The Effectiveness of the Science- Inquiry Teaching Approach
On the Students' Achievement and Engagement in the UAE Public Schools

دراسة لفعالية تدريس العلوم ضمن طرق البحث العلمي

و تأثيره على إنجاز الطلاب وتفاعلهم

في المدارس الرسمية في الإمارات العربية المتحدة

By Hind Gergi Abou Nasr Kassir
Student ID. 110017

Dissertation submitted in partial fulfilment of the requirements for the degree of Med in Science

Faculty of Education

Dissertation Supervisor
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"I am indebted to my father for living, but to my teacher for living well."
(Alexander the Great)

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Maria and Antoine my two little inspirers and emotional supporters, it is only to make you proud!

Abstract

The guided scientific inquiry investigations are designed to help students reaching particular answers through their high thinking processes and their skills in scientific activities. This paper investigates the impact of the science-inquiry teaching approach on the students' achievement and evaluates its effectiveness on the students' engagement level over a period of four months and a half in a UAE public school for girls located in the northern Emirates. Subjects of the study were 52 girls UAE nationals from the 6^{th} grade, following the scientific reform in their school, these schools are called "Madares Al Ghad". The sample has been divided in two: the first one n=26, is the experimental group where students received the science instruction from a trained science-inquiry teacher, while the second one called the controlled group n=26, received a more traditional scientific instruction of the same content.

The dependent variables in the study were the students' achievement and their engagement level. Both variables were measured through a mixed-method approach: first the quantitative data was collected using a pre- and a post-test to assess the students' science achievement. Second the qualitative data was collected using an observation tool designed for the study and entitled EIT 2013 to evaluate the students' engagement. The analysis of the quantitative data was done using the T-test. The results have revealed that the science-inquiry teaching approach produced a significant greater achievement among 6^{th} grade students than the classical teaching approach. Qualitative data analysis of the results revealed that students in the experimental group developed significant positive attitudes towards science more than did those in the controlled group.

صُمِّم التعليم الاستكشافي الموجَّه لجعل الطالب محور التعليم و مساعدته على الوصول الى أجوبة محددة على اسئلة استكشافية بواسطة التفكير المنطقي و الانشطة التعليمية العلمية الهادفة. هذا البحث العلمي يهدف الى تقييم فعالية عملية التعلُّم هذه في مادة العلوم في الصف السادس بأسلوب الاستكشاف و التفاعل و

يقيس هذا البحث العلمي مدى تطور التحصيل العلمي عند الطلاب كما يقيّم نسبة اهتمامهم و مشاركتهم في داخل الحصّة الصفِّية. استمرت هذه الدراسة 4 أشهر و نصف الشهر، و تمت هذه الدراسة على عينة من 52 فتاة يرتَدن المدارس الحكومية في الإمارات الشمالية التابعة للنهج الإصلاحي في العلوم بحسب المعايير العالمية و تسمى هذه المدارس ب "مدارس الغد" . قسمت الدراسة العينة المؤلفة من 52 فتاة الى قسمين : الأول مؤلف من 26 فتاة يتلقين المعلومات العلمية بواسطة استراتيجيات التعلّم الحديثة اي بواسطة عملية الاستكشاف، أما القسم الثاني المؤلف من 26 فتاة فهنَّ يتلقين التعليمات العلمية بواسطة النهج التلقيني. هذه الدراسة تقيس فعالية النهج التعليمي المبني على الاستكشاف و تأثيره على التحصيل العلمي كما انها تقيِّم نسبة مشاركة التلاميذ و انخراطهم بالعملية التعليمية في داخل حصة العلوم. تم تجميع البيانات الرقمية للتحصيل العلمي بواسطة امتحانات اولية تشخيصية ثم امتحانات نهائية بعد انتهاء فترة الدراسة و ثمَّ تحليلها: اما البيانات النوعية وهي المشاركة الفعّالة للتلاميذ فتم تجميعها بواسطة حصص المشاهدة الصفية التي تم تقييمها بالاستعانة بورقة تقييم خاصة بهذه الدراسة سميت ب EIT 2013 . بعد تحليل البيانات بواسطة محلل البينات الإلكتروني T- Testاظهرت النتائج تقدم في التحصيل العلمي عند الطلاب الذين تبعوا التعلم و التعليم الاستكشافي و لم يكن ذلك الحال للطلاب الذين اتبعوا النهج التقليدي. اما تحليل البيانات النوعية فأسفرت عن نتيجة مماثلة لكلا الفريقين.

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Chapter I
Introduction

I.1- Introduction

Since 1979, the educational services in the United Arab Emirates (UAE) have evolved and expanded to distinguish a wider variety of categories in all disciplines especially in science education. The UAE country before 2004 was classified as an under-average scoring country at the international level yet ranked as the first Arab country in the test of international math and science skills (TIMSS 2009; TIMSS 2010 and TIMSS 2012). From November (2004) after his highness ruler of Abu-Dhabi, Sheikh Khalifa Bin Zayed's announcement till November (2012) great steps in the UAE education were taken such a crucial restructuring of the education business targeting first, the teaching approaches and second the assessments' strategies in all subjects towards a more standardized framework particularly in both scientific disciplines: science and math. The main goal behind this reform is to help the UAE citizens to be more involved in the global market and literate about their local culture and environment in more than one language. Dubai initiated the first action plan that integrated english language first and science and math second in a bilingual setting and was implemented in the governmental schools by the year 2006 as "Madares Al Ghad" (MAG) project (The National July 2013).

Meanwhile, in 2006, the Major USA educational policy that no child is left behind as well as science is for all statement (AAAS), were aligned with the introduction of the federal law No. 29 in the UAE: "School for all" (2006). From that day onwards, all individuals have the right for equal educational opportunities, in the public and in the private education sectors regardless their abilities and potentials. So, the UAE government took part in the new educational reform, notably in science and math, and a new project was launched in 2007 called "the Madares Al Ghad" -as mentioned earlier- to restructure the public sector and make it similar to the private one by integrating the new hands-on teaching approach in english, science and math. Students by the 12th grade should be able to bridge the gap between the public and the private sector and remove their refreshment year; Emirati students will have a smoother university start and decrease the level of drop out by the age of 16 years (MAG 2007, Al Muhairi J., & Al Karam A. 2010 in DSIB report).

In order to accomplish these educational goals and outcomes, the Ministry of Education in UAE constructed a competitive educational system in Madares Al Ghad that offers the new generation knowledge and skills needed to take part entirely of the economic and social life, and be competitive fellows in the global marketplace. The main vision of the ministry of education in Dubai (MOE) for the year 2020, that all Emiratis could reach the scientific bi-literacy (Education council Abu-Dhabi, Boujaoude & Dagher 2009 p.1).The new educational structure in the MAG program, meets the same goal as it brings up the governmental education to the international levels through standardized controlled curricular for all subjects especially in science and math and incorporate the student-centred learning approach in all emirates schools. In order to monitor the change with the new reform, all science educators (most of them are emirates nationals) in the MAG program, should integrate the science- inquiry teaching approach in science as an effective continuous teaching approach and an integral part of the curriculum taught from pre-K -12 (Donnelly 2009). Acknowledging the difficulty to determine its effectiveness on the short-term basis as per Hudson (2007), the purpose of the present study is to evaluate the effectiveness of this science-inquiry teaching approach implemented in one of the governmental schools and part of the MAG project, on the students' achievement and their level of engagement.

Whenever an effective instruction occurs, this means an effective teaching is taking place. Effective instructional strategies and effective teaching both are derived from a psychological perspective on thinking about teaching. Moreover, the emphasis is placed on identifying observable behaviors in the classroom that can be linked to observable outcomes"; it is all about making a difference in the students' lives (Kyriacou 2009, pp. 11).

If the effective instruction in teaching could be defined as a fruitful teaching that could help students to attend the required learning outcome defined by the teacher himself, this statement infers that the teacher has a clear idea in mind about what he is going to teach and how he should teach it. The teacher should be able to create a learning experience that could involve the students in their own learning in order to achieve his specific goals (Marzano 2001). Therefore effective teaching evolves with the teacher's experiences and his own beliefs about teaching (Wideen 1998 in Hudson 2007).

