencing the results of the study or an influence on students' attitudes. The teaching environment of these selected schools can be described as collaborative. This serves nicely the purpose and the orientation of the study. The teachers in these schools are multinational, they have different cultural backgrounds but most of them have education qualifications or a teaching license as required by the Ministry of Education. The sizes of the school ranged from a medium-sized schools to big-sized school. The selected schools can be classified according to ADEK classification as Good to Very Good.

Private schools were favored over public schools due to the fact that they are more accessible. Their logistic approvals usually take shorter than the logistics for public schools which fits perfectly into the time frame of the research. Moreover, private schools usually show more willingness to participate in research. Their mission and vision encourage collaboration with researchers, helping in research and using the outcome of research for development. All of the selected schools have a clear vision and mission of what is expected from the students.

The study mainly focused on high school students, due to the fact that science starts splitting into the three main branches, physics, Chemistry and biology, only in high school. Chemistry starts in the selected schools from grade 10. Since Al Ain residents are mostly locals Emiratis, almost all of the selected students are local Emiratis. This puts the students in socioeconomic status in a category of being medium to highly economically stable students. To better support generalization, the chosen students differ in terms of their academic level.

Chapter 4: Results

4.1 Overview of the Chapter

This chapter presents all the results of the data collected throughout this research study whose main aim was to assess and investigate the attitude of high school students studying in Al Ain, UAE towards Chemistry.

This chapter is divided into three main sections each of which answers one of the research questions that were raised earlier in chapter 1 which are listed below:

1. What level of scientific attitudes do grades 10 to 12 have towards Chemistry?
2. Are there any statistically significant differences in the level of attitudes in relation to gender as measured by the Social implications of Chemistry, Attitude of Chemistry inquiry and Leisure interest in Chemistry?
3. Are there any statistically significant differences in the level of attitudes in relation to grade level as measured by the Social implications of Chemistry, Attitude of Chemistry inquiry and Leisure interest in Chemistry?

The three sections are then followed by a concluding section that summarizes the answers of all the three questions and presents a comparative detail of all the findings of the study.

4.2 Overall Level of Attitudes of Students

In order to assess the overall level of attitude of all students participating in the study, a descriptive statistic was performed on the data collected via the questionnaire described in the methodology section. Table 2 shows comparison of the responses of all participants in each of the three scales. The students show higher mean score (M=3.5245) with regard to social implications of Chemistry compared to their attitude of Chemistry inquiry (M=3.4297) and their leisure interest in Chemistry which shows the lowest mean score (M=3.0120). In contrary, the distribution around the mean is the highest for the leisure interest in Chemistry scale (SD=.72978 and SE= .05267)

compared to the social implication of Chemistry scale (SD=.68896 and SE= .04972) and the social implications of Chemistry scale (SD=.55671 and SE= .04018)

Table 2: Descriptive statistics for all participants' level of attitudes towards Chemistry

	N Statistic	Mean	Standard Deviation	Standard Error
Social Implications of Chemistry	192	3.5245	.55671	.04018
Attitude of Chemistry Inquiry	192	3.4297	.68896	.04972
Leisure Interest in Chemistry	192	3.0120	.72978	.05267
Valid N (listwise)	192			

Table 3 presents the results of each item used under the social implications of Chemistry. The mean score of the items reflects that students responded with the highest mean value (M=4.08) to the item that states "Chemistry can help to make the world a better place in the future". However, the lowest mean score value (M=2.88) reflects the statement that states "This country is spending too much money on Chemistry". All the other mean values presented in the table are fall within approximately the same range that reflects neutral attitude slightly slanted towards the positive attitude (M=3.32 to M=3.86).

Table 3: Descriptive statistics of items of social implications of Chemistry

	N	Mean	Std. Error	Std. Deviation
Too many Chemistry laboratories are being built at the expense of the rest of education.	192	3.29	.073	1.006
Chemistry helps to make life better	192	3.77	.078	1.078
This country is spending too much money on Chemistry.	192	2.88	.084	1.158
Chemistry can help to make the world a better place in the future.	192	4.08	.081	1.116
Money spent on Chemistry is well worth spending.	192	3.86	.080	1.108
Money used on Chemical projects is wasted	192	3.70	.084	1.159
Chemistry is man's worst enemy	192	3.57	.090	1.247
Public money spent on Chemistry in the last few years has been used widely.	192	3.41	.065	.905
Chemical discoveries are doing more harm than good.	192	3.37	.082	1.141
The government should spend more money on Chemical research.	192	3.32	.077	1.072

Table 4 shows the results of each item used under the attitudes towards Chemistry inquiry. The mean score of the items reflects that student responded with the highest mean value (M=3.89) to the item that states "I would prefer to do Chemistry experiments rather than to read about them.". However, the lowest mean score value (M=2.72) reflects the statement that states "I would rather find out things by asking an expert than by doing a Chemical experiment.". All the other mean values presented in the table are fall within approximately the same range that is almost neutral slanted towards positive attitude (M=3.05 to M=3.86).

Table 4: Descriptive statistics of items of the attitude towards Chemistry inquiry

	N	Mean	Std. Error	Std. Deviation
I would rather find out things by asking an expert than by doing a Chemical experiment.	192	2.72	.094	1.300
I would rather solve a Chemistry problem by doing an experiment than be told the answer.	192	3.86	.083	1.151
It is better to ask a teacher the answer than to find it out by doing Chemical experiments	192	3.05	.093	1.285
I would prefer to do an experiment on a topic than to read about it in Chemistry magazines.	192	3.78	.089	1.235
It is better to be told Chemical facts than to find them out from experiments.	192	3.10	.084	1.162
I would prefer to find out why something happens by doing an Chemistry experiment than be being told.	192	3.84	.077	1.063
Doing Chemistry experiments is not as good as finding out information from teachers.	192	3.46	.083	1.148
I would prefer to do Chemistry experiments rather than to read about them.	192	3.89	.082	1.132
I would rather agree with other people than do an experiment to find out for myself	192	3.29	.091	1.264

Table 4: Descriptive statistics of items of the attitude towards Chemistry inquiry (Continued)

	N	Mean	Std. Error	Std. Deviation
I would prefer to do my own experiments than to find out information from a teacher about Chemistry.	192	3.31	.090	1.243
Valid N (listwise)	192			

Table 5 summarizes the results of each item used under the leisure interest in Chemistry. The mean score of the items reflects that students responded with the highest mean value (M=3.44) to the item that states “I would enjoy visiting a Chemistry Museum on the weekend”. However, the lowest mean score value (M=2.74) reflects the statement that states “I dislike reading newspaper articles about Chemistry”. The other mean values presented in the table are divided into two categories, where four of them are slanted towards the negative attitude (M=2.77 to 2.95) and four others are close to being neutral slanted towards the positive attitude (M= 3.06 to 3.32).

