The Effects of Instructional Homework Technique on Chemistry Achievement of the United Arab Emirates Male and Female Tenth Graders

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Abstract: The purpose of this study was to investigate the effects of Instructional Homework Technique (IHT) - as a systematic preparation homework assignment- on the chemistry achievement of the UAE tenth graders. The sample of this study consisted of 8 classrooms with an average of 24 students in each class. The 8 classes were divided equally in terms of gender. The schools were selected conveniently, and the classrooms were randomly assigned into experimental and control groups. The students in the experimental groups received an instructional homework twice a week while students in the control groups received regular homework assignments. The experiment lasted ten weeks and included 19 assignments and each assignment consists of a minimum of 20 items. This study used a pretest posttest control group design. The results revealed that students in the experimental group (with IHT) scored significantly higher on the chemistry posttest achievement measure. The Eta squared for a posttest as a dependent variable for treatment was 0.15 which is partially high. There was a significant statistical difference in term of gender with the UAE male tenth graders scored significantly higher than female counterparts in the chemistry achievement test.

Keywords: *Instructional Homework Technique (IHT), UAE, Tenth graders, Chemistry achievement, Students gender, Arab students*

Introduction

Homework has been at the central debate for more than a century among educators. For example, many researchers found that homework was considered as an important educational means because it fosters both academic and nonacademic benefits (Cooper, 1989; Cooper, 2001; Cooper, Lindsay, Nye, & Greathouse, 1998; Cooper, Robinson, & Patall, 2006; Cooper & Valentine, 2001; Corno, 2000; Hong, Peng, & Rowell, 2009; Lubbers, Van Der Werf, Kuyper, & Hendriks, 2010; Reinhardt, Theodore, Bray, & Kehle, 2009; Trautwein, 2007; Warton,

2001; Zimmerman & Kitsantas, 2005). On the other hand, others such as Bennett and Kalish (2006), Kohn (2006), and Kralovec and Buell (2000), suggested that doing homework may not advance students' academic and nonacademic benefits. Cooper et al (2006) summarized both potential positive and negative effects of homework.

Review of the Literature

In attempt to study homework's effects on students' achievement by comparing homework and no-homework conditions two major meta-analysis studies have been conducted. For example, Cooper (1989) used meta-analytical strategies to analyze in details 120 empirical studies of homework's effects. For instance, 20 studies conducted between 1962 and 1986, 14 produced effects favoring homework while 6 favored no homework. Cooper (1989) also found an overall effect of d = .21 favoring homework conditions over no-homework conditions. The effect of homework assignments was stronger in higher grades (grades 4-6: d = .15; grades 7-9: d = .31; grades 10-12: d = .64). However, Trautwein, Köller, Schmitz, & Baumert (2002) stated that some studies (i.e. Cooper, Lindsay, Nye, & Greathouse, 1998; Farrow, Tymms, & Henderson, 1999) have casted doubt on the positive influence of homework on achievement reported by Cooper's (1989) review. Furthermore, the empirical support for the homework-achievement association was not clear (Trautwein, 2007).

Another meta-analysis was conducted by Cooper, Robinson, and Patall (2006) by updating Cooper's (1989) review of homework studies that have been reported between 1987 and 2003. In this meta-analysis three groups of studies were classified. One of these group consisted of six studies that reported positive effects of homework that had an experimental design and none of these studies were published in peer-reviewed journals. Example of these studies was that of Foyle (1990) who assigned randomly four whole grade five classrooms to a practice homework (one classroom) condition, a preparation homework (one classroom) condition, and a no-classroom (two classrooms) condition. The results showed that students doing homework outperformed no-homework students on unadjusted posttest scores. Although their review seems to be impressive, it may yet be too early to draw any final conclusions about the positive effects of homework. One reason for this is that the Cooper et al's. (2006) review was limited to research conducted in the US, leaving open question of cross-cultural generalizability. Moreover, Cooper et al. (2006, p. 3) warned that "all studies regardless of type, had design flaws" which draws concerns about the quality of the studies that were covered in the meta-analysis. Further, the majority of the studies included in the meta-analysis focused almost entirely on time spent on homework and its relation

with students' academic performance where other important variables such as the quality and quantity of homework were absent.

Homework as an Instructional Tool

Many studies have indicated that homework has been usually assigned to students for instructional or non-instructional purposes (Epstein & Van Voorhis, 2001; Mulhenbruck, Cooper, Nye, & Lindsay, 1999). The well-known instructional purpose for the homework is to give students opportunities to review or practice lessons that have already been taught. Another purpose for the instructional homework is to design homework as a preparation task. In this case, students do the homework to acquire knowledge that could help them become more active when the new lesson is taught and to help them "obtain the maximum benefit when the new material is covered in class" (Muhlenbrack, Cooper, Nye, & Linddsay, 1999 quoted in Cooper et al., 2006, p. 1). However, how teachers prepared and assigned homework for preparation purposes was not evidently examined. The educational literature has discussed other instructional or non-instructional purposes for the homework assignments, such as public relations, peer interactions, participation, parent-child relations, parent-teacher communications, personal development, and policy (see, Epstein, 2001; Epstein & Van Voorhis, 2001, Markovic, Randjelovic, & Trivic, 2010; Van Voorhis, 2003; Xu, 2005; Xu & Corno, 1998). The current study investigated the effect of preparation homework as an instructional technique on chemistry achievement of United Arab Emirates (UAE) male and female tenth graders.