Since 1960's research on effective teaching strategy within the classroom has shown that, it effective teaching had several positive aspects such as engaging students in their own learning process, fostering the students' scientific literacy in a motivated environment (Lujan 2005). Moreover, a teacher who has an effective instructional strategy could enhance the students' understanding of the science concept, as well as their vocabulary knowledge (Dean 2012). Teachers could improve the students' critical thinking with a better interaction teacher- student through the science-inquiry hands-on strategy (Lindberg 1990; Narode et al. 1987 in Anderson 2002). Indeed, there is no doubt that this kind of teaching strategies are closely related to the teachers' attributes such as personality, gender, age, knowledge and his continuous professional development as well as his affective domain, which has been found to be a major aspect of influence on the teaching strategy such as enthusiasm, clear vision about the science topic and his high level of pedagogical knowledge. And above all these teachers should acquire the classroom management skills to provide students a very positive learning environment (Kyriacou 2009) & (Hudson 2007).

Some research identified -but didn't prove yet- some specific instructional strategies that might affect the students' achievement such as summarizing and taking notes, identifying similarities and differences, questions, cues and organizers, cooperative learning. Further research on the topic shows that students' concentration begins to decline after 15 to 20 minutes of the beginning of the class (Bligh 2000), therefore, active learning strategies that include a wide range of hands-on activities are needed in the science session that involves students in a creative thinking and engage them in all areas such as in critical and creative thinking, sharing ideas with peers, communicating and expressing thoughts with peers through writing or drawing, exploring personal attitudes and ethical values, giving and receiving feedback and reflecting on their own learning process (Bonwell & Eison 1991).These active learning procedures will diminish risks such as abstract concepts in the students' mind, or scientific misconceptions and certainly will help students to understand quickly and correctly the content and for a long-term basis.

Evaluating the effectiveness of an instruction in teaching, is evaluating what has been mainly taught according to the observable and/or measurable students' outcomes. This evaluation is not done by positive feelings expressions about what is happening within the classroom, yet it is an issue that should be concerned with the learning experiences' aspects that contribute to its effectiveness and reciprocally. That statement infers that an observer needs to understand how these features have the effect they do on the effectiveness of the instructional teaching strategy (Kyriacou 2009).In consequence, the study will not evaluate the instructional technique itself, but how this specific instruction is being effective on the overall learning process and specifically on the students' achievement and their engagement level. Research has not proven yet as mentioned earlier, that some specific instructional strategies are more effective in certain subject areas or per grade level than others. Research has not recognized if some instructions are better than others for students' from different backgrounds and demographics (Marzano 2007).

This present study is considered as pioneer in the UAE region, because it works on "evaluating the effectiveness of the science-inquiry teaching approach and its effect on improving the students' achievement and engagement level. As per Dubai MOE recommendations, students need to feel that they are unique in their own way and they are receiving the best education's quality provided within a safe and caring environment. The MOE vision stresses the importance of the stimulating environment to make sure the growth of the student is done in all areas: emotionally, physically and intellectually. The UAE government requires teachers' commitment and demonstrated support by providing them training opportunities to improve their teaching skills and to help them develop the maximum potential in the students' mind based on challenging scientific hands-on activities (UAE School for all, Dahmashi 2007).

The study will use an evaluative mixed-method approach to answer the following two questions: 1) How effective is the science-inquiry teaching approach based on hands-on approach on the improvement of students' achievement? And 2) how effective is the science-inquiry teaching approach on the students' engagement level?

Chapter II
Literature review

II. 1- What is inquiry?

Defining science-inquiry as a teaching strategy and as a pedagogical structure is not enough as Bryan (2000) and Richardson (2008) suggest: science inquiry is interconnected to four factors such as teachers' belief in inquiry, teachers' explicit and implicit knowledge about inquiry, teachers' practice in inquiry and finally the students' learning via the science-inquiry teaching approach.

Using science inquiry-based strategies for science teaching and learning is an idea that started in the 19th Century with Kropotkin (1885). Kropotkin advocated that rote-learning method of teaching should be with independent inquiry and discovery-based on problem solving instead of a didactic teaching approach.

As a part of the constructivist theory the science inquiry-teaching approach emphasizes that knowledge is constructed by the student's mind as a part of his active thinking, and his organization of the received information than integration and knowledge replacement. Therefore, students need to be actively engaged in the science learning process in both behavioral and mental so the learning could take place (Cakir, 2008; Mayer, 2004). So as a constructivist and a teaching approach, the focus of the science-inquiry permeated much of educational practices in the 1970s, particularly in science education. Furthermore, national reform in science education recall for inquiry as a main instructional strategy that contributes to construct in the students' mind the scientific understanding and contribute to build their own ideas.

Science-inquiry-teaching approach is a way students could explore the working world. According to Rosebery (2008) inquiry is the world's wisdom that requires a curious explorer able to make connections between unexpected items. It is a better understanding of the science essence and the science enterprise and a new strategy in teaching and learning in her new technical and reasoning processes that carries research (Dewey1996) through cognitive perception just like the brain function (Hinrichsen 1999).

As per Deboer (1991) science is a product and a process, one cannot work without the other. The science product is its' content and knowledge as per the process it is the technical approach that includes the science-inquiry teaching approach. There is a mental rigor between science-inquiry teaching approach and traditional sciences. Inquiry is a teaching approach that helps students understand a difficult scientific concept and understand a complex topic; therefore science-inquiry as a teaching approach must be built on substantive, accurate and relevant knowledge for the learner. This knowledge progresses on ideas' integration.

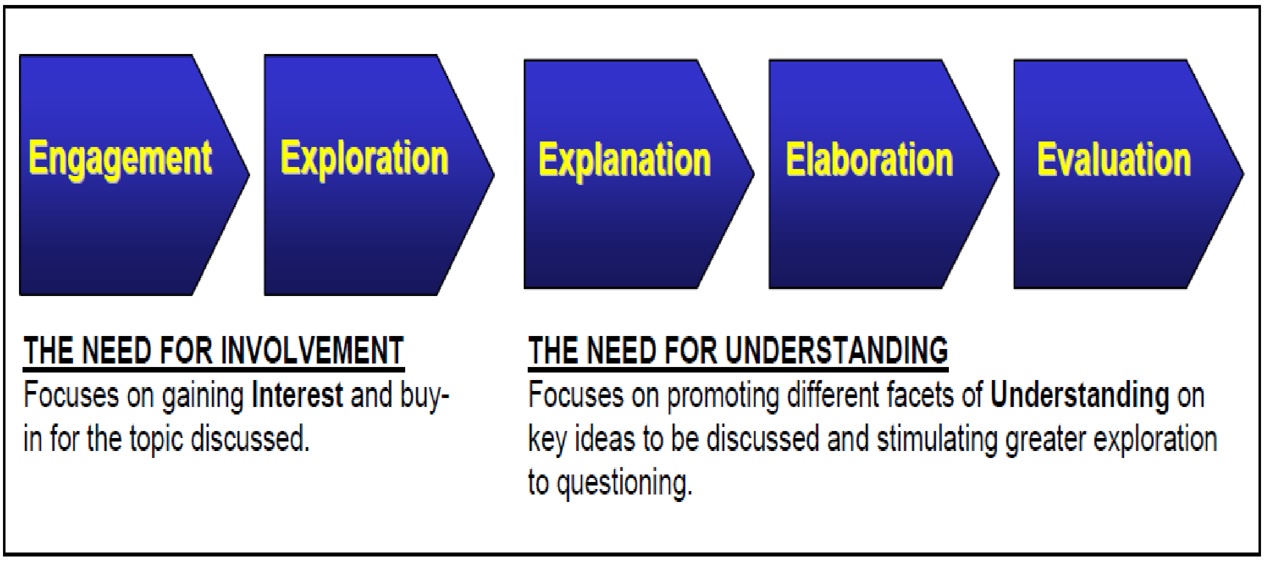
The main goal of the inquiry as a teaching approach is to help the students to take control in an increased manner, under the guidance of an effective inquiry teacher. Students should be able to ask questions and seek for meaningful answers by designing hands-on investigations. An inquiry-based classroom is more than gathering individuals for economic reasons, it is mainly a simulation of the scientific community of students and teachers who share the learning responsibility and collaborate for a better understanding (Schifter 1996). On the other hand, the traditional classrooms where instruction emphasizes lecture and individual seat work discourages interruptions by such things as students' questions and creativity or critical thinking that often is not present and misconceptions can go undetected (Jarret 1999).

The science-inquiry teaching approach is considered as a vehicle for scientific teaching and learning in the classroom that delineates and highlights the occurrence of the students'engagment in the science classroom for the experimental group (chalufour 2010). As stated earlier in the literature review, the engagement as redefined by the Next generation of science standards (NGSS 2013), involves both the scientific sense-making and the language,as a way to combine both hands-on and minds-on and this scientific sense is assessed clearby the written and the oral trace done by students. Engagement is a language: as students make the transition form their unproven notions of the world to more scientifically based conceptions, they have to read, write and express their ideas through participating in the science classroom discourse visually or by using models and explanations (NGSS 2013). Students engaged with peers in reasoned argumentation refine their ideas and share their conclusions expressed on their achievement scores (Findlay 2004).