Table 5: Descriptive statistics of items of leisure interest in Chemistry

	N	Mean	Std. Error	Std. Deviation
Talking to my friends about Chemistry after school would be boring.	192	2.83	.090	1.246
I would enjoy having a job in a Chemistry laboratory during my school holidays.	192	3.10	.095	1.313
Listening to talk about Chemistry on the radio would be boring.	192	2.79	.095	1.318
I would enjoy visiting a Chemistry Museum on the weekend.	192	3.44	.093	1.293
I dislike reading newspaper articles about Chemistry.	192	2.74	.086	1.190
I would like to belong to a Chemistry club.	192	3.11	.088	1.217
I get bored when watching Chemistry programs on TV at home	192	3.06	.089	1.235
I would like to be given a Chemistry book or a piece of science equipment as a present.	192	2.95	.095	1.321
I dislike reading books about Chemistry during my holidays	192	2.77	.084	1.158
I would like to do Chemistry experiments at home	192	3.32	.089	1.236
Valid N (listwise)	192			

4.3 The Impact of Gender on the Levels of Attitudes.

Table 6 below shows the descriptive statistics of each scale for both genders. In terms of scale 1, Social Implications of Science, both males and females showed almost the same mean value (M= 3.5052 and 3.5442) respectively. The mean was slightly higher for females (M=3.5263) than males (M=3.3351) in terms of scale 2, Attitude of Scientific Inquiry. Similarly, the females showed a slightly higher mean (M=3.084) than the males (M=2.9381) in terms of the scale 3, Leisure Interest in Science.

Table 6: Descriptive statistics of both males and females per scale

	Gender of Respondents	N	Mean	Std. Deviation	Std. Error Mean
Social Implications of Chemistry	Male	97	3.5052	.51445	.05223
	Female	95	3.5442	.59888	.06144
Attitude of Chemistry Inquiry	Male	97	3.3351	.61442	.06238
	Female	95	3.5263	.74850	.07679
Leisure Interest in Chemistry	Male	97	2.9381	.72406	.07352
	Female	95	3.0874	.73169	.07507

Table 7 features the results of the t-test performed per scale to determine if there are any statistically significant differences between males and females regarding their responses for each scale. An independent t-test sample was used to test the hypothesis that states that there is no statistically significant difference between males and females with regards to their social implications towards Chemistry. The t (190/2) = 0.485, p=0.628. This result show that there is no statistically significant differences between males and female in terms of their understanding of the benefits of Chemistry to real life. However, the result of the t-test for their attitude towards performing inquiring activities such as experimenting, researching and analyzing shows that even though there is no significance difference between both genders participating, it was very close to being

statistically significant with t (190/2) = 1.937, p=0.054. Similarly, the students' interest in performing Chemistry-related activities during their leisure time, shows no significance difference between males and females with t (190/2) =1.420, p=0.157.

Table 7: Results of the t-test per scale

	t	df	Sig. (2-tailed)
Social Implications of Chemistry	-.485	190	.628
Attitude of Chemistry Inquiry	-1.937	190	.054
Leisure Interest in Chemistry	-1.420	190	.157

Table 8 summarize the results of the t-test performed in order to assess any statistically significant differences between males and females per item under the social implications of Chemistry scale. It is shows that there are no statistically significant differences between the responses of males and females for 9 out of 10 items presented. The only statistically significant difference appears for their responses towards "This country is spending too much money on Chemistry" with t (190/2) =3.379 and p=0.001.

Table 8: Participants' attitudes towards social implications of Chemistry

	t	df	Sig. (2-tailed)
Social Implications of Chemistry.	-.485	190	.628
Too many Chemistry laboratories are being built at the expense of the rest of education.	.747	190	.456
Chemistry helps to make life better.	.834	190	.406
This country is spending too much money on Chemistry.	-3.379	189.074	.001
Chemistry can help to make the world a better place in the future.	1.614	190	.108
Money spent on Chemistry is well worth spending.	.408	190	.684
Money used on Chemical projects is wasted	-1.588	190	.114
Chemistry is man's worst enemy	-1.050	190	.295
Public money spent on Chemistry in the last few years has been used widely.	.492	190	.624
Chemical discoveries are doing more harm than good.	-.868	190	.386
The government should spend more money on Chemical research.	.832	190	.407

Table 9 summarize the t-test results for items of the attitude towards Chemistry inquiry. It clearly assists in assessing whether there are any statistically significant differences between the attitude of males and females towards Chemistry. As concluded from the table, 8 out of 10 items show no statistically significant differences between the attitude of males and females towards Chemistry inquiry. However, the responses to "Doing Chemistry experiments is not as good as finding out information from teachers" and "I would rather agree with other people than do an experiment to find out for myself" show statistically significant differences between the attitude of males and female students.

Table 9: Results of the t-test of items of the attitude of Chemistry inquiry

	t	df	Sig. (2-tailed)
Attitude of Chemistry Inquiry	-1.937	190	.054
I would rather find out things by asking an expert than by doing a Chemical experiment.	-1.755	190	.081
I would rather solve a Chemistry problem by doing an experiment than be told the answer.	.080	190	.936
It is better to ask a teacher the answer than to find it out by doing Chemical experiments	-1.584	190	.115
I would prefer to do an experiment on a topic than to read about it in Chemistry magazines.	-.733	190	.465
It is better to be told Chemical facts than to find them out from experiments.	-1.132	190	.259
I would prefer to find out why something happens by doing a Chemistry experiment than be being told.	-.181	190	.856
Doing Chemistry experiments is not as good as finding out information from teachers.	-2.681	188.966	.008
I would prefer to do Chemistry experiments rather than to read about them.	-.686	190	.493
I would rather agree with other people than do an experiment to find out for myself	-2.522	190	.012
I would prefer to do my own experiments than to find out information from a teacher about Chemistry.	.254	190	.800

Table 10 summarizes the t-test results obtained per item measuring the leisure interest of students in Chemistry. 9 out of the 10 items measuring the leisure interest in Chemistry show that there are no statistically significant difference between males and females. Visiting Chemistry museum was the only item that showed statistically significant difference between the responses of males and females t (190/2) = 2.482 and p= .014.

Table 10: Results of the t-test of items of the leisure interest in Chemistry

	t	df	Sig. (2-tailed)
Leisure Interest in Chemistry	-1.420	190	.157
Talking to my friends about Chemistry after school would be boring.	-.675	190	.501
I would enjoy having a job in a Chemistry laboratory during my school holidays.	-1.837	190	.068
Listening to talk about Chemistry on the radio would be boring.	-.524	190	.601
I would enjoy visiting a Chemistry Museum on the weekend.	-2.482	190	.014
I dislike reading newspaper articles about Chemistry.	-.635	190	.526
I would like to belong to a Chemistry club.	-.546	190	.586
I get bored when watching Chemistry programs on TV at home Equal variances assumed	-.357	190	.721
I would like to be given a Chemistry book or a piece of science equipment as a present.	-.758	190	.449
I dislike reading books about Chemistry during my holidays	-.719	190	.473
I would like to do Chemistry experiments at home	.371	190	.711

4.4 Comparison of Students' Attitudes Towards Chemistry Based on Grade Level

In order to assess whether there are any statistically significant differences between students based on grade level (grades 10, 11 and 12), a one-way ANOVA test was performed. Table 11 summarizes the results from the ANOVA test.