Lucas (2009) indicated that there was a relative absence of information and research on design homework and its association with the instructional methods of secondary school teachers and that almost all the studies that were conducted about homework have not clearly identified the relationship between homework assignments and the instructional methodology of the teachers. Others emphasized that the "role of homework assignment has not been clearly defined yet" (Markovic, Randjelovic, & Trivic, 2010, p. 70). For example, Cooper (1989) defined homework as "tasks assigned to students by school teachers that are meant to be carried out during non-school hours" (p. 7). Lucas (2009) suggested a framework of methodological beliefs that take into consideration teachers' instructional methodology, development of teacher's classroom instruction, assessment materials, and whether different types of assignments such as homework, long-term projects, labs, and classwork which done inside or outside the classrooms. Other studies such as that of Agnieszka (2010) called for more properly planned, organized and applied homework, and for students' awareness of the aims attached to homework. Moreover,

homework assignments should be planned based on the learning objectives of specific teaching content. Students can be motivated to do homework assignments frequently and responsibly by including the application of their results into the teaching and learning of new content (Markovic, Randjelovic, & Trivic, 2010).

In the current study students were assigned homework for teaching, learning and preparation purposes to participate actively in teaching and learning activities. This preparation homework is called Instructional Homework Technique (IHT) and is defined here as well prepared (planned/designed) task assigned to students by teachers prior to the lesson for instructional purposes and this preparation homework should be carried by students during non-school hours. The IHT as a well prepared task was fully described in the procedure sub-section in this study. In this case, a well-prepared task is intended to solve the flaws in poorly designed homework mentioned in the literature (Epstein & Pinkow, 1988) and to only assign homework that is valuable to student learning instead of assigning homework as a matter of policy (Kohn, 2006). In the present study, homework is designed to extend student prior knowledge beyond the classroom about chemistry topics that will be taught. Furthermore, homework will facilitate teacher instruction approach when the student comes to class completed the assigned homework. Therefore, this approach may help to create an attractive classroom environment that could increase the likelihood of student-teacher interaction, enhancing active learning, and facilitating students understanding and achievement.

The previous sections in the current study mentioned some major limitations of the past research on homework in science education. First, the doubt on the positive influence of homework on achievement has been reported. Second, there was no strong evidence of association was found between homework and achievement and the empirical support for homework-achievement association was not clear. Therefore, Cooper et al. (2006) suggested further research in this area. Third, time spent on homework has been almost the focus of the most homework studies. Fourth, teachers prepared and assigned homework for preparation purposes was not evidently examined. Finally, the relationship between homework assignments and the instructional methodology of the teachers has not clearly identified. The current study addressed some of those limitations and included other important variables such as student gender and specific school science topic which is chemistry. The next sections describe how the present study addressed the previous mentioned limitations and how the new variables included.

Homework and Gender Achievement:

Studies that have examined homework and gender differences has mainly focused on gender differences in regard to issues associated with homework management, attitudes, self-regulation, learning processes, self-efficacy beliefs, management and organization, family support, and emotions. For example, Xu (2006) investigated gender and grade level to five features of homework management which were setting an appropriate work environment, managing time, and controlling attention, motivation, and potentially interfering emotions. Xu found that female students were more frequently reported working to manage their workspace, budget their time, and monitor their emotions. Moreover, females also reported that they spent more time doing homework and were considered homework less boring. Another example is that of Else-Quest, Hyde, Hejmadi (2008) who studied the emotions expressed by U.S. mothers and their 11-years-old children while solving pre-algebra homework. They found no evidence of gender differences in the emotions while doing homework. However, studies that focused on homework and its association with gender achievement differences were rarely found. Mau and Lynn (2000) conducted a study that focused on gender differences in homework and test scores in mathematics, reading, and science at tenth and twelfth grade. The results of their study indicated that male students obtained significantly higher mean scores in math and science while females obtained significantly higher mean scores in reading and amount of homework.

In regard to gender achievement differences in school subjects, during the last three decades a huge body of studies has been conducted in the areas such as science, mathematics, art, and reading. Generally, male students have been found to be better at more theoretical and logical subjects including math, and science, while female students have been found better in biology and creative subjects such as art and reading (Beaton et al., 1996; Jacobson, Doran, & Schneider, 1992; Mullis et al., 1998).