II. 2- Science-inquiry Instruction and the Five "E" Models For Scientific Scope and Sequence

The science-inquiry instruction uses the 5Es' model **Fig 2** that includes engaging the students in the science learning using hands-on activities that would help them to explore the new scientific concept and students could be able to explain whatever they were taught as they develop skills such as analyzing, evaluating evidence, experiencing and discussing. This kind of instruction could empower the students' critical and logical thinking through an auto-evaluation and a peer communication within the same group or with different groups competing together: called cooperative learning strategy. It is a constructivist environment, which allows students to construct their scientific concepts over time and to think critically and reflect on their own misconceptions (Kyriacou 2007).

Fig 2. The 5E Model Instructional Strategy



II. 3- Science-Inquiry Instruction and Standards

The National Science Teachers Association (NSTA 2004) recommends that all teachers embrace the science-inquiry as the centerpiece teaching approach of science teaching from K–16, because the science-inquiry could provide students the opportunity to express their ideas by participating actively within the lesson in an effective science-inquiry framework applied by the teacher (Slavin 2012)& (Kern & Moore 2007). When students are exposed to different point of views within the science-inquiry classroom instruction, they could seek cognitively the explanation within the inquiry context that usually reports an increase in students' engagement (Brown, 2004).

II.3.a. The Next Generation of Science Standards (NGSS)

3.a.1-The Next Generation of Science Standards, the Science Inquiry Teaching Approach and Engagement.

The next generation of Science standards (NGSS 2013) is a two-step outcome of joined forces of twenty-six states with the official scientific academies such as: the national academy of sciences (NAS), the American association for advancement of science (AAAS 2000), and the national science teachers association (NSTA 2004) including many teachers and stakeholders, and which main purpose is to advise all nations on the importance of some scientific and engineering matters.

The first draft framework for K-12 science education, was released on 19th July 2011 by the national research council (NRC 2011), identifying what students should know in science from K-12. The twenty-six leading states and writers took in hand the NGSS, in a time of educational changes at a national level and congruent with the first appearance of the Common Core State Standards (CCSS) for English language arts and literacy and for mathematics. Within a changing environment on the demographic level for all students, the writers' goal is to open more science opportunities for students all over the world, when persisting gaps are affecting non-dominant students such as the decrease of their science achievements, the educational policies transformations, by crosscutting concepts across K-12.The

NGSS' authors realized that standards alone as a practical and utile framework do not work; therefore, it is mandatory to implement effective new teaching strategies to have an effective outcome. The science inquiry teaching approach has been one of the effective strategies advised by the writers for the effective implementation of the new science framework. The science-inquiry teaching approach is considered as a vehicle for crosscutting between disciplines, not only inside the science classroom, but also at the school level, home and community levels to improve students' science literacy.

The NGSS redefined the science inquiry as follows:

"Scientific inquiry, is the core of science teaching and learning through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (p. 23).

The NGSS (NGSS 2013) refined and deepened the "science-inquiry teaching strategy explicitly by adding the eight scientific engineering practices that include all the students' groups (Lee, Quinn, & Valdés, in press; Quinn, Lee, & Valdés, 2012).These eight science and engineering practices were identified for professional science and engineering applications, to develop the students' understanding of the nature of science, as well as their own scientific skills. The eight science practices from the NGSS framework include: 1) asking questions and defining the main problems or the scientific hypothesis; 2) developing and using models;3) carrying out investigations after planning them;4) interpreting and analysing data, and cross – disciplinary approach;5) computer technology to construct explanations and designing solutions; 6) engaging students in argumentation based on evidence and finally after 7)obtaining the results, 8) evaluating and communicating information. According to research, and the NGSS overview (NGSS 2013), the students are capable of learning science and improving through their comprehension of the scientific sophisticated language functions (e.g., arguing from evidence, providing explanations, developing models); if effective teachers appropriately support the students, and the implementation of the science-inquiry teaching approach is being effective. It could be concluded that science teachers' training and continuous follow-up is mandatory for the estimated outcome for the present paper.

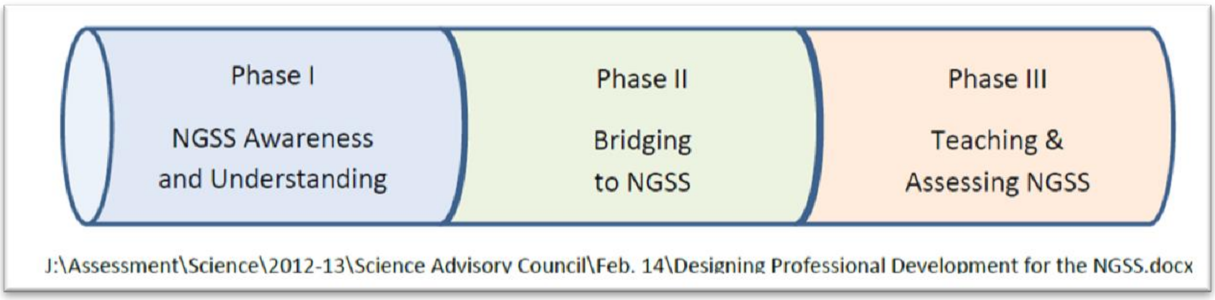
II.4- Teachers’ Professional Development

For more than one hundred years the scientific and educational communities have agreed that classroom management, students’ achievement, students’ engagement, as well as implementing a new scientific instructional strategy are all difficult tasks on the teachers’ shoulders; therefore teachers need to be supported by the entire teaching and learning community. Teachers need to develop skills for managing new reformed curriculum in science and to be able to implement the scientific inquiry learning strategies necessary to guide students in reasoning instead of just being passive receptacles. Teachers need to create new responsibilities as a result of implementing new learning approaches aligned with the reform work. Because of the students’ diversity and cultural backgrounds, teachers requisite the use of instructional strategies that respect diversities and cultures while helping students to build their own learning experience and construct their scientific concepts and acquire new scientific skills and processes.

When it comes to reforms in all over the world teachers’ learning and their own professional development is always the last factor taken in consideration and is implemented. On-going learning is an essential component of continuous improvement for teachers (Barber & Mourshed 2007) and it is considered as a key element in any clinical practice profession (Alter & Coggshall 2009). Moreover, demands on teachers are growing, as evidenced in the 2010 draft revisions of the Interstate Teacher Assessment and Support Consortium (InTASC) Model Core Teaching Standards (Council of Chief State School Officers InTASC 2010). ADEC recruited 1200 sciences and math teachers for the year 2013-2014 with very generous offers. During the five years and more, the National Comprehensive Center for Teacher Quality have reached to consensus that teachers could effect on students’ achievement in the following points: First, according to international statistics, students with low economic status are more likely to be assigned less experienced teachers and some of them uncertified, which likely would influence negatively on the students ability to produce high level of learning (Clotfelter, Ladd, & Vigdor, 2007; Secretary’s Priorities for Discretionary Grant Programs, 2010). Second, in order to minimize the teachers’ influence in its inequity on students’ learning and thereby reduce achievement gaps, policy makers must redesign all systems that recruit, prepare, select, develop, retain, evaluate, advance, and compensate teachers (Consortium for Policy Research in Education Strategic Management of Human Capital, 2009; Curtis & Wurtzel, 2010; Hill, Stumbo, Paliokas, Hansen, & McWalters, 2010). Teachers must receive continuous knowledge on how to access technical skills, complex knowledge, sophisticated tools, and research-based techniques to make sure that they are being and continue to be successful with all students. Thus, this kind of high-quality learning activities and the awareness of the new teaching standards on a local and on an international basis need to be extended to all teachers all over the globe.

As per the NGSS (2013), the science teachers' professional development is divided into three phases as per the table 4 below. The table explains that teachers should be aware first (phase one) of the scientific standards they are going to follow in their teaching and learning approach, so they could be able to make the bridge between what students know and what they will learn (the bridging phase). Moreover, as per the NGSS (2013) recommendations for the teachers' professional development, teachers should understand the science content as well as the instructional science-inquiry teaching approach methods to foster the science practices and help students to be more engaged in their own science learning. Finally in phase three, teachers should determine methods to assess the NGS standards in the classroom and evaluate the effectiveness of the instructional methods used during their teaching and learning.

Table 4: The three phases of the teachers' professional development.