Table 11: One way ANOVA between Grades 10, 11 and 12

		Sum of Squares	df	Mean Square	F	Sig.
Social Implications of Chemistry	Between Groups	.626	2	.313	1.011	.366
	Within Groups	58.569	189	.310		
	Total	59.195	191			
Attitude of Chemistry Inquiry	Between Groups	2.254	2	1.127	2.409	.093
	Within Groups	88.407	189	.468		
	Total	90.661	191			
Leisure Interest in Chemistry	Between Groups	3.726	2	1.863	3.593	.029
	Within Groups	97.997	189	.519		
	Total	101.722	191			

As for students' social implications of Chemistry and their attitude of Chemistry inquiry, it is reported that there is no statistically significant differences between all the three grade levels involved in the study with F (190/2) = 1.011 and p=.366 and F (190/2) = 2.409 and p= 0.093 respectively. However, there a significance difference between the groups in terms of their leisure interest in Chemistry with F (190/2) = 3.593 and p=0.029. A Post Hoc analysis was then performed in order to gain the knowledge about the source of the significance differcence. Table 12 shows that the statistically significant difference was found to be between students in grade 10 and students in grade 11 with a p=0.025.

Table 12: Post Hoc analysis of Grade levels involved in the study

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
Social Implications of Chemistry	Grade 10	Grade 11	.07071	.09700	.747
		Grade 12	.13819	.09745	.334
	Grade 11	Grade 10	-.07071	.09700	.747
		Grade 12	.06749	.10206	.786
	Grade 12	Grade 10	-.13819	.09745	.334
		Grade 11	-.06749	.10206	.786
Attitude of Chemistry Inquiry	Grade 10	Grade 11	.21904	.11918	.160
		Grade 12	-.02960	.11973	.967
	Grade 11	Grade 10	-.21904	.11918	.160
		Grade 12	-.24864	.12540	.119
	Grade 12	Grade 10	.02960	.11973	.967
		Grade 11	.24864	.12540	.119
Leisure Interest in Chemistry	Grade 10	Grade 11	.33050*	.12548	.025
		Grade 12	.09299	.12606	.741
	Grade 11	Grade 10	-.33050*	.12548	.025
		Grade 12	-.23751	.13202	.173
	Grade 12	Grade 10	-.09299	.12606	.741
		Grade 11	.23751	.13202	.173

Table 13 shows a clear analysis of the participants' attitudes as measured by social implications towards Chemistry considering each item under the social implications scale. The Table shows that all the items show no statistically significant differences bbetween the groups with an exception of two items; "Chemistry helps to make life better" and "Money spent on Chemistry is well worth spending" with a p value of 0.033 and 0.038 respectively. Examining this difference using a post hoc analysis, it was concluded that these differences occur between students studying in grades 10 and 11 with p value of .046 and .034 respectively as shown in Table 14.

Table 13: Comparing participants in grade 10, 11 and 12 in terms of their social implications towards Chemistry

		Sum of Squares	df	Mean Square	F	Sig.
Social Implications of Chemistry	Between Groups	.626	2	.313	1.011	.366
	Within Groups	58.569	189	.310		
	Total	59.195	191			
Too many Chemistry laboratories are being built at the expense of the rest of education.	Between Groups	1.326	2	.663	.653	.522
	Within Groups	191.919	189	1.015		
	Total	193.245	191			
Chemistry helps to make life better	Between Groups	7.863	2	3.931	3.471	.033
	Within Groups	214.054	189	1.133		
	Total	221.917	191			
This country is spending too much money on Chemistry.	Between Groups	.097	2	.048	.036	.965
	Within Groups	256.148	189	1.355		
	Total	256.245	191			
Chemistry can help to make the world a better place in the future.	Between Groups	3.902	2	1.951	1.576	.209
	Within Groups	233.926	189	1.238		
	Total	237.828	191			

Table 13: Comparing participants in grade 10, 11 and 12 in terms of their social implications towards Chemistry (Continued)

		Sum of Squares	df	Mean Square	F	Sig.
Money spent on Chemistry is well worth spending.	Between Groups	7.959	2	3.980	3.320	.038
Chemistry is man's worst enemy	Between Groups	3.781	2	1.890	1.218	.298
	Within Groups	293.339	189	1.552		
	Total	297.120	191			
Public money spent on Chemistry in the last few years has been used widely.	Between Groups	1.435	2	.718	.875	.419
	Within Groups	155.060	189	.820		
	Total	156.495	191			
Chemical discoveries are doing more harm than good.	Between Groups	1.390	2	.695	.531	.589
	Within Groups	247.355	189	1.309		
	Total	248.745	191			
The government should spend more money on Chemical research.	Between Groups	1.601	2	.800	.694	.501
	Within Groups	218.019	189	1.154		
	Total	219.620	191			

Table 14: Post Hoc analysis of grade levels involved in the study measuring social implications towards Chemistry

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
Social Implications of Chemistry	Grade 10	Grade 11	.07071	.09700	.747
		Grade 12	.13819	.09745	.334
	Grade 11	Grade 10	-.07071	.09700	.747
		Grade 12	.06749	.10206	.786
	Grade 12	Grade 10	-.13819	.09745	.334
		Grade 11	-.06749	.10206	.786
Too many Chemistry laboratories are being built at the expense of the rest of education.	Grade 10	Grade 11	.070	.176	.916
		Grade 12	.200	.176	.493
	Grade 11	Grade 10	-.070	.176	.916
		Grade 12	.131	.185	.760
	Grade 12	Grade 10	-.200	.176	.493
		Grade 11	-.131	.185	.760
Chemistry helps to make life better	Grade 10	Grade 11	.444*	.185	.046
		Grade 12	.383	.186	.102
	Grade 11	Grade 10	-.444*	.185	.046
		Grade 12	-.061	.195	.948
	Grade 12	Grade 10	-.383	.186	.102
		Grade 11	.061	.195	.948
This country is spending too much money on Chemistry.	Grade 10	Grade 11	.054	.203	.962
		Grade 12	.023	.204	.993
	Grade 11	Grade 10	-.054	.203	.962
		Grade 12	-.031	.213	.988
	Grade 12	Grade 10	-.023	.204	.993
		Grade 11	.031	.213	.988

Table 14: Post Hoc analysis of grade levels involved in the study measuring social implications towards Chemistry (continued)

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
Chemistry can help to make the world a better place in the future.	Grade 10	Grade 11	-.019	.194	.995
		Grade 12	.300	.195	.275
	Grade 11	Grade 10	.019	.194	.995
		Grade 12	.319	.204	.264
	Grade 12	Grade 10	-.300	.195	.275
		Grade 11	-.319	.204	.264
Money spent on Chemistry is well worth spending.	Grade 10	Grade 11	.310	.191	.239
		Grade 12	.482*	.192	.034
	Grade 11	Grade 10	-.310	.191	.239
		Grade 12	.173	.201	.665
	Grade 12	Grade 10	-.482*	.192	.034
		Grade 11	-.173	.201	.665
Money used on Chemical projects is wasted	Grade 10	Grade 11	-.303	.201	.289
		Grade 12	.088	.202	.901
	Grade 11	Grade 10	.303	.201	.289
		Grade 12	.391	.211	.157
	Grade 12	Grade 10	-.088	.202	.901
		Grade 11	-.391	.211	.157
Chemistry is man’s worst enemy	Grade 10	Grade 11	.129	.217	.823
		Grade 12	.339	.218	.267
	Grade 11	Grade 10	-.129	.217	.823
		Grade 12	.210	.228	.627
	Grade 12	Grade 10	-.339	.218	.267
		Grade 11	-.210	.228	.627