Many studies have examined the effect of age differences of male and females on their science achievement. Those studies have reported that male and female students tended to achieve almost equal scores in science tests at the elementary level and males tend to achieve higher scores than females at the beginning of middle schools up to high school (Becker, 1989; Connelly, 2008; Downey & Yuan, 2005; Entwhistle, Alexander & Olson, 1997; Fleming & Malone, 1989; Looker & Thiessen, 2004; McMullen, 2004; Simpson & Oliver, 1990). More recently, in the U.S., the National Assessment of Educational Progress At grade 8 (National Center for Education Statistics, 2011) reported that in 2011, male students scored 5 points higher on average

than female students in science. World-wide, studies indicated that male students still showed significantly greater achievement than female students in science. However, in the 2003 Trends in International Mathematics and Science Study (TIMSS) among 34 nations, showed a considerable variability in the size of the gender difference, and grade 8 female students in 3 nations significantly achieved higher than male students in science (Gonzales et al., 2004; Martin, Mullis, & Chrostowski, 2004). Dubai TIMSS and PIRLS report shows that in different school subject such as science and mathematics, female Emirati students were found to outperform Emirati male students in all but fourth grade mathematics at private MOE schools. Moreover, the gap between male and female Emirati students was larger in favor of females in eighth grade (International Study Center, 2011).

In the UAE as reported in the next section of this study, male and female students study in single-sex schools. Young and Frazer (1990), in an attempt to study the degree to which science achievement varies with student gender and school type, investigated the findings of previous studies that suggested that students in single-sex schools achieved higher in science than students in co-educational schools. They found that females who attended all-female schools achieved better in science than did the females who attended co-educational schools. The same finding was reported for males who attended all-male schools. Similar findings were reported by Hyde, as cited in Stromquist (1989), who found that females in single-sex schools achieved significantly better in mathematics and science than females in co-educational schools.

Previous studies which have investigated homework as pertinent to gender focused on different issues (i.e. homework frequency, attitudes, self-regulation, learning processes, self-efficacy beliefs, management and organization, family support, efforts, and time allocation). However, there was not a single study which the author was aware of that focused on gender and homework variables such as quality, purposes, and instructional use which have been found to have direct effects on achievement, practicality and time management for teachers and students (See for example, Harris, Nixon, & Rudduck, 1993; Hong & Milgram, 1999; Mau & Lynn, 2000; Reinhardt, Theodore, Bray & Kehle, 2009; Trautwein, 2007; Xu, 2006). Thus, the current study hoped to provide empirical evidence regarding gender differences in homework-achievement direct relations.

Chemistry

For almost last thirty years on learning science research has shown that chemistry has proved to be a very complex subject (Bonder, 1991;

Gabel, 1998; Knaus, Murphy, Blecking, & Holme, 2011). Many studies were carried out to discover the reasons behind this complexity (see for example, Gabel, 1997 & 1999; Tyson & Treagust, 1999). One of the possible reasons is that many students are not constructing correct understandings of fundamental chemical concepts at the beginning level in their elementary school. Therefore, they cannot fully understand the more complicated chemical concepts that build upon the basics. Gabel (1999) summed up some barriers that could prevent students from learning chemistry. Some of these barriers are the nature of the chemistry concepts which are abstract and are inexplicable without the use of analogies or models, the high density of chemistry concepts in elementary science textbooks which make learning these concepts difficult, and the frequent use of mathematical symbols, formulas, and equations to convey relationships at the macroscopic and microscopic levels.

Although there were studies conducted at higher education level (see for example, Bayram & Comek, 2009; Cole & Todd, 2003) that investigated the relations between student's learning and some variables related to tertiary chemistry education such as using web-based multimedia homework and immediate rich feedback, there is a paucity in research with regard to the effects of homework on students' chemistry achievement specially at high school level. Therefore, the current study tried to investigate the effect of homework assignments on the UAE tenth graders chemistry achievement where no research was carried out in that area. The context where this study was carried out empowers its findings since almost all previous studies regarding the influence of homework assignments on students' academic achievement have been conducted in the Western World and to some extended in Far Asian schools. Thus, this research explored the effect of the preparation homework assignment in a new context where the preparation homework outcomes become important portion of classroom instructional activities and not just a work that students routinely carry out at homes.

Chemistry in the UAE Educational System

In the UAE k-12 education consists of kindergarten education and two cycles. Kindergarten is a co-educational, pre-school education and children attend kindergarten at the age of four and spend two years in these schools. Following kindergarten education, education system in the UAE compromises of two cycles: Cycle One is basic education which consists of nine years; Cycle Two is secondary education which consists three years, tenth, eleventh, and twelfth grades. All students in the first year of cycle two study a general curriculum. After the tenth grade, students are assigned to study in the eleventh and twelfth graders

either in the science or art division based on their performance and their interests. Governmental schools (public schools) in cycle two and grade six to nigh from cycle one are single-sex schools for students and administrators. Schools that only include first grade to fifth grade students are also single-sex schools for students and not for administrators and teachers where administrators and teachers in these schools are females.