In order to assess the efficacy of the science-inquiry approach in the classroom, it is mandatory to make sure that there is an effective inquiry approach that happens. The study has designed a whole planning for the students as well as the teachers

participating in the study. The planning included the content of the 6th grade science, inquiry skills, hands-on activities, lesson plans, lesson reviews, unit tests all aligned to the standards listed by Mininstry of education, and NGSS (2013), aligned as well with the teaching standards for the science inquiry required by the NSES (2000).
The table 5 and table 6 (appendices) show the standards that the study is going to follow especially standard B and standard C that target the teacher. The standards explain that the effective teacher is a facilitator, and a person who engages the students in their own learning process in significant oriented questions.

II.5- Science-Inquiry and Student's Achievement

An article published by Lee & Luykx in (2006) discusses issues that could influence on the students' achievement following the science-inquiry teaching approach as a hands-on teaching approach. The article explains the existence of three main concerns that could have a direct influence on the student' achievement and these concerns are the appropriate curricula, the teaching quality i.e. the pedagogical knowledge of the teachers using appropriate pedagogical materials, and the students' attitude towards science and their level of engagement.

The curricula and the materials if chosen adequately may decrease science achievement gap. Most of the curricula used in the UAE are imported from western science curricula, foreign to many students and non-relevant to their national culture and in most cases do not take in consideration the differentiated instruction such as students with low income families, second language learners, students with low background experience in science, students with special needs. Moreover all these factors could influence on the students' achievement level their scientific skills such as reasoning, and argumentation.

The teaching' quality is an additional crucial factor. The Quality of teaching influences on the disparity in students' achievement in science and that is attributable to teachers' characteristics cited earlier. In reform-oriented practices, policy makers need to provide effective science instruction by recruiting teachers coming from the same students' background to teach effectively. Teachers from the same students' background understand the students' culture and could establish the code for mutual respect. Moreover, because science is not a school issue only but a community literature, and as part of the new science reform, teachers need to give examples from every day's knowledge and practices that students practice in their homes (Cuevas, P., Lee, O., Hart, J., & Deaktor, R. 2005). As for the science assessment it is more valid and equitable when it is relevant to the students' community knowledge and what students experience so they could demonstrate meaningfully what they know.

A research done at school district based on different American states discovered that students' attitudes toward science were significantly related to their achievement. The findings were that boys' achievement test scores were more positively related to their attitudes toward science than were girls' attitudes. In addition, teachers who followed a standardized –based instructional strategy and who participated in a professional development program focusing on collaborative construction of understanding and adaptation of science materials and science-inquiry practices using software, modular science curriculum and information search tools had better students' scores (Kahle et al.2000 & Marx et al.2004).The effect of scientific inquiry instruction on students' achievement, as well as the students' engagement, is a great interest of policy makers. This is particularly true as the "No child left behind" act (2002) required testing students' achievement and engagement level. However, despite these investments and heightened emphasis on science achievement, few studies were made on findings across individual about the relationship between science- inquiry instruction and students' achievement (Minner 2009).

II. 6- Science Inquiry and Student Engagement

In our twenty first century technological facilities, engaging students in science learning is becoming increasingly problematic (Castell & Jensen, 2004). However, capturing attention is not enough to have teaching and learning. In 2002 The National Center for Educational Statistics discovered in his research that only 57.9% of the students could apply the scientific concepts that were thought form a total of 92.7% of students that apparently understood the basic scientific principles, and barely 10.9% could analyze procedures and data. Bybee (2003) wrote that offering students engaging opportunities in real-world situations which involve science data could help them construct their knowledge through active authentic experiences. The national academy of science suggested in (1995) that the determination of using the science-inquiry as a teaching approach is to engage students within the main ingredient of the science-inquiry model recognized in the 5Es model (Bybee1989). However, it is hard to define engagement as it is related to emotions and commitment: indeed students are committed and care about their scientific investigations and they consider their work valuable to them (Newmann1986).

Engagement is recognized qualitatively by observation. Several ways of engagement were added to the science classrooms, to enhance student learning, achievement and development, such as a technology rich classroom and technology meaningful assignments that allows students to experiment and investigate (Apple of tomorrow 1984). The engagement is mainly defined as the intrinsic motivation that immerses students totally in a certain activity; this activity should be balanced between being challenging, skilful and confidence-building within a positive context that students call fun. Engagement within the inquiry allows freedom of exploration within a meaningful assignment such as problem-solving per example, yet students as well as the teacher that facilitates the inquiry should be acknowledged about the problem as well as its process (Savery & Duffy 1996). Engaging students in the real world and driving learning with interest help students to be more willing to be more engaged and to invest energy and time in science applications (Joseph & Daniels 2005).

In conclusion, the first appearance of science-inquiry instruction is difficult to trace in the longstanding dialogue of teaching and learning. Piaget and Vygosky as well as David Ausbel blended the constructivism philosophy (Cakir, 2008), which was then used to shape instructional materials. As moniker of inquiry-based and including hands-on activities, the science-inquiry teaching approach is a way to motivate and engage students while concretizing science concepts.

Chapter III
Methodology

III.1-Setting:

The main purpose of this case study is to evaluate through a mixed-method approach the effectiveness of the science-inquiry teaching approach on improving: 1) the students' achievement through a quantitative analysis of the students' progress scores using a pre-test and a post-test data collection and; 2) The students' level of engagement in the classroom using qualitative classroom observations and analysis. This study is pioneer in UAE similar to a study done in Qatar in 2012 (Areepattamannil 2012). The sample of the study is fifty two students from the 6th grade girl's public schools, located in the eastern educational zone of the United Arabs Emirates (UAE), in a four months and a half period time. The sample of students is a part of a population of eight hundred fifty students' boys and girls of 12 years old, following the MAG program. The students' parents approved to let their children take part of the four months and a half study as a part of the MAG project that implements the science reform curriculum and uses the science-inquiry teaching approach as the main teaching approach in the science classes of "Madares AL Ghad" (MAG) specialized schools; a letter was sent to all parents so they get informed about the case study implemented in the first four months and a half from the school year (first term of the school year).

The mixing-method concept dates from 1959 when Campbell and Fiske, tried to study the validity of some psychological traits. As all research methods, the mixed-method have limitations and could hold within biases therefore the study will use the triangulation concept of seeking for convergence in both methods; an additional reason for mixing-method use in this study is the fact that it could provide insights into different levels or units of analysis (Creswell 2009).

The present study is using concurrent procedures, in which both quantitative and qualitative data converges and go along together to provide a comprehensive analysis of both questions asked in the introduction section. In this type of design, data is collected from both tests and class observations at the same time during the study timeline, and the interpretation was integrated with the overall results. Within this study paradigm, the mixed-method is the best way to assess both students' achievement and engagement as it could combine different methods of data' collection and analysis.

The quantitative method using students' scores collection emphasizes data based on measurements, which need to be collected and analyzed. This procedure should follow a scientific model such as hypothesis, deduction through pre-test and post-test to establish objective knowledge that could be significant for the case study (Common Wealth 2004). The qualitative part of the present case study emphasizes attitudes rather than numbers, but in order to make an appropriate analysis through a descriptive tool, some of the items were interpreted quantitatively as per the earlier researchers' suggestions regarding the qualitative method approach (Common Wealth 2004).

In the current mixed-method research study the researcher is evaluating during the four months and a half the effectiveness of the science-inquiry teaching approach as the independent variable on both students' samples therefore, one sample of the students will be receiving the science-inquiry –teaching approach by an effective teaching and learning approach: a well-trained inquiry teacher entitled in the study as (TT). The other sample of students is the controlling group: twenty-six students from another 6th grade section from the same girl school, located in the same educational zone, in order to remove any kind of external influencing factors receiving the science instruction by lecturing with a classic lecturer teacher who will be entitled in the study as (LT); the dependent variables in the study are first the students' achievement measured for both samples quantitatively through the pre-test and the post-test, the second is the level of engagement evaluated for both students' samples through classroom observations using the EIT tool designed specifically for the current study after being tested.

The study used the 6th grade science content aligned with the next generation of science standards and the teacher was advised to use the same sciences' resources provided by the school so the project does not interfere with the students' normal academic year' scope and sequence. However, the teacher had to use some extra resources to reinforce the science-inquiry teaching approach and design extra science-inquiry activities.