Table 14: Post Hoc analysis of grade levels involved in the study measuring social implications towards Chemistry (continued)

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
Public money spent on Chemistry in the last few years has been used widely.	Grade 10	Grade 11	.182	.158	.481
		Grade 12	-.009	.159	.998
	Grade 11	Grade 10	-.182	.158	.481
		Grade 12	-.191	.166	.484
	Grade 12	Grade 10	.009	.159	.998
		Grade 11	.191	.166	.484
Chemical discoveries are doing more harm than good.	Grade 10	Grade 11	-.062	.199	.948
		Grade 12	-.204	.200	.567
	Grade 11	Grade 10	.062	.199	.948
		Grade 12	-.142	.210	.778
	Grade 12	Grade 10	.204	.200	.567
		Grade 11	.142	.210	.778
The government should spend more money on Chemical research.	Grade 10	Grade 11	-.097	.187	.861
		Grade 12	-.221	.188	.468
	Grade 11	Grade 10	.097	.187	.861
		Grade 12	-.124	.197	.804
	Grade 12	Grade 10	.221	.188	.468
		Grade 11	.124	.197	.804

Table 15 shows the results obtained from a one-way ANOVA test to measure for significance differences between students of different grade levels in terms of the items measuring their attitude of Chemistry inquiry. Out of all the 10 items measuring their attitude of Chemistry inquiry, only 3 items showed statistically significant differences between groups; “I would rather find out things by asking an expert than by doing a Chemical experiment.” With F=3.885 and p=0.022, “I would rather solve a Chemistry

problem by doing an experiment than be told the answer" with F (190/2)=4.666 and p=0.011 and "It is better to ask a teacher the answer than to find it out by doing Chemical experiments" with F (190/2)=3.038 and p=0.050. The differences were examined using a post hoc analysis and it was figured out the for the first and the third item the difference occurs between grades 11 and 12 with p= .017 and p=.010. whereas for the second item the difference occurs between grades 10 and 11 with p= .040.

Table 15: Comparing participants in Grade 10, 11 and 12 in terms of their attitude towards Chemistry inquiry

		Sum of Squares	df	Mean Square	F	Sig.
I would rather find out things by asking an expert than by doing a Chemical experiment.	Between Groups	12.747	2	6.373	3.885	.022
	Within Groups	310.066	189	1.641		
	Total	322.813	191			
I would rather solve a Chemistry problem by doing an experiment than be told the answer.	Between Groups	11.914	2	5.957	4.666	.011
	Within Groups	241.289	189	1.277		
	Total	253.203	191			
It is better to ask a teacher the answer than to find it out by doing Chemical experiments	Between Groups	9.825	2	4.913	3.038	.050
	Within Groups	305.654	189	1.617		
	Total	315.479	191			

Table 15: Comparing participants in Grade 10, 11 and 12 in terms of their attitude towards Chemistry inquiry (Continued)

		Sum of Squares	df	Mean Square	F	Sig.
I would prefer to do an experiment on a topic than to read about it in Chemistry magazines.	Between Groups	1.046	2	.523	.341	.712
	Within Groups	290.323	189	1.536		
	Total	291.370	191			
It is better to be told Chemical facts than to find them out from experiments.	Between Groups	6.640	2	3.320	2.497	.085
	Within Groups	251.277	189	1.330		
	Total	257.917	191			
I would prefer to find out why something happens by doing an Chemistry experiment than be being told.	Between Groups	4.306	2	2.153	1.922	.149
	Within Groups	211.688	189	1.120		
	Total	215.995	191			
Doing Chemistry experiments is not as good as finding out information from teachers.	Between Groups	.590	2	.295	.222	.801
	Within Groups	251.154	189	1.329		
	Total	251.745	191			

Table 15: Comparing participants in Grade 10, 11 and 12 in terms of their attitude towards Chemistry inquiry (Continued)

		Sum of Squares	df	Mean Square	F	Sig.
I would prefer to do Chemistry experiments rather than to read about them.	Between Groups	2.723	2	1.361	1.063	.347
	Within Groups	241.980	189	1.280		
	Total	244.703	191			
I would rather agree with other people than do an experiment to find out for myself	Between Groups	.942	2	.471	.292	.747
	Within Groups	304.303	189	1.610		
	Total	305.245	191			
I would prefer to do my own experiments than to find out information from a teacher about Chemistry.	Between Groups	1.493	2	.747	.481	.619
	Within Groups	293.377	189	1.552		
	Total	294.870	191			
Attitude of Chemistry Inquiry	Between Groups	2.254	2	1.127	2.409	.093
	Within Groups	88.407	189	.468		
	Total	90.661	191			

Table 16: Post Hoc analysis of Grade levels involved in the study measuring attitude of Chemistry inquiry

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
Attitude of Chemistry Inquiry	Grade 10	Grade 11	.21904	.11918	.160
		Grade 12	-.02960	.11973	.967
	Grade 11	Grade 10	-.21904	.11918	.160
		Grade 12	-.24864	.12540	.119
	Grade 12	Grade 10	.02960	.11973	.967
		Grade 11	.24864	.12540	.119
I would rather find out things by asking an expert than by doing a Chemical experiment.	Grade 10	Grade 11	.268	.223	.454
		Grade 12	-.383	.224	.205
	Grade 11	Grade 10	-.268	.223	.454
		Grade 12	-.651*	.235	.017
	Grade 12	Grade 10	.383	.224	.205
		Grade 11	.651*	.235	.017
I would rather solve a Chemistry problem by doing an experiment than be told the answer.	Grade 10	Grade 11	.581*	.197	.010
		Grade 12	.402	.198	.108
	Grade 11	Grade 10	-.581*	.197	.010
		Grade 12	-.179	.207	.662
	Grade 12	Grade 10	-.402	.198	.108
		Grade 11	.179	.207	.662
It is better to ask a teacher the answer than to find it out by doing Chemical experiments	Grade 10	Grade 11	.244	.222	.514
		Grade 12	-.329	.223	.305
	Grade 11	Grade 10	-.244	.222	.514
		Grade 12	-.573*	.233	.040
	Grade 12	Grade 10	.329	.223	.305
		Grade 11	.573*	.233	.040

Table 16: Post Hoc analysis of Grade levels involved in the study measuring attitude of Chemistry inquiry (Continued)

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
I would prefer to do an experiment on a topic than to read about it in Chemistry magazines.	Grade 10	Grade 11	.155	.216	.753
		Grade 12	-.009	.217	.999
	Grade 11	Grade 10	-.155	.216	.753
		Grade 12	-.164	.227	.751
	Grade 12	Grade 10	.009	.217	.999
		Grade 11	.164	.227	.751
It is better to be told Chemical facts than to find them out from experiments.	Grade 10	Grade 11	.243	.201	.449
		Grade 12	-.229	.202	.493
	Grade 11	Grade 10	-.243	.201	.449
		Grade 12	-.472	.211	.068
	Grade 12	Grade 10	.229	.202	.493
		Grade 11	.472	.211	.068
I would prefer to find out why something happens by doing a Chemistry experiment than be being told.	Grade 10	Grade 11	.315	.184	.205
		Grade 12	-.018	.185	.995
	Grade 11	Grade 10	-.315	.184	.205
		Grade 12	-.332	.194	.203
	Grade 12	Grade 10	.018	.185	.995
		Grade 11	.332	.194	.203
Doing Chemistry experiments is not as good as finding out information from teachers.	Grade 10	Grade 11	.118	.201	.828
		Grade 12	.111	.202	.848
	Grade 11	Grade 10	-.118	.201	.828
		Grade 12	-.007	.211	.999
	Grade 12	Grade 10	-.111	.202	.848
		Grade 11	.007	.211	.999