During the 2010-2011 schools year, tenth graders used chemistry textbook that covered the following topics: matter and change; measurement and calculations; atoms; electronic configuration; the periodic table; and chemical bonding (Ministry of Education, 2011a). Meanwhile, science division's eleventh graders studied chemical topic such as chemical formulas and compounds; chemical equations and reactions; chemical calculation; physical properties for gases; structural molecules for gases; and liquids and solid materials (Ministry of Education, 2011b). On the other hand, science division's twelfth graders studied chemistry topics which were chemical solutions; ions in water solutions and colligative properties; acids and basis; acid-base titration and pH factor; reactions energy; reactions speed; chemical equilibrium; oxidation-reduction reactions; electrical chemistry; carbon and hydrocarbons; organic chemistry; and nuclear reactions (Ministry of Education, 2011c).

The purpose of this study was to investigate the effects of Instructional Homework Technique (IHT) on chemistry achievement of UAE male and female tenth graders. Based on the extensive literature review discussed in the previous sections, two research hypotheses were developed for this study.

Research hypotheses

Research hypothesis 1: The UAE tenth graders who were exposed to IHT will score significantly higher than those who were not exposed to IHT in chemistry.

Research hypothesis 2: The UAE male tenth graders who exposed to IHT will score significantly higher in chemistry than female tenth graders who were also exposed to IHT.

Definition of Terms

Instructional Homework Technique (IHT): A well prepared (planned/designed) task assigned to students by teachers prior to the lesson for instructional purposes and this preparation homework should be carried by students during non-school hours. In the current study the IHT was applied by both male and female chemistry teachers for 19 periods of their chemistry teaching at tenth grades.

Chemistry Achievement: Student scores in electron configuration, the Periodic Table, and the chemical bonding that measured by the chemistry test developed by the researcher and consisted of thirty-seven mutable choice items.

Method

Participants

The participants of this study were 192 UAE tenth graders who were studied in eight classrooms. Half of these classes were for female students. The four males' intact classrooms were chosen from one male school and were taught chemistry by an expert male teacher and the four females' intact classrooms were chosen from one female school and were taught chemistry by an expert female teacher. The classrooms in each school were randomly divided into experimental and control group. The random assignment had taken place before the treatment began. In conducting the random assignment, each classroom was given a number and a table of random numbers was then used to select classrooms of the experimental and control groups. The experimental group included two male classrooms and two female classrooms. The control group consisted of two male classrooms and two female classrooms (See Table 1 for participants' description). As it is shown in Table 1, both experimental and control classroom were sufficiently large where that the total of students in experimental and control classrooms was 97 and 95 students respectively.

As mentioned above, the male experimental and control classes were taught chemistry by one chemistry male teacher and this was also the case with the female experimental and control classes where they were taught chemistry by one chemistry female teacher. These two teachers had taught chemistry for more than six years at the secondary school level. The two teachers were specialists in chemistry and both of them had a bachelor's degree with a diploma. Therefore, it was assumed that there were expert chemistry teachers. When this study was conducted, the two teachers had teaching load of 18 periods per week and they had chemistry as their primary teaching assignment.

The teachers were well-known to the researcher and they both agreed to participate in this study. Moreover, the two teachers were also recommended by their school supervisors to carry out the task of this study. To officially accept and approve their participation, a letter was issued by the Dean of the College of Education to the school districts to approve the two teachers' participation in the study. As a result, the district representatives and the teachers signed the acceptance and the approval.

Table 1
Participants' Description

Variables		N	Classrooms and Classrooms' Sizes
Gender	Males	93	4 (classrooms, sizes = 25, 20, 25, & 23)
	Females	99	4 (classrooms, sizes = 27, 23, 25, & 24)
Treatment	Experimental	97	4 (classrooms) Males: sizes = 25 & 23 Females: sizes = 25 & 24
	Control	95	4 (classrooms) Males: sizes = 20 & 25 Females: sizes = 27 & 23

To control for confounding variables, the sample was chosen from two secondary general public schools and included male and female students. The male and female students in the classes participated in this study were equivalent and comparable. For example, they were all tenth graders, they were 16-15-years-old, used same science curricula, studied in almost similar classroom size, and are comparable in terms of cognitive ability. They were enrolled in two large secondary schools in the UAE with almost 600 students and these schools were located in two cities. Each one of these two schools included classes for only tenth, eleventh, and twelfth graders. Students participated in this study were mainly UAE citizens and they came from families with similar background.

The purpose of including male and female students was to examine whether the students' gender makes a difference in homework achievement. Moreover, the sample of this study was classrooms not students within the classrooms. This method helped to avoid issues of demoralization and compensation and/or treatment diffusion effects that could have negative impact on the IHT on the experimental groups and to avoid interaction between intervention and control groups (Cooper et al., 2006).