III.2- Methodology procedure

Some bureaucratic procedures were necessary before entering the schools. In order to get the approval of the MAG administration office for entry clearance inside the schools the following documents should be presented such as the researcher's personal papers, the main objective of the study (make sure that the present study would not influence negatively on the schools' reputation or the MAG's office reputation as well). The EIT observation tool, should be sent to the administration office in the MAG, located in the ministry of education building, and should be reviewed, commented and cleared from cultural, ethical as well as academic point of views in order to be used as the observation tool for the study. As for the tests used to assess the students' scores, the MAG department as well as the curriculum and the tests department in the ministry of education had to review and add their comments on the scientific content knowledge, level of English, and check for their accuracy and alignment with the MAG and the ministry of education' standards and vision.

Second step is acknowledge the parents that a certain case study is going to take part in the school for the four months and a half of their current year, and their children, will take part of it by sending an official letter. Third step, get the teachers' approval to be part of the case study, and make sure that their scores and results analyzed and evaluated will not put them in any kind of accountability facing the administration office of the school, and will not affect negatively on their yearly appraisal.

Fourth step is to design a clear timeline for classroom observation, field work and students' assessment that should take into account several factors such as the teacher's timetable, public holidays, local events in the school such as the UAE clean-up campaign, as well as the international celebrations such as the water day; the earth day, and the teachers' professional development and trainings required by the ministry of education as well as by the MAG administration, finally the administrative requirements of the school's principal.

The first sample of the twenty six students received the instruction by their classic teacher, the classroom observation was made as well as the analysis of the written trace; in addition students had to do the same assessments designed for the current study for analysis purpose. On the other hand, the second sample of the twenty six students was exposed to the science-inquiry teaching approach for four months and fifteen days, equal to eighty-four hours of effective science-inquiry teaching, a big amount of teaching hours that could effect on the students' outcome. For this reason, the science-inquiry teacher needs to be continuously followed to guarantee its effectiveness in each science session and to make sure that the outcome and the students' learning process is being effective. In consequence, the present study designed a continuous professional development program (table 6 in appendices) coupled with continuous follow up and classroom observation from the opening to the closer of each science lesson of the science-inquiry teaching approach. The TT teacher was observed seven times according to a specific schedule, and the number of times students showed engagement was recorded.

On the other hand, the (LT) teacher did not follow any continuous professional development sessions, and did not receive any of the tutoring sessions. The (LT) teacher designed, instructed the seven sessions and was observed, and the number of times students showed engagement in his sessions was noted but no feedback was given for the science teacher of the controlled group.

III.3- The Science-Inquiry Teacher's Professional Development Program.

A science-inquiry professional development program has been executed during the four months and a half as presented in table 6 (appendices). In order to help the teacher implementing the science-inquiry as a teaching approach and understanding how it works in the classroom. The professional development was coupled with modelling sessions and one to one follow up with regular counselling. The choices of the topics were specifically aligned with the teachers' needs to implement science-inquiry in the classroom.

The professional development training sessions had specific topics such as getting to know what the standards in science are and how a science-inquiry teacher can explore them. The standard workshop is for the teacher a global vision to assess why it is necessary to align our science content to international scientific standards. The second topic is about the cooperative learning and the teacher's role in the peer work and the interaction between teacher-student and student-student. The next topic is the choice of the science-inquiry task and the vocabulary words, in order to empower the scientific content. Science teachers need to know more about the science content itself to avoid misconceptions and students' disappointment so the topics of the next professional development program is "science misconceptions in textbooks", so science governmental teachers could discover that science textbooks are one of many resources that a science-inquiry teacher should follow. To improve the critical thinking in the students' mind, the training sessions included questions and answers that develop students' critical thinking in the science lesson. Moreover, choosing critical questioning as a workshop topic is aligned with the engagement items figuring in the "engage" section: teachers need to know how to asking the right questions to build a constructivist learner. This all could help to bridge the gap between passively accepting the scientific concept and memorizing it, to other active and dynamic skills such analysing and synthesizing: students should explore through the critical thinking new arguments' components, conclusions and assumptions even improve their language abilities, to reach to a solid foundation of personal choices such as rejecting or accepting a given scientific result (Keeley 2011). In investigation and thinking processes each student is engaged emotionally to seek answers for challenging questions (Browne & Keeley 2012);

The science-inquiry teacher has to observe other science-inquiry teachers and these observation sessions proposed by the professional development schedule are important for the teacher to witness a science-inquiry teaching approach that works and evaluates how far he is from being an effective science-inquiry teacher.

III.4- The Study Tool

According to the NSES (2009), the scientific inquiry as a learning process engages students mentally in a constructivist environment and the scientific inquiry in her multiple stages such as writing, communicating and reflecting within a range of specific activities, involves the students in peers work and cooperative learning (Anderson 2002). The present study delineates and assesses quantitatively the students' acheivement improvement after a science-inquiry teaching approach and a classic teaching session for both experimental and controlled group using a pre-test that students do in the first beginning of the year and another post-test at the end of the four months and a half science-inquiry teaching approach. On the other hand, the study evaluates qualitatively the effectiveness of the science inquiry on the students' level of engagement for both groups' samples by observing specific aspects that reported a positive change on the students' engagement within their science-inquiry learning classroom. The null hypothesis is the fact that despite the science-inquiry teaching approach implementation, the teacher's professional development, and the integration of hands-on science-inquiry activities, students' achievement did not show any significant positive changes, moreover, no significant changes were detected in the students' engagement level within the science classroom session.

III.5-The Design of the Quantitative Tool

The study assessed the students' achievement based on the 6^{th} grade using standardized tests from California, Tennessee, and the University of New York as well as Virginia, writers and inspirers of the NGSS (2013) and the ministry of Education in the United Arabs Emirates (2009).

The assessment of the students' knowledge had a two phases' process: phase I is the phase to administer the pre- test in September 2013, to place all 6^{th} grade students' and check their level regarding the science content as well as their attainment in inquiry-skills. Phase II is the final test that assess both students' samples achievement, using their scores after four months and a half of effective instruction received by the experimental group, and the non-effective instruction received by the controlled group.

The case study administrated the final test in two rounds: December 2013 (end of term I) the first round using the final test part I that covers the Life science content, and in March 2013 (end of term II) the second round that uses the final test part II, that covers the Earth science and Geology. The reason behind this type of administration is mainly the students' age and their limited cognitive ability to understand and verbalize a certain amount of information in a short period especially if they are Arabic native speakers with English language barriers (Piaget 2009).

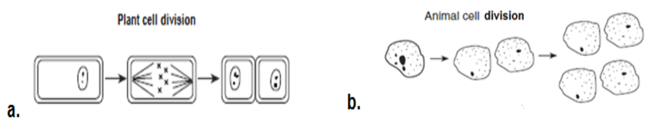
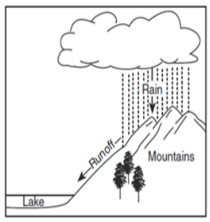
Taking into account all these listed factors above, the standards, the language barrier, the Ministry of education requirements, and the students' cognitive ability, the quantitative tools which are the pre-test as well as the post-test 1 and post-test 2, were designed as per the TIMSS layout and the local National assessment Program (NAP) and aligned with the NGSS standards. The pre-test had three sections: the first section as multiple-choice exercises, the second section as fill in the blank and the third section as matching. The post-test 1and post-test 2 had both the multiple-choice section that proved to be the best tool to assess content as well as skills for second language speakers and the open-ended questions to assess their ability to communicate and verbalize the science concept understood, and the modelling which is transforming a text into a diagram. Moreover, because of the students' language barriers some Arabic translation was added to the main question in order to assess the skill in adequate manner regardless the language competency of the student; moreover the language will not be a negative influencing factor on the students' achievement (table 7 below).

The questions assessed the science-inquiry skills such as infer, predict, compare and contrast as per the NGSS (2013) requirements for the 6th grade. On the other hand the test scoring was distributed according to the weight of the standards taught during the period of the study: the multiple choice questions each one had one point and a total of 25 marks to assess the content knowledge. The Fill in the blank part where students should conclude what could be the correct word had 2 marks for each correct answer. As per the experimental questions and the questions that delineate some abstract representations they were the lowest questions graded as to differentiate between students who had higher cognitive abilities more than others.