Table 16: Post Hoc analysis of Grade levels involved in the study measuring attitude of Chemistry inquiry (Continued)

Dependent Variable	(I) Grade of Respondents	(J) Grade of Respondents	Mean Difference (I-J)	Std. Error	Sig.
I would prefer to do Chemistry experiments rather than to read about them.	Grade 10	Grade 11	.006	.197	1.000
		Grade 12	.261	.198	.388
	Grade 11	Grade 10	-.006	.197	1.000
		Grade 12	.255	.207	.438
	Grade 12	Grade 10	-.261	.198	.388
		Grade 11	-.255	.207	.438
I would rather agree with other people than do an experiment to find out for myself	Grade 10	Grade 11	.159	.221	.752
		Grade 12	.020	.222	.995
	Grade 11	Grade 10	-.159	.221	.752
		Grade 12	-.139	.233	.822
	Grade 12	Grade 10	-.020	.222	.995
		Grade 11	.139	.233	.822
I would prefer to do my own experiments than to find out information from a teacher about Chemistry.	Grade 10	Grade 11	.101	.217	.887
		Grade 12	-.122	.218	.841
	Grade 11	Grade 10	-.101	.217	.887
		Grade 12	-.224	.228	.591
	Grade 12	Grade 10	.122	.218	.841
		Grade 11	.224	.228	.591

Table 17 presents the results of a one-way ANOVA test for all the items that was used to measure the leisure interest of students in Chemistry. The results of the ANOVA shows that there are no statistically significant differences between the responses of students in grades 10, 11 and 12 for the 10 items presented.

Table 17: Comparing participants in Grade 10, 11 and 12 in terms of their leisure interest in Chemistry

		Sum of Squares	df	Mean Square	F	Sig.
Leisure Interest in Chemistry	Between Groups	3.726	2	1.863	3.593	.029
	Within Groups	97.997	189	.519		
	Total	101.722	191			
Talking to my friends about Chemistry after school would be boring.	Between Groups	4.211	2	2.106	1.361	.259
	Within Groups	292.455	189	1.547		
	Total	296.667	191			
I would enjoy having a job in a Chemistry laboratory during my school holidays.	Between Groups	5.416	2	2.708	1.581	.208
	Within Groups	323.703	189	1.713		
	Total	329.120	191			
Listening to talk about Chemistry on the radio would be boring.	Between Groups	1.684	2	.842	.482	.618
	Within Groups	329.983	189	1.746		
	Total	331.667	191			
I would enjoy visiting a Chemistry Museum on the weekend.	Between Groups	5.885	2	2.942	1.774	.172
	Within Groups	313.485	189	1.659		
	Total	319.370	191			

Table 17: Comparing participants in Grade 10, 11 and 12 in terms of their leisure interest in Chemistry (Continued)

		Sum of Squares	df	Mean Square	F	Sig.
I dislike reading newspaper articles about Chemistry.	Between Groups	3.127	2	1.564	1.105	.333
	Within Groups	267.368	189	1.415		
	Total	270.495	191			
I would like to belong to a Chemistry club.	Between Groups	2.706	2	1.353	.913	.403
	Within Groups	279.998	189	1.481		
	Total	282.703	191			
I get bored when watching Chemistry programs on TV at home	Between Groups	4.292	2	2.146	1.414	.246
	Within Groups	286.958	189	1.518		
	Total	291.250	191			
I would like to be given a Chemistry book or a piece of science equipment as a present.	Between Groups	10.263	2	5.131	3.001	.052
	Within Groups	323.216	189	1.710		
	Total	333.479	191			
I dislike reading books about Chemistry during my holidays	Between Groups	5.862	2	2.931	2.215	.112
	Within Groups	250.055	189	1.323		
	Total	255.917	191			

Table 17: Comparing participants in Grade 10, 11 and 12 in terms of their leisure interest in Chemistry (Continued)

		Sum of Squares	df	Mean Square	F	Sig.
I would like to do Chemistry experiments at home	Between Groups	5.292	2	2.646	1.747	.177
	Within Groups	286.328	189	1.515		
	Total	291.620	191			

4.5 Summary of the Results

This chapter mainly focused on reporting all the findings of the current research. The chapter was divided into four main sections each of which reports an answer to one of the research questions raised before the study was conducted. To begin with, the results shows that students generally tend to have positive attitude towards Chemistry. Moreover, the data showed that there were no statistically significant differences between males and females in terms of their attitudes towards Chemistry as measured by the social implications towards Chemistry and their leisure interest in Chemistry. However, the responses towards the attitude of Chemistry inquiry were very close to being statistically significant. Even though in terms of scale the statistically significant differences were not reported, yet, there were some differences in different items in each of the mentioned scales. Finally, when comparing the responses of students as per their grade level per scale, there was a statistically significant difference existing only between grades 10 and 11 in terms of their leisure interest in Chemistry. However, some items within each scale showed a difference between the grade levels participating.

Chapter 5: Discussions

5.1 Chapter Overview

The main purpose of the current study is to explore the level of attitudes high school students in Al Ain have towards Chemistry as well as to investigate if there are any statistically significant differences between students based on their gender and their grade level. The main aim of this chapter is to discuss the data presented in the results chapter. Additionally, it presents a clear comparison in light of the previous studies that dealt with the same topic. Furthermore, the discussion of these findings was geared towards findings answers to research questions mentioned in chapter 1.

The current study focused mainly on aspects of attitudes as described by Farser (1978) namely the social implications towards Chemistry, attitude towards Chemistry inquiry, and leisure interest in Chemistry. The results of the study show that all participants in the study show positive attitudes towards Chemistry in terms of their social implications of it (M= 3.52) and their attitude of Chemistry inquiry (M=3.43). However, their attitude is not clear towards their leisure interest in Chemistry with a slight tendency towards the positive attitude (M=3.01). This shows that the participants of the study do believe that Chemistry is a socially important subject that helps make life better. This was reported earlier by Salta and Tzougrake (2004) in their study where most of the students participating in their study do agree with the importance of the Chemistry subject in their everyday life. Additionally, it proves that students participating in the study do prefer inquiring about the subject by performing lab experiments and working with chemicals as well as analyze, reflect and come up with conclusions rather than gaining the information from a teacher. This shows that when students are given opportunities to practice inquiry skills, they are likely to be positive about Chemistry. The results seem similar to findings by Khalil and Aldridge (2019) who reported that students tend to show more positive attitudes towards science-related subjects when cooperative learning strategies are adopted by science teachers. This is because cooperative learning strategies were proven to enhance the engagement of students in classroom activities, where they students tend to interact with each other's,

discuss, exchange ideas and thereby enhance their inquiry skills resulting in better progress (Chen, 2018). However, their attitude towards enjoying Chemistry or Chemistry-related activities during their free time is unclear compared to other scales.