Instrument

According to Trautwein et al. (2002), research shows that homework assignments might have different effects in different school subjects. Therefore, the decision was made for the current study not to combine achievement measures in different science subjects into a single score as has been done in many previous studies (e.g., Cooper et al., 1998). Instead, the investigation focused on one of the science areas which was chemistry. Chemistry achievement scores were obtained by conducting a chemistry achievement test which was developed by the researcher using Bloom's taxonomy of the cognitive domain. The test was used as

the measuring instrument for this study. The test was administered to the experimental and control groups as a pretest on the mid of February, before covering all chemistry topics in the test and a post test on mid of May after covering all chemistry topics. The test was designed for tenth graders to measure students' chemistry achievement. The final version of the test consisted of thirty-seven multiple-choice items that covered different topics such as atomic theory, atomic structure and electrons configuration, the historical development of the periodic table, periodic table law, periodic properties, and the chemical bonding. These chemistry topics were covered in three chapters of the UAE tenth graders' chemistry textbooks. These chapters were: 1) Electron Configuration, 2) The Periodic Table, and 3) The Chemical Bonding. The chemistry textbook for tenth graders placed a great deal of emphasis on the low levels of cognitive domain, such as Knowledge, Comprehension, and Application. However, because of the nature of chemistry the higher levels of the cognitive domain, such as Analysis and Synthesis, were also represented. In order to more accurately represent the learning outcomes that were provided by the chemistry textbook, the chemistry test included more low level items and fewer high level item of the cognitive domain. The development of the test underwent several steps: First, the selected chemistry topics of tenth graders' chemistry textbook (Ministry of Education, 2011b) were analyzed to pinpoint the facts, concepts, and generalizations in content presented. Second, thirty-two learning outcomes that covered the knowledge, comprehension, and application cognitive levels that provided at the beginning of each chapter were used to develop the multiple-choice items. The following are examples of these learning outcomes which were designed for students to accomplish:

1. Describe Bohr Model for hydrogen atom.
2. Compare between the Bohr and quantum models for the atom.
3. Identify the four quantum numbers.
4. Apply Aufbou's and Pauli Exclusion principles and Hund's rule.
5. Describe the Periodic Table.
6. Identify the atomic and ionic radius, ionization energy, electronic affinity, and electronegativity.
7. Describe the ionic and covalent bonding.
8. Apply the basic six stages used to draw Lewis structures.

Third, forty-five multiple-choice items were written and grouped and mapped to their corresponding mentioned learning outcomes. Fourth, a panel of experts that included college instructors and secondary school science teachers were asked to review the complete package for validation purposes. The panel was chosen based

on their knowledge of chemistry, chemistry curriculum development, chemistry teaching and learning, tenth grade chemistry textbook in the UAE, secondary school students, and evaluation. The panel included two college professors, three associate professors, two assistant professors, and two chemistry teachers. Each expert was provided with a letter explaining the questions and the hypotheses of the study and how the items in the chemistry test were developed. The experts provided their judgment individually. Finally, from the initial version of forty-five items only thirty-seven items were considered by the panelists. Examples of the exam items were displayed in Appendix 1. Internal consistency reliability (coefficient alpha) was computed for the posttest and it was found to be .891. The test was not examined for differential item functioning (DIF) with respect to male and female students participated in this study which could be considered as a limitation of the study.

Quasi-Experimental Design

The design applied in this study was a quasi-experimental design (Fraenkel & Wallen, 1996; Gay, 1992) where the pretest posttest control group technique was applied. This design was used to support the research purpose and hypotheses. Moreover, the researcher used convenience sampling in selecting one male school in a district and one female school in another district. However, the tenth grader classes in these two schools were randomly assigned as experimental and control groups. That is, there was random assignment of intact classrooms to conditions. As a result, the combination of random assignment and establishment of a control groups served to eliminate the majority of threats to the internal and external validity of the study. The compositions of all classes that participated in the study remained constant throughout the study and the degree of absenteeism was similar for all classes and both genders.

Procedures

Students in the experimental groups received only an instructional homework twice a week during their two regular chemistry periods while students in the control groups received only regular homework assignments also twice a week during their two regular chemistry periods. Students in the experimental groups did not receive regular homework. Regular homework assignment includes questions at the end of each chemistry chapters in the chemistry school textbooks and usually assigned as homework by teachers for students to give students opportunities to review or practice lessons that have already been taught. Regular homework assignment is usually checked at the beginning of the class and did not affect new lesson instructional

methods. By checking regular homework, teachers intend to identify students who failed to do the homework assignment. Before the treatment started both experimental and control classrooms used to get regular homework assignments for their chemistry class and this is a common school practice in the UAE that almost involves all school grades and subjects.