Table 7. Sample of Science Post-test 1 Questions

Type	Standard	Sample items
Multiple-choice	**6.3.2**. Observe and infer an experimental protocol identify and label the experiment and analyze its usage	**1. Which <u>statement</u> is correct about the experiment below?**  **a.** Evaporation & condensation **b.** water cycle **c.** infiltration **d.** Temperature
Fill in the blank	**6.5** draw conclusions and apply in a text format	**Non-living** | **groundwater** | **disappear** | **Water cycle** | **Scientific method** | **Populations** | **Characterisitics** **a.** The hypothesis and the experiments are **two parts** from the .... **b. Classification** is grouping organisms with similar .... **c.** The temperature and the water **are two** .... factors. **d.** If one living thing **dies** from the food web all the **food web** will .... **e.** A **community** in an ecosystem **is made of different** .... living together. **f.** When the **water** turns around the ecosystem it **is called** .... **g.** The **treatment** of the water **keeps the** .... Safe to use.
Matching	**6.5.2.** Correlate a conclusion to an earlier experience and try to extend into a new hypothesis	**<u>2- Match the correct number from column 2 to the correct number in column 1</u>** | | **Column 1** | **Column 2** | | (.........) | **a**. *Felis domesticus* | **1**. Linnaean System | | (..........) | **b.** classification | **2.** scientific method | | (..........) | **c**. boiled water has a .... temperature | **3.** 100 °C | | (.........) | **d.** give conclusions | **4.** the cat |

Table 8. Sample of Science Post-test 2 Questions

Type	Standard	Sample items
Multiple-choice	**6.2.2** Compare and contrast between phenomena such as mitosis, meiosis	**2- Picture ☐a or ☐b, below is Meiosis. (2pts)** 
Open-ended	**6.5** draw conclusions and apply in a text format	**26- Answer the following questions أجب عن الأسئلة التالية مستعينا بالرسم (4pts)** **1- What type of boundary has formed the mountains? (2pts)** .... **2- What could happen to the mountain after this heavy rain ? (1pt)** .... **3- Whv is runoff important to nature? (1pt)** .... 
Modelling	**6.4.3**. Transform a table into a graph, chart, or a concept map using computer applications, or the traditional ways	

III.6-The Qualitative Tool

The Engagement Inquiry Tool (EIT) used in the present study has been designed specifically for the current study to evaluate the effectiveness of the science-inquiry teaching approach on the students' enaggement level. The tool was constructed from several other relaible tools designed by very well-known authors known in the assessment and evaluation field such as Johnson & Smith, Yager & Enger and Chikering & Gamson. The tool has the next generation of science standards NGSS' framework for the engagement and has been amended to answer the local needs such as the language barrier, the students' dmeographics, the students' backgrounds and culture and specifically the fact that they are used mostly on lecturing approach more than hands-on approach. Therefore the tool needed to highlight the teamwork, the cooperative learning approach, the communication factor by oral or written trace, and should stress the tasks within the science-inquiry teaching approach as well as designing independently the scientific investigation and stress the fact that students are positive independent learners. The EIT (2013) engagement tool has been the result of the 1) (CLOP) instrument considered as the criterion-referenced instrument for cooperative learning and engagement. The (CLOP) is the based-core evaluation classroom observation protocol (CEPT) and has prooved to be a useful instrument to rate the effectiveness in which students are collaborating and working on a specific task, within the five elements of the cooperative learning as advised by Johnson & Smith (2002) as well as their level of engagement. 2) the science –inquiry surveys done by Yager & Enger (2012) (shown in appendix # 4). 3) The NSES standards for inquiry and for science teaching and learning. Finally 4)The 5E's model for the science inquiry that could empower the students' engagement as required by the NSES and the National Survey of Student Engagement (NSSE 2009),taking into account the seven principles of effective engagement of Chikering & Gamson (2007).

The EIT instrument, hence, includes four sections: the first section is the general information such as the class grade, the topic of the lesson as well as the assigned inquiry task specific for the lesson. The second section is about the classroom environment; the purpose of this section is to evaluate to what extent the positive classroom environment could foster the students' engagement towards more creativity, positivity as well as good being. In this section, the seating arrangement could have a direct influence on the interaction student-student and could even give an idea to the observer about the kind of approach used by the teacher in the science lesson. The third section is the scope and sequence and how students are engaged in the sequence itself: hands-on work, expressions, writing, creating, debating, and asking questions, within the classroom discourse. The fourth section is mainly about the teacher effectiveness within the science-inquiry teaching approach and the teacher-student relationship as well as his role as facilitator and how his positive affective domain is influencing positively on the students' outcome and engagement within the lesson itself.

Between the 5E model engage, explore, explain, evaluate and elaborate that are added to the tool the case study will consider only two items of the (EIT) tool which are the "engage" and the "explain" items and during the classroom observation the researcher will be noting the number of occurrence of these items in the observation session and the engagement results will be analysed accordingly. These selective choices were done because of the study timeline and capacity that restrain the researcher from assessing the four items. The explore item and the evaluate items are two items that need more time for the study timeline to be developed and therefore evaluated, moreover the students need to acquire a higher cognitive ability to be able to auto-evaluate and assess correctly their work, the four months a half of science-inquiry cannot help the students to make their own observations and make a full inquiry analysis based on a scientific method.

The researcher visited both teachers seven times from the beginning of the study until its end to follow the students' engagement progress. The observer used the EIT tool and was following the whole class and specifically one group of students for the seven sessions to make sure that the items of engagement are well evaluated. The results are shown in the table 9 (appendices)

Chapter IV
Results and Findings

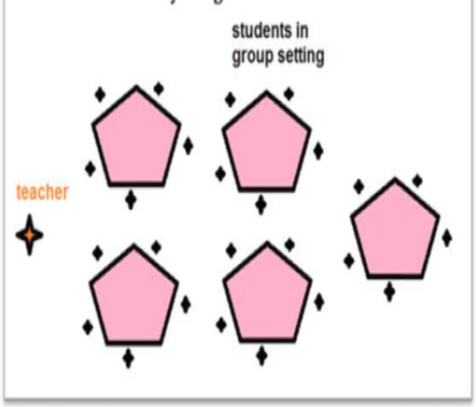
IV-1- Introduction

throughout four months and a half of the science-inquiry teaching approach given by two types of teachers: the first trained inquiry teacher named as “TT” and “LT” teacher, the 12 years old students, Arabic native speakers went through the pre-test and the post- test according to the schedule mentioned in the methodology procedures. After the students did the pre-test and the post-test part 1 and later on the post-test part 2, data collected was gathered and grouped and analyzed by committee of science researchers who volunteered for the analysis and who signed a privacy contract to keep all information classified. The post-tests part 1 and post-test part 2 were added and the mean was taken from both post-tests 1 and 2 as they are only one test that has been given in two rounds. The reason the case study chosen this kind of manoeuver (that is similar to the TIMSS testing procedures) is the fact that students in 6th grade could have some difficulty at the concentration level, to remain more than 3 hours seated for a test: taking into account their cognitive ability at their age level. Data collected was grouped and percentage was calculated to have a look at a glance of the students’ improvement after the 4 months and a half of effective teaching and hands-on strategy and in lecturing process. For more accuracy and to check the results reliability, the data was gathered and through the SPSS software, the T-test was calculated to define the variance, the standard deviation as well as the t value to check if these results could be considered reliable for further research and analysis.

IV-2- The Seating Arrangement

The science teacher in public schools gives the scientific instruction in the laboratory considered as his classical classroom. Therefore, the seating arrangement is always convenient for teamwork of five students. The choice of increasing or decreasing the group number is limited to the availability of the

Chart 10 Laboratory design



tools provided for each group, as well as the fact that there is always shortage in the laboratory assistant staff supporting the science teacher. For this reason, the teacher would prefer keeping the students' within a little number of groups as per the chart 10 shown above that shows the laboratory design for the group work. Therefore, during all the seven sessions of classroom observation, the structure of the teamwork setting has not been changes and was considered effective. The teachers' main task was to push the students to communicate, and exchange their ideas within the group work. In addition, the teacher's choice of the specific science-inquiry task accomplished only in group work was discussed before the lesson.

The positive interdependence is a key for the students to know their specific roles and divide the task in order and a way they could know how to divide roles in the society. It is the way that they use to depend on each other's' skills and potentials to finish the given task on time. In the first observation session, the students' were all working with the teacher. At each moment, the questions were addressed to the teacher such as: "didn't know the task"; "didn't know what we had to do";" can we do this example?", "can we use the ruler?" The dialogue was with the teacher for the whole fifteen minutes assigned for the activity. Therefore, after the first observation session, some changes were done regarding the choice of the task to give more interdependence for the students, and keep their critical thinking and the science content of the 6^{th} graders' level. The steps of the scientific method were mainly the steps that they had to use. The different roles within the same group should rotate from one student to another at each session especially the written trace that gives the student the opportunity to coordinate between each other in the same group, in consequence students could understand the task's requirements, and elaborate the conclusion from the different point of views. When the choice of the science-inquiry task is adequate, students are positive interdependent, questions and answers by the students and the teacher make more sense, and the dialogue that takes place between the students will be around the task itself. The students evolve in their investigations and solutions, to a higher thinking level as per Bloom taxonomy revised draft (2012).