5.2 Social Implications Towards Chemistry

The level of attitudes of high school students was also evaluated per item presenting each scale. With regards to the students' social implications towards Chemistry, that aims to measure the attitude of students towards the research conducted in the field of Chemistry and its benefit to the society (Welch, 2010), the statement that showed the highest mean value was that "Chemistry can help to make the world a better place in the future". This reflects how students do have a good understanding of the importance of Chemistry to the real world and how it is crucial for future innovations and that it helps benefiting the future (Surya & Arty, 2020). This proves their understanding of the main concepts of the Chemistry subject and their applications in real life. Surya and Arty (2020) concluded in their study that most of the participants consider the Chemistry subject as an important subject to understand and that it is helpful to our lives in their study that assesses high school students' attitudes towards the Chemistry subject measure based on the learning experiences of the participants. However, the lowest mean score, was awarded to their belief that the country is spending too much money on Chemistry, indicating a negative attitude towards their social implications about Chemistry. This could be interpreted in two ways, one; is that students might believe that the money spent on Chemistry is never too much due to its importance to the future, which reflects a positive attitude. In countries like Sweden even though large investments are taking place in Chemistry-related technologies and systems, such as anaerobic digestions, yet, there is a need for more of such investments due to their essential needs in real life (Anukam, Mohammadi, Naqvi, & Granström, 2019). The other could be that they see that the country is not giving much importance to Chemistry in terms of allocating enough budget for it. However, this is not supported by empirical evidence, due to the fact that most research papers related to investments in Chemistry in the UAE proves that the country gives priority to science and innovation-related investments (Kim, Kim, Lee, Lee, & Lim, 2021; Soonmin, et al., 2018; Belwal, et

al., 2019). Additionally, the UAE tends to organize competitions that provides opportunities for students to innovate and therefore provides opportunities for development of positive attitudes such as the National Science Technology and Innovation Festival NSTI and Think Science.

5.3 Chemistry Inquiry

Looking into the attitude of students towards chemical inquiry, that aims to measure the attitude of students towards gaining deeper understanding of Chemistry and the world around them using scientific experimentation and getting engaged in investigative activities (Welch, 2010), the item with highest mean value was the one that reflects the preference of students in performing Chemistry experiments rather than hearing about them and the lowest one that reflects their negative attitude towards asking an expert about an experiment rather than performing it. Both statements reflect that participant of the study have positive attitudes towards inquiring about Chemistry. This shows that the participants of this study are more interested in performing experiments and they would prefer finding out about scientific concepts and facts themselves by drawing conclusions rather than them being told about them. These findings are similar to those reported by Baker and Robinson (2019) who suggested that students learn better when involved in curriculum that involve active experimentation. Kolb and Kolb (2009) also supported the idea that most learners prefer experimenting ideas whether using laboratories, practical application or simulations in order to grasp the ideas and concepts in a more understandable and realistic way. Learning the subject better with a preferred way would break inconsistencies in attitudes of students related to Chemistry and will therefore help in building a positive attitude towards the subject (Jiang, et al., 2016). Moreover, this positive attitude could be due to the classroom environment provided by the school. This is because classroom environment has been proven by several researchers that it has an impact on students' learning and their attitudes towards certain subjects. Maharaj-Sharma and Sharma (2017) supports this argument by concluding that classrooms that are interacting and comfortable to students helps in enhancing and building their scientific skills. Enhancing scientific skills supports students decrease their uncertainty towards the subject (Jiang, et al., 2016) and therefore increases their interest

in experimenting, analyzing, processing, creating, innovating and researching with passion without fear of failure. However, due to current circumstances and the spread of Covid-19, providing an engaging learning environment was considered as one of the challenges that educators face. This is due to the fact that teachers tend to deliver instructions through online platforms and they do not get to meet students physically. This limits the ability of educators being able to control any distracting environment around the students or even be able to involve students in cooperating activities that involve interaction with the environment and with their colleagues. Lee and Recker (2021) oppose this view by arguing that students are given more opportunities to interact using several platforms and get involved in online applications that enhances their ability to communicate together and work in groups effectively and cooperatively unlike what might happen in face-to-face classes. This will return develop positive attitudes towards science generally, and Chemistry specifically. This was also supported by Henriksen, Creely, Henderson, and Mishra (2021) who argued that if online tools are integrated properly in a constructive way, it will open the door for students to enhance their attitudes, research, innovative and creativity skills and therefore will develop their level of understanding of concepts and their application and therefore would be reflected in their attitudes.

5.4 Leisure Interest in Chemistry

Leisure interest in Chemistry aims to measure the attitude of students towards participating in activities that involve Chemistry outside the boarders of the classroom (Welch, 2010). Giving more attention to participating in scientific actions are clear signs of positive attitudes. This is considered as an important aspect due to the fact that it takes students away from the school environment and rather involve them in real-life applications of the subject. It enhances their ability to see the value of knowing more about the Chemistry that surrounds them and supports them in real life. Interpreting the items used to reflect the participating students' leisure interest in Chemistry shows that the students show most positive attitude towards visiting a Chemistry museum in their weekend. However, the mean value of their responses was 3.44, which reflects that even though it is the highest among all items, yet is closer to being neutral. This shows that

some of the participants would actually enjoy spending their leisure time knowing more about Chemistry and Chemistry concepts. The lowest mean value was towards a negative statement that states “I dislike reading newspaper articles about Chemistry”. This also reflects positive feedback from students about spending their leisure time knowing more about the Chemistry subject. This in return shows to the researchers that students participating in this study are interested in spending time finding more about Chemistry outside the school borders. The reason behind such a finding could be due to students being more engaged in online Chemistry classes (AlMahdawi, Senghore, Ambrin, & Belbase, 2021) which enhanced their understanding of topics and made students more interested in knowing more about the subject they tend to enjoy.

5.5 Impact of Gender

In the current study, when comparing the level of attitudes towards Chemistry based on gender, it was concluded that there are no statistically significant differences between the responses of female participants and male participants in terms of the importance of Chemistry in real life, attitude towards using Chemistry to understand the world around them and leisure interest in knowing more about Chemistry outside the classroom boarder. The interaction between attitudes and gender was previously reported by several researchers in different dimensions (Can, 2012; Montes, et al., 2018; Said, et al., 2016). Can (2012) concluded in his study that there is a statistically significant difference between boys and girls in terms of their enjoyment of the Chemistry subject where male students showed more positive attitudes towards enjoying the subject than girls. However, Said, et al. (2016) reported in his study that there are no statistically significant differences between male and female students in terms of their attitudes towards the science subject. Similar results were also reported by Montes, et al. (2018) who reported that gender did not have any influence on the students’ attitudes towards the Chemistry subject.

Findings similar to the ones reported in the current study were also reported by Akram, Ijaz, and Ikram (2017) who assessed the factors responsible for the decline in students’ interest in the Chemistry subject and reported that there are no statistically significant differences between students’ attitude towards the Chemistry subject.

However, their responses towards items representing their attitude of scientific inquiry were very close to show significance differences between gender. This difference was then studied in terms of each item and it was concluded to be due learning styles preferred by each gender and the way by which they prefer to grasp the knowledge. These findings are similar to the findings of a study conducted by Ratamun and Osman (2018) who concluded that there is no statistically significant difference between the attitude of both genders participating in their study. Similarly, Said, et al. (2016) also concluded that there are no statistically significant differences between genders in terms of their attitudes towards sciences in general in their study conducted in Qatar.