The IHT was a combination of systematic steps that were taken by the teachers and students (Al-Naqbi, 2010). To apply IHT, the author consulted two chemistry teachers, then, the author analyzed the content that students were going to study in the next class meeting to scientific facts, concepts, and generalizations. The results of the analysis were used to develop homework assignments for male and female students in the experimental groups and this process has been done for 19 chemistry lessons. Therefore, each chemistry topic that was taught during any of the 19 chemistry lessons (periods) had its homework items which developed according to the chemistry facts, concepts, and generalization each topic included. During the experiment duration (almost ten weeks), the male and female students in the experimental classrooms in advance of their chemistry classes, received similar homework for similar chemistry topics as a pre-class assignment. Therefore, students in the experimental groups continually experienced chemistry homework assignments twice a week for total of 19 periods of their chemistry school schedule. As a result, IHT was applied by both male and female chemistry teachers for 19 periods of their chemistry teaching at tenth grades. To do each homework assignment students read their school chemistry textbooks, therefore; it was expected that each student spent between thirty to forty-five minutes to finish answering any of the nineteenth homework assignments during the experimentation period.

Following Mikk's (2006) advice, the focus here was on using the knowledge that students gained from homework on direct instruction and not on spending more instructional time in the classroom dealing with homework. The intention was to prepare more creative and thoughtful homework (Natriello & McDill, 1996). The experiment lasted for almost ten weeks and it involved 19 homework assignments and each homework assignment consisted of a minimum of 20 items. Homework assignments were based mainly on true/false questions (N = 86 items), fill in blanks (N = 106 items), complete the table (N = 16 items), short essay items (N = 14 items), and solve problems (N = 11 items). Teachers have not used the homework outcomes (answers) of the control groups as part of any instructional purposes. Students in the experimental and control groups were taught the same chemistry topics which were atomic theory; atomic structure and electrons configuration; the historical development of the periodic

table; periodic table law; periodic properties; and the chemical bonds. In the UAE, these chemistry topics were considered a formal start to chemistry education in the secondary school chemistry curriculum. Moreover, these topics were basis for more advanced chemistry topics especially in eleventh and twelfth grade

s as well as in the introductory courses at higher education levels.

To successfully apply IHT, teachers should use teaching strategies that give students opportunities to participate and to use their prior knowledge that they could gain by doing the homework. Examples of these teaching methods are discussion, problem solving, modeling, guided discovery, and active lecturing. An example of how chemistry teachers may apply IHT during their teaching is summarized as follows:

1. The homework assignments should be given to students at the end of each chemistry classes and the students should do the homework and bring their answers to the next class. Each homework assignment should cover all chemistry facts and concepts incorporated in the topic that will be taught next chemistry class.
2. In groups or in pairs, students check and review their homework assignment answers at the beginning of each class. This may take around five minutes.
3. Then, the teacher should respond to any of students' concern about any incorrect point or argument in the students' homework answers.
4. The teacher should collect all students' homework assignment responses for review and grading purposes and then return them back to students at the beginning of the next class.
5. Before start teaching a new chemistry topic, the teacher should ask students some general questions about the topic to make sure that all students have done the homework assignment by themselves and the majority of them have learned something about the topic from the homework assignment. This may take around three minutes.
6. At this point, the chemistry teacher should start teaching the new chemistry topic using any teaching methods that allow students to use and share knowledge that they gained from the homework assignment. The previous five tips clearly indicate that when real teaching and learning processes take place, students will be actively engaged in classroom activities since they prepared themselves to participate in the new chemistry lesson.

The male and female chemistry teachers who have carried out the experiment have been trained for almost two weeks by the author on how to use IHT in their classes. During the training sessions the two teachers were shown how the chemistry homework assignments and the chemistry test were developed for this study and they were provided with ideas about the different purposes for the homework assignments. The major task that was accomplished during the training sessions concentrated on the implementation of IHT.

During the implementation the author has met once per week with each teacher for three purposes. The first purpose was to give the teachers the next week homework assignments that they will distribute to their students. The second purpose was to answer questions that may rise by the teachers during the study implementation and to give them advices and recommendations to successfully carry out the experiment and to make sure that all students regardless of their gender taught by the same methods. The third purpose was to evaluate how students did in their homework assignments during the previous week. The last purpose provided ideas for the researcher about how the teachers used IHT and how students reacted with the homework assignments.

Results

The pretest and posttest mean scores and standard deviations for the sample are displayed in Table 2. For both the experimental and control groups the achievement overall mean at the pretest (M = 10.10, SD = 3.58). Table 2 also shows that the experimental groups and the control groups means for the pretest were almost identical (M = 10.11, SD = 4.00 & M = 10.09, SD = 3.12 respectively). For the experimental groups the achievement overall mean at the post test (M = 25.30, SD = 8.23) which was greater than the mean of the control groups (M = 19.51, SD = 5.77). This result showed that students who were receiving IHT scored higher on a chemistry posttest achievement measure than those who were not receiving IHT.