As for the LT observation, as mentioned earlier the seating arrangement was the same yet in none of the seven sessions that the trainer observed, the (LT) teacher gave a task that needed the whole group's effort. The students always had to work alone in a group seating with no effective communication between each other.

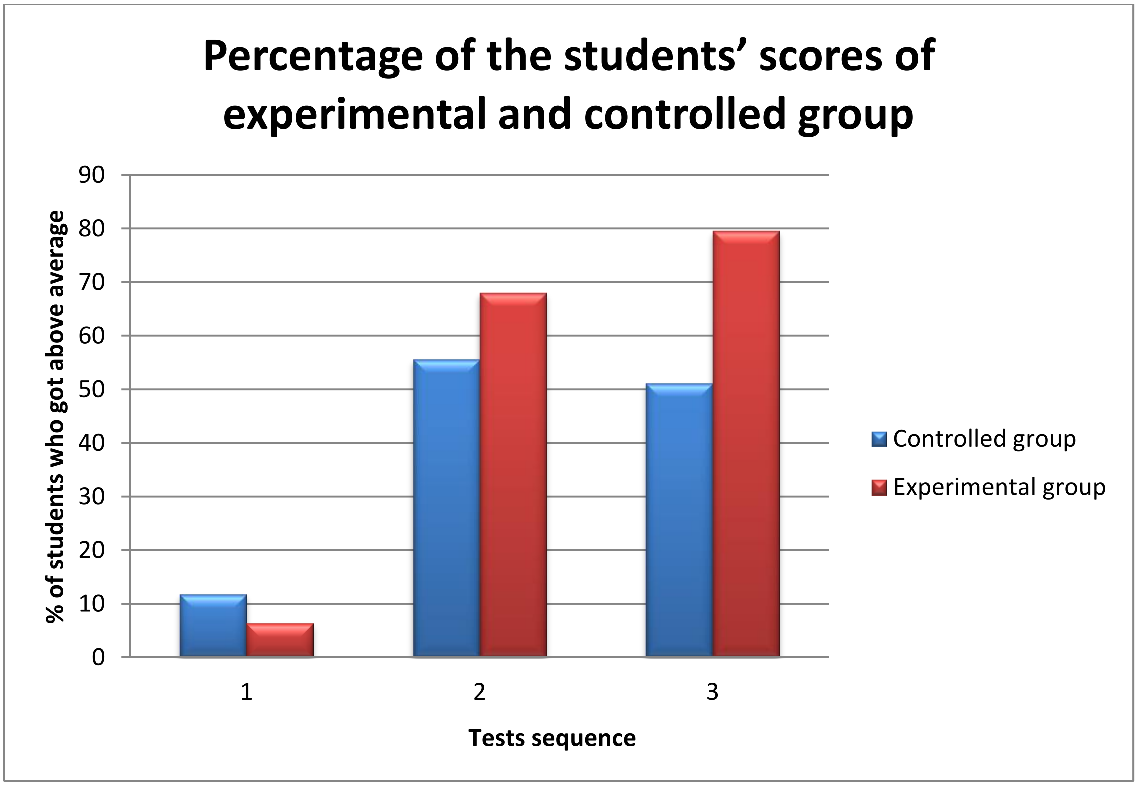
IV. 2 -Students' achievement

The results of post-test 1 and post-test 2 were gathered and added and the mean was calculated in order to have one result of the post-test. The percentages results are shown in chart 14 and chart 15 for both group samples: the controlled group taught by the teacher who didn't receive any of the new science –inquiry teaching approach training, using the traditional ways of teaching and the experimental group where students received the science instruction as an inquiry-teaching strategy.

<u>Chart 14 Students' scores for of the experimental and controlled group</u>

Percentage of the students' scores of experimental and controlled group				
		Pre-test	**Test 1 part 1**	**Test 1 part 2**
Controlled group	Sum of the scores	626	2947	2718
	Percentage	11.8	55.6	51.2
Experimental group	Sum of the scores	343	3610	4223
	Percentage	6.4	68.1	79.6

Chart 15 Students' scores of the both pre-test and post-test for both experimental and controlled group in percentage



After doing the data collection and the data analysis using the percentage method, the findings of the students' scores were different for both groups. Both groups were at a very low starting point with 11.8 % of success for the controlled group and 6.45 % of success for the experimental group, in addition the controlled group students were had a higher level of success in their pre-test compared to the experimental group 11.8%> 6.45% . Moreover, both groups improved in the second assessment, with a 55.6% for the controlled group and 68.1% for the experimental group. The results infer that both teaching methods were fine, and the difference between the controlled group and the experimental group was not quite high; yet the experimental group showed a progress and a higher increase in the total score average in the last post-test 2 designated for both students' samples. The final post-test designated as number 3 in chart 14, shows the difference between the experimental group and the controlled group with 79.6%

versus 51.2% for the controlled group indicating that students decreased in their engagement as well as in their commitment to the science discipline showing a demotivation for taking the test and a non-willingness for the improvement (Zhu & Leung, 2011).

These results and findings are aligned with earlier research on science-inquiry teaching approach and inquiry science learning that reports positive relationship between inquiry approach and students' science achievement (Hakan 2012). The table 15 above shows explicitly the scores' improvement of the students following the effective science-inquiry teaching approach from 6.4% to 79.6 % regarding the level of students' achievement. Traditional teaching methods are no longer effective to create long-term learning in students which could be implied with the decrease in the students' achievement scores for the controlled group from 55.65 to 51.2%, because the twenty first century students are evolving and demand immediate feedback and answers, by their own investigation abilities, not through lecturing (Healy 2000). The science –inquiry teaching approach is not an easy task that aims to make students move in the classroom, yet it is an active learning that totally engage the student mentally and physically (Enger & Yager 2001), the student in that case will be engaged in his own learning and this improvement will show in his achievement scores as per the experimental group scores that are not considered as high compared to other private schools where students usually begin their academic year with 65%, however show an improvement in the students' achievement an issue that was challenging by the beginning of the academic year.

Table 16 the T-test result of both experimental and controlled group

		Statistic	Bootstrap[a] Bias	Std. Error	95% Confidence Interval Lower	Upper
Controlled group Pretest	N	26				
	Mean	10.58	.01	.54	9.54	11.65
	Std. Deviation	2.730	-.085	.385	1.990	3.426
	Std. Error Mean	.535				
Controlled group Postest	N	26				
	Mean	53.69	-.05	3.05	47.96	59.81
	Std. Deviation	15.252	-.394	1.855	11.061	18.459
	Std. Error Mean	2.991				
experimental group Pretest	N	26				
	Mean	7.00	.02	.49	6.12	8.00
	Std. Deviation	2.561	-.074	.406	1.705	3.283
	Std. Error Mean	.502				
experimental group Postest	N	26				
	Mean	79.15	.22	3.45	72.38	86.04
	Std. Deviation	17.301	-.496	1.865	12.380	19.829
	Std. Error Mean	3.393				

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

To check the level of significance of the students' achievement scores, the t-test presents a 95% of confidence level the opportunity to compare the mean, the standard deviation for both samples of students with N equal 26 which is the number of students per class. The t-test as per the percentage shows that the mean of the pre-test is higher for the controlled group with 10.58 > 7.00 which shows some insignificance in the start of the experiment; on the other hand the standard deviation of the post-test for the experimental group (17.301) is higher than the standard deviation of the controlled group (15.252) which shows that the experimental group showed a significant improvement compared to the controlled group. The comparison of our two samples shows that the t value in the controlled group from the pre-test towards

One-Sample Test

	Test Value = 0 t	df	Sig. (2-tailed)	Mean Difference
Controlled group Pretest	19.754	25	.000	10.577
Controlled group Postest	17.950	25	.000	53.692
experimental group Pretest	13.936	25	.000	7.000
experimental group Postest	23.328	25	.000	79.154

the post-test with $t_1 = 19.754 > t_2 = 17.950$ and the difference in the mean between the pre-test and post-test is equal to 43.115. On the other hand the t value in the experimental group is increasing from the pre-test towards the post-test with $t_1 = 13.936 < t_2 = 23.328$ and the difference in the mean between the pre-test and post-test is equal to 72.154, greater than the mean difference of the controlled group. All of these comparisons show that the experimental group performed better than the controlled group which is significant with a p value $0.000 < 0.05$. So the results infer by the data analysis that the null-hypothesis is not true, therefore rejected in favour of the study with a level of confidence of 95% in the mean, It is therefore concluded, that there is an actual difference in the students' achievement scores between the ones receiving the science-inquiry teaching approach (that had an increase in their scores), and the ones receiving the science instruction as a lecturing (and had a decrease in the achievement scores, in favour of the experimental group receiving the science-inquiry teaching approach.