The reasons behind the similarities between gender in the current study could be that all participating students have several common characteristics. All participating students were part of the same school, which means that they were always taught the same curriculum by the same teachers. Additionally, they were also exposed to the same number of Chemistry-inquiring activities including experimenting, investigating, posing questions and analyzing as well as same type and level of examination. The methods of instructions delivery are also a common factor that might have resulted in the results showing no significance differences. In addition, the common learning environment, many of the participating students come from similar social background and follow the same culture which could also be factors that contributed to no significance differences in their responses. Furthermore, all participants in the study have been studying the subject distantly for the past 2 years due to Covid-19 precautionary measures. Learning Distantly might have similarly affected their attitudes due to lack of actual inquiry activities such as carrying out experiments and lack of social activities that may impact their leisure activities. This could have affected their attitudes towards the subject in a similar way resulting in no statistically significant differences between both genders. This is in line with by Fraser (2018) who argued that learning environment similarly affect the students' attitudes and their cognitive outcomes.

Analysis was also performed in order to find if there are any statistical differences related to students' gender in terms of each item presented under each of the investigated scales. Considering the social implications of Chemistry, the results showed no statistically significant difference between males and females for 9 out of 10 items

presented to reflect their attitude towards social implications of the subject. The only item that showed statistically significant difference was the one that states “This country is spending too much money on Chemistry”. The reason for this statistically significant difference might be due to one gender being more exposed to expenses allocations in the country than the other. As per a study conducted by AlMahdawi, et al. (2021), studying the performance indicators of students studying Chemistry distantly during the pandemic in the UAE, female students were concluded to have better engagement and understanding of concepts during Chemistry classes which enhances their abilities to perform researches about them. Additionally, Henriksen, et al. (2021) reported that students get more chances to research and find out ideas and concepts online using different applications and different platforms, this could be the driving force for the difference. Female students might have gone through several studies to understand and have more idea about the allocations of expenses and the investments performed in the country unlike male students who might not have made use of distance learning to research more about the investments of the country in Chemistry in this region.

5.5.1 Impact of Students’ Gender on their Attitude Towards Scientific Inquiry:

Considering the students’ attitude towards Chemistry inquiry, 8 out of 10 items show no statistically significant differences between the attitude of males and females towards Chemistry inquiry. However, female and male students showed statistically significant difference in two items reflecting their preference in performing Chemistry experiments versus agreeing with other people’s opinion without doing any inquiring activities. The statistically significant difference could be due to the difference in the willingness to do work or in one gender being more active than the other and preferring to perform hands-on activities to inquire than to simply grasp knowledge (Sarabi-Asiabar, et al., 2015). It could also be due to the ease of gaining knowledge, where one of the genders would prefer to seek gaining knowledge from a source than inquiring about it. It is observed by the researcher that female students in Al Ain region show more preferences to acquiring information from teacher to find evidence and explanations unlike boys who would go for trial-and-error technique to acquire knowledge by experimentation. Culturally, female students are more likely ask more questions in class

than boys depending on their teachers, unlike boys who prefer to rely on their skills to obtain knowledge. According to a study conducted in Iran by Sarabi-Asiabar, et al. (2015), male students were found to have more preference towards kinesthetic learning style than female students who prefer the aural learning style. This means that male students prefer movement and performing when learning unlike female students who prefer listening to information rather than taking risks to reach it. In contrast, Altun and Serin (2019) concluded that most of their participants of males and females was proven to adopt converger learning style, interested to turn theoretical views into reality by experimentations (Kolb & Kolb, 2009). This shows that both genders have interest in experimentations as per this study but it might slightly differ in terms of personal preference.

5.5.2 Impact of Students' Gender on their Attitude Towards Leisure Interest in Chemistry:

Finally, 9 out of the 10 items measuring the leisure interest in Chemistry show that there are no statistically significant differences between males and females. Visiting Chemistry museum was the only item that showed statistically significant difference between the responses of males and females. The interpretation of this difference could be due to the fact that one of the genders does not have interest in visiting museums, whether related to Chemistry or not. It could also be due to the fact that male students were found to prefer learning by doing than learning by observing. This supports the argument mentioned earlier that one of the genders could be more interested in seeking knowledge than acquiring about it or that one of the genders prefer on learning style over the other. Sarabi-Asiabar, et al. (2015) reported that by concluding that the male students are more interested in learning by performing experimentations and more engaged in learning styles that involve movement in contrary to female students who prefer seeking the knowledge orally from an educator rather than acquiring about it. This was reported earlier by Kharb, Samanta, Jindal, and Singh (2013) who did not only conclude that each gender has its own learning style, but rather, concluded that every individual differs from one another in terms of the way they learn or the way they acquire knowledge. This basically reflects the fact that gender and personal preference are two factors that

account for differences in learning styles (Kharb, et al., 2013) and therefore they both could for sure account for statistically significant differences between gender in terms of their interest in the subject within and outside the classroom boarder.

5.6 Impact of Grade Level

One-way ANOVA was performed in order to compare student attitudes based on grade level. The results concluded that there are no statistically significant differences between grades 10, 11 and 12 in terms of their social implications of Chemistry and their attitude of Chemistry inquiry. The findings of the current study could be due to the fact that all the three groups belong to the same school, following the same curriculum and same system. Oginni, Awobodu, Alaka, and Saibu (2013) suggested that class and school environments are highly correlated to students' attitudes and achievement in a certain subject. Additionally, most of the participants come from the same geographical area which means similar culture and similar way of being raised up.

However, it was observed that there is a statistically significant difference between the responses of participants in grade 10 and 11 in terms of their leisure interest in Chemistry. Similarly, Can (2012) reported statistically significant differences between students based on their grade levels and gender when he researched the high school students' attitude towards school Chemistry. Additionally, Montes, et al. (2018) reported in their study that measures students' attitudes towards Chemistry that grade level does has a clear influence on the students' attitudes towards Chemistry. In the current study, Grade 10 students show a positive mean difference, this could be due to the fact that it is their first year to take subject, they are taking basic topics and they are more motivated to perform better academically and therefore, they are interested in it. Additionally, grade 10 is considered as a determinant factor where students usually start thinking about specialization and therefore, it might have an effect on their attitude where they try to grasp ideas and information about every subject to have better understanding of the career, they would want to pursue (Badri, et al., 2016). However, grade 11 students show a negative mean difference, this could be due to the fact that they are taking Chemistry for the second year in a row, they are now taking more advanced topics, they have a better understanding of most of the topics, therefore, they might have lost the enthusiasm

and interest they had when they first started studying the subject. Can (2012) reported in his study that the attitude towards Chemistry decline for male students from grades 9 to 11, which supports our study in terms of both genders. Both studies were performed on students studying in a single school, however, the difference could be due to the difference in the country at which the study was performed, where Can (2012) performed his study in Turkey unlike this study which was performed in the UAE. This might be due to the difference between the culture of participants in both studies or due to the fact that our study is conducted in Al Ain which is a smaller region of the UAE country where students get to come from similar families and therefore usually have similar environments and perspectives.