Table 2
Tenth Graders' Pretest-Posttest Mean Scores and Standard Deviations

			Pre Test		Post Test	
Gender	Treatment	N	M	SD	M	SD
Males	Experimental	48	10.19	3.26	27.63	9.42
	Control	45	09.56	2.98	20.67	6.02
Total		93				
Females	Experimental	49	0.04	4.64	23.02	6.15
	Control	50	10.58	3.19	18.46	5.38
Total		99				
Total	Experimental	97	10.11	4.00	25.30	8.23
	Control	95	10.09	3.12	19.51	5.77
Total		192	10.10	3.58		

A two way analysis of variance (ANOVA) was conducted to determine significant main effects and interaction effects of treatment and gender for the chemistry posttest scores. The posttest scores were used for the outcome variable of the two-way ANOVA. The result of this analysis is reported in Table 3. However, when the gain scores (post-pre) were used a similar result was obtained. The analysis showed a significant main effect for treatment, $F(1, 187) = 35.182$, $p \leq .000$. Therefore, the first research hypothesis is supported. The Eta squared (η^2) for treatment was calculated by dividing the sum of squares of the treatment (1576.76) by the total sums of squares (10624.51) (Cohen, 1988; Hays, 1994; Levine & Hullett, 2002; Kirk, 1995) and found to be 0.15 which is partially high (Cohen, 1988) and it indicated that IHT explains 15% of the variance in student chemistry achievement. As for gender, a significant difference between male and female students in the post test ($F(1, 187) = 14.01$, $p \leq .000$) was observed. As previously reported in Table 2, in the experimental groups the male students achieved higher ($M = 27.63$, $SD = 9.42$ than female students ($M = 23.02$, $SD = 6.15$) in the chemistry achievement posttest. Thus, the second research hypothesis is accepted.

Moreover, as shown in Table 3, the gender accounted for 6% of the variance, and 79% is accounted for by error. Table 3 illustrates that there was no interaction effect between the treatment and gender ($F(1, 187) = .868$, $p \leq .35$).

Table 3
The Two-Way ANOVA and Gender Variable

Source	SS	df	MS	F	Sig.	η^2
Gender	627.90	1	627.90	14.01	.000	0.06
Treatment	1576.76	1	1576.76	35.18	.000	0.15
Gender x Treatment	38.92	1	38.92	.87	.353	0.00
Error	8380.93	187	44.82			0.79
Total	107851.00	192				
Corrected Total	11235.12	191				

To estimate the effect of IHT on the measure of students' chemistry achievement in the posttest, the standardized mean different (*d*-index) was used (Cohen, 1988). The control groups mean was subtracted from the experimental groups' mean (IHT students) mean and the difference was divided by their average standard deviation (Cooper et al., 2006). The findings indicated that the students who did IHT outperformed the students who did not receive IHT in posttest scores (d-*index* = .83). This indicated that the IHT students outperformed the no-IHT students on chemistry posttest by (SD = .83).

Discussion

The purpose of this study was to investigate the effects of Instructional Homework Technique (IHT) on chemistry achievement of the UAE's male and female tenth grade students. The results of the present study reveal that the means of the experimental and control at the pretest are almost identical (M=10) which is an indication that the overall achievement of both groups in the pretest is weak. One reason to explain why students did poorly in the pretest could be attributed to the lapse of time where students usually exposed to these introductory topics instruction at the sixth grade. It appears that students were not able to recall this basic chemical information that they had studied almost four years ago. Moreover, the results indicate that regardless of the students' gender and the type of school, they were taught science and chemistry by using similar teaching methods and using the same science and chemistry textbooks. Furthermore, since the experimental groups and the control groups regardless of their gender have studied chemistry during their school years prior to this study by using same textbooks that assigned for each grade level it could suggest that they

shared almost the same prior chemistry knowledge which could give another explanation of the similarity of the means at the pretest.

The results also show that the chemistry achievement overall mean for the experimental groups in the post test is (M = 25.30) which is greater than the mean of the control groups (M = 19.51). Based on these findings, students who were receiving IHT scored higher in a chemistry posttest achievement measure than those who were not receiving IHT. Because the chemistry achievement test was based on the curriculum and reflected the emphasis of the current textbooks, the mean scores on the chemistry achievement test in the pretest for experimental and control groups indicate that applying IHT made the difference which is reflected by the high achievement of the experimental groups.

The study reported here shows that students who did IHT outperformed the students who did not receive IHT in chemistry achievement posttest scores (d-*index* = .83). This demonstrates that the IHT students outperformed the no-IHT students on chemistry posttest by (SD = .83). It seems that IHT could be viewed as an active learning approach since students could be viewed as active learners when they use knowledge they have constructed from the homework assignment. It appears that IHT may enhance constructing students' scientific prior knowledge about the chemistry topics that there are about to study which helps them to enter their classes with good preparation and experience. Furthermore, using this technique may not just sharpen students' reading ability but also may allow them to identify scientific facts, concepts, and generalizations to increase their scientific knowledge base. It is more likely that IHT enhances students review skills and increases their participation rate in the classroom discussion. Furthermore, it appears that IHT could promote students' positive attitude toward chemistry and increase the likelihood of the students' participation in learning materials in class. This finding corroborates the findings of Cooper (1989; Cooper et al., 2006). However, the overall effect in this study is higher than the homework's effects found by Cooper (1989) who reported in his meta-analysis that for grades 10-12 the d-index was .64.