The comparison between grade levels was also performed per item per each scale. The items intending to measure the leisure interest in Chemistry showed no statistically significant differences between all three grade levels. However, it may be concluded that the only statistically significant differences between grade levels exist between grades 10 and 11 in items presenting their attitude towards the benefits of conducted research and their attitude towards using Chemistry to understand the surrounding world. Students in grade 10 tend to show positive attitudes in two statements in each of the above-mentioned scales, unlike students in grade 11 who show negative attitudes. The reason for the negative attitude reflected by the findings for grade 11 might be due to uncertainty of students about the advanced topics they are taking in their grade level and uncertainty about their future specialization. This is supported by the theoretical framework work discussed earlier in chapter 2 that describes the Affective Cognitive Consistency theory that describes students' having a negative attitude or feeling ambivalent towards any subject due to their inconsistency towards it (Jiang, et al., 2016). Therefore, being uncertain about a specific topic, idea or future specialization would definitely affect students' attitude negatively and result in an overall negative attitude towards a subject. Additionally, the negative attitudes of students in grade 11 could be due to the fact that the Chemistry concepts do not fall under their latitude of acceptance as per the social judgement theory (Xiao-Yun, 2021).

Chapter 6: Conclusion

In this thesis, a study is conducted to explore the scientific attitudes of students towards Chemistry as one of the branches of science, in the context of the UAE. These attitudes are measured using three dimensions of scientific attitudes namely; social implications of Chemistry, the students' Chemistry-related inquiries and their leisure interest Chemistry. Additionally, this study examines the influence of categorical variables such as gender and grade level on the development of the students' attitudes towards Chemistry. Results of the study demonstrate that students had positive attitudes towards Chemistry, as described by social implications of Chemistry, their attitude towards Chemistry inquiry and their leisure interest in Chemistry. Additionally, results also revealed that there are no statistically significant differences in gender-based attitudes towards Chemistry, based on the three assessment dimensions used in this study. Furthermore, this study also shows that there are no statistically significant differences in attitudes attributed to student grade level, measured in terms of their social implications of Chemistry and their attitude towards Chemistry inquiry. However, there are statistically significant differences between the students' attitudes in grades 10 and 11 when assessed based on their leisure interest towards the subject.

Due to Covid-19 restrictions and restrictions in visiting multiple schools, this study was conducted using small sample. Due to the small sample, it is recommended to perform the research using larger sample following the same curriculum as was first planned for this research. Additionally, it is recommended that the research is performed using mixed methods in order to gain in-depth understanding of the attitudes of students towards the subject and predict reasons behind those attitudes. Such research will open the eyes of curriculum developers and educators on reasons behind a certain attitude and will help them plan their lessons accordingly. Moreover, it will support in coming up with intervention plans that facilitates students' achievement in the subject based on their attitudes. It is recommended to use all the scales of the TOSRA instrument to have a clearer picture of the attitudes of students and would be also beneficial if another study compare attitudes concluded using the TOSRA instrument and other attitude instruments were used in previous research. This could be used as a confirmation of results to those

presented in the current study and would enhance the findings to have a better idea about the scientific attitudes of high school students towards Chemistry and whether there are any statistically significant differences between their attitudes based on their gender and grade level. Further research studies maybe be conducted using different variables to have a clear and deep understanding of the effect of different variables on the scientific attitudes of high school students towards Chemistry.

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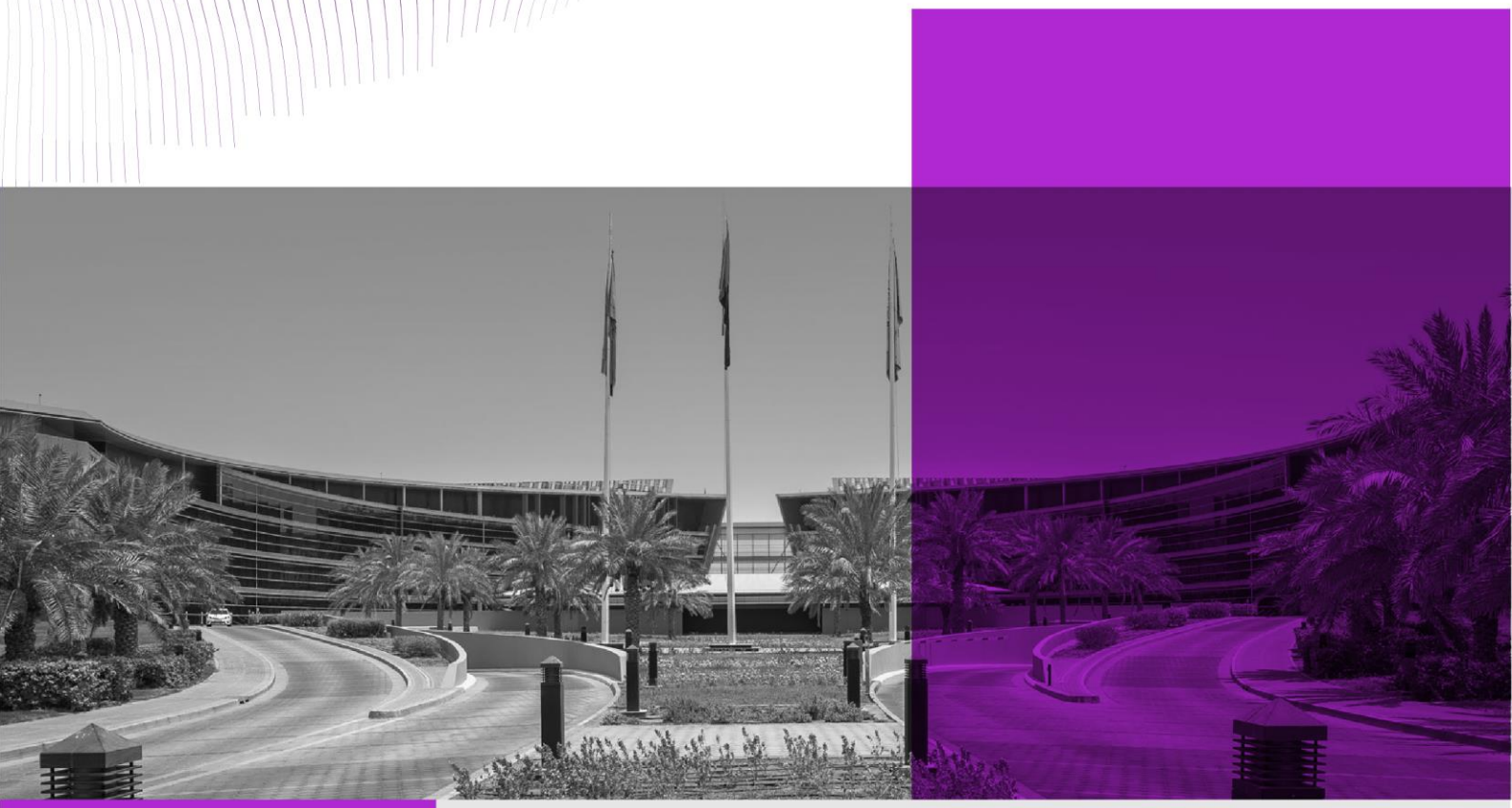

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The main purpose of this study is to assess the scientific attitudes of students towards Chemistry as one of the branches of science, in the context of the UAE as well as examines the influence of categorical variables such as gender and students' grade level on the development of the students' attitudes towards the subject.

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