Regarding the gender, as shown in the result of this study, although male and female students in the experimental classes did better in the chemistry achievement posttest, male students scored higher than female students where a significant statistical difference in gender for chemistry posttest is observed. The higher scores in chemistry achievement posttest obtained by males is consistent with a number of other studies reviewed in the introduction. For example, studies done by Becker, 1989; Connelly, 2008; Looker and Thiessen, 2004; Mau and Lynn, 2000; Mullis et al., 1998; Simpson & Oliver,

1990 showed that male students have some advantage over females in physical sciences such as chemistry. The findings of the current study indicate that in the UAE, where the community provides equal opportunities for males and females to study science (Khalaf, 2000), male students tended to do better in chemistry at secondary school level and that the "gender gap" and the perception of male dominance in science as suggested by literature still exists. The effect of IHT on the student gender can be observed that male and female students in the experimental groups outperformed male and female students in the control groups in the posttest.

Based on the results of a two-way ANOVA, there is a significant main effect for treatment and has high effect on students' chemistry achievement. Therefore, the results indicate that students who were receiving IHT scored significantly higher in the chemistry achievement posttest than students who did not receive IHT. This finding is consistent with the findings of previous studies which considered homework as an important educational means because it fosters both academic and nonacademic benefits (see for example, Cooper, 2001; Cooper, Lindsay, Nye, & Greathouse, 1998; Cooper, Robinson, & Patall, 2006; Cooper & Valentine, 2001; Hong, Peng, & Rowell, 2009; Lubbers, Van Der Werf, Kuyper, & Hendriks, 2010; Reinhardt, Theodore, Bray, & Kehle, 2009; Trautwein, 2007). Moreover, this finding does not support other studies such as that of Kohn (2006) who found out that there are many research studies suggesting that doing homework may not advance students' academic and nonacademic achievements.

In addition, the results reveal that IHT explains 15% of the variance in student chemistry achievement which is partially high according to Cohen (1988). Although the treatment accounts for 15% of the variance, there is 79% of the variance of chemistry achievement was not explained by the Eta squared analysis. A possible explanation for this is that not all the variables relate to chemistry achievement were included in the study.

Finally, a two way ANOVA indicate that there are no significant differences in treatment by gender interaction effect. This can be explained in the light of the results of the descriptive statistics which show that the overall mean scores of the chemistry achievement posttest for the male students in both experimental and control groups are higher (M = 27.63) and (M = 20.67) respectively than those of the female students in the experimental and control groups (M = 23.02) and (M = 18.46) respectively. This emphasizes the finding of the previous research studies which indicated that males students at the secondary school level generally tend to score higher than their female

counterparts (see for examples, Connelly, 2008; Khalaf, 2000; Looker & Thiessen, 2004; McMullen, 2004).

The current study explored ideas about the homework-achievement relation pertaining to culture other than Western or Far Asian cultures. It is most likely that IHT can be successfully applied by both male and female teachers and can be assigned for both male and female students at different school levels (Al-Naqbi, 2010).

Educational Implications

The present study offers the following educational implications. First, teachers regardless of the subject they teach should become more aware about the importance of the instructional homework and they should consider homework as a viable instructional tool. Second, teachers should carefully plan for the homework assignments so that homework can support students' learning and help them construct fundamental knowledge that they need to use when they come to study more complicated concepts in the classroom. Third, IHT offers a significant potential for the development of chemistry education at the secondary school level, it should be therefore, become part of school science teaching methods. Fourth, students at high schools should receive homework prior to the formal instruction and it should be part of the teaching preparation and the instructional techniques. Fifth, knowing how to prepare instructional homework needs to be part of science teacher education programs. Therefore, teachers at their training programs should spend a great deal of time and efforts on developing appropriate designed homework instruction. Finally, homework assignment strategies at schools today should be reviewed so that regular homework which students usually receive should be changed or modified.

The current study could open new windows for research to explore the role of teachers as well as students in preparation and carrying out homework assignment in a way that could directly influence student’s achievement and other student dependent variables as mentioned in the educational literature. Future research relate to IHT should consider other variables that were not included in the current study, such as students’ attitudes toward IHT, students’ participation level in classroom instructional activities where IHT is applied, and home support for homework assignment completion. Using a mixed methods approach that offers insights into how students undertake the IHT and normal homework assignments relating to specific chemistry topics should also be considered for a future research that examining the effects of IHT.

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