IV. 3-Students' Engagement Level

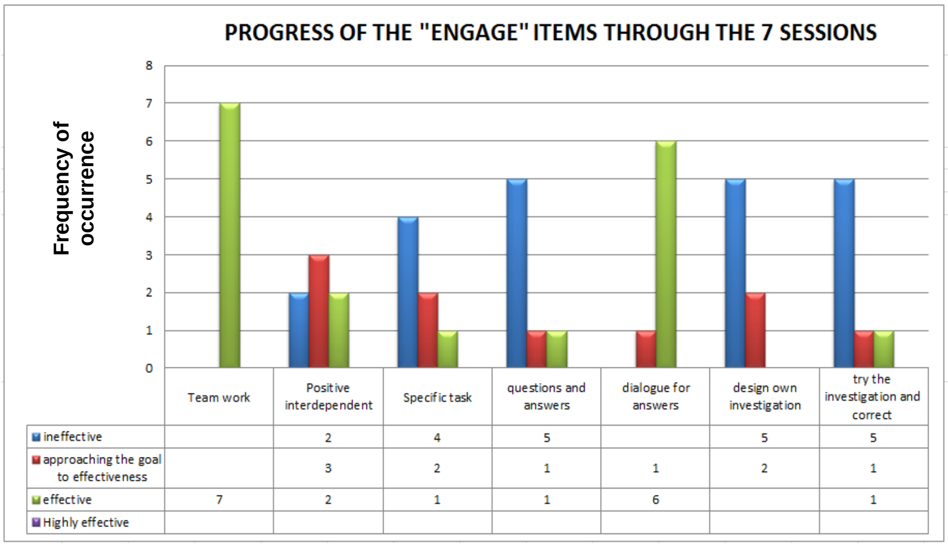
Qualitative analysis

During the fourth months and a half students were observed in both classes the one following the science-inquiry teaching approach and the other following the traditional lecturing teaching approach. The engagement items were detected in each of the science class session and recorded. After recording all the engagement factors, data was analysed and some pictures were taken to keep record of the engagement attitudes of the students during the hands-on activity and the lecturing class, shown in the methodology section in chapter three.

a- Engage

The chart 17 below shows the whole items of the students' engagement of the EIT tool and their level of occurrence in the classroom. The number of times each item occurred during the observation session transformed into percentage. However the analysis of the whole items given by the EIT tool will not be significant for our case study; therefore, as mentioned in the chapter 3 of the methodology the analysis of the EIT will highlight the main categories referred to “engage” and “explain.

***Chart 17**: The “engage” Items progress shown in percentage*



	Team work	Positive interdependent	Specific task	questions and answers	dialogue for answers	design own investigation	try the investigation and correct
ineffective		2	4	5		5	5
approaching the goal to effectiveness		3	2	1	1	2	1
effective	7	2	1	1	6		1
Highly effective							

The engage items as mentioned in the methodology section has the team work, the positive interdependence, the specific task, students’ dialogues in order to acquire the desired answers and try correctly a scientific investigations. The numbers 1 to 6 refer to how many times this specific item occurred out of seven observation sessions.

Teamwork in the EIT tool does not mean the seating arrangement only or the group work that most of the teachers have in mind; it is mainly working in groups on a task that could not be easily achieved individually; teamwork is the cooperative learning event that occurs between the students themselves and the teacher. The teamwork in the present tool is the cooperative learning and the engagement, it is the effectiveness rate in which students are collaborating and working on a specific task: the science inquiry within the five elements of the cooperative learning and the level of engagement (Johnson & Smith 2002). The team work shown in the table 17 above, has been effective in the seven observations sessions without however a huge progres into highly effective, for it is related to some other items such as the task, the positive interdependance as well as the investigation design of these items were not at all times effective. This type of result could infer a positive attitude and a willingness from the students for further learning, despite the fact that the choice of the inquiry task was four times out of seven not appropriate. The students showed motivation and team work and had in mind fininshing what was asked by the teacher. For this reason, the teacher's professional development is mandatory to help him acknowledge what is a science-inquiry task and what is not and continue to engage his students in science-inquiry.

As for the positive interdependance, the table 17 shows that throughout the seven observation sessions, the students were not able to understand what and how they could work a scientific invetsigation and accomplish a scientific task.In the three sessions that followed, their work was more efficient because of the teacher's efficient role in facilitating appropriatly how the work should be done. The positive interdependence reflects immediately the way students are directing their work, once they feel commited to the job. If students feel that the task they assigned to do is their own responsibility, they will ask and answer questions more critically : it is shown that the questions and answers during the sixth and seventh sessions were more efficient, and the students' dialogues are more directed towards the specific task required by the teacher : in six times out of seven the student-student dialogue was highly efficient, and they are able to design their own investigation and correct it : the learners could be efficient and highly efficient after the four months and a half of science-inquiry teaching approach.

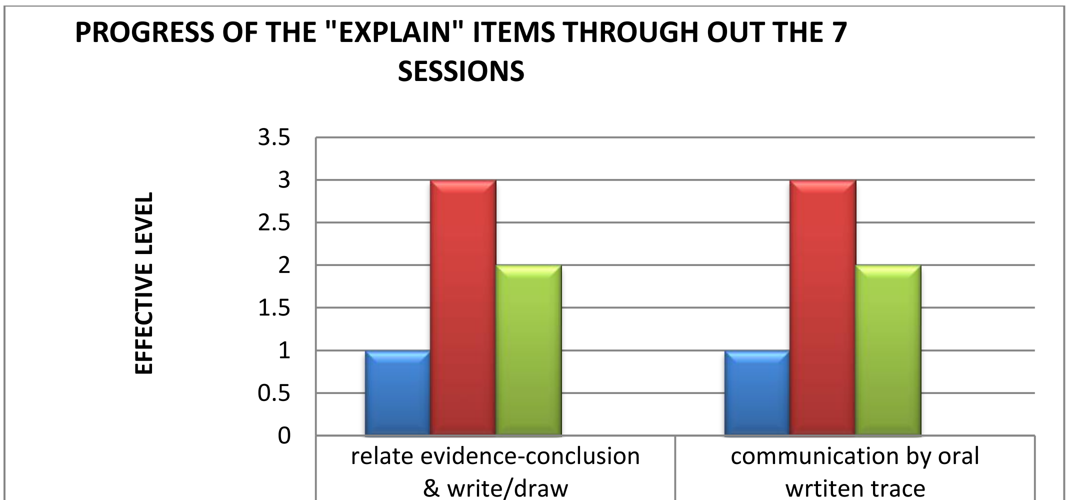
These findings align with earlier findings that cooperative learning and peer group is an empowering part of the engagement within the inquiry-based teaching and learning strategy. If the inquiry task was challenging for the students, the cooperative learning will encourage students' participation and learning and promotes positive social interactions, and will empower students' awareness about the positive interdependence that peers have towards each other inside the same scientific task. Edelson, Gordin & Pea (1999) affirm that the science- inquiry teaching approach creates a permanent desire for the student to learn through a perceive need to pursuit and answer open-ended questions generated by the learner himself or by his instructor. The choice of the science inquiry task is crucial as well as the choice of the investigation, the choice of questions and answers, and the choice of the specific tasks assigned to each group and how they are going to explore it together by peer work. At a higher level, the engagement in peer work in the science inquiry is a way to show to students that by learning together they can subsequently perform and achieve tasks unachievable as individuals alone (Kern & Moore 2007*).* Moreover, the table 17 above shows that in a specific task students were efficiently assigning each other to complete the investigation (f1=4,f2=2,f3=1).

Johnson (2002) defines cooperative learning within the science-inquiry teaching approach, as an instructional strategy that appeals benefit from the students' interaction to make the most of each student's own potential and increase their engagement. This engagement has proved according to research to be one of the items that could affect positively on the students' academic achievement, attitudes, social ability, retention, and self-esteem as well as their cognitive development (Piaget & Vygotsky's theories in Moore 2007). The Chart 17 above shows explicitly that students designed their investigation and tried their own investigation correctly. Moreover, the students are more capable to lead a dialogue as shown by the results of the chart 17 above (f1=1,f=6) and evolve to ask efficient questions and answers after five observations where the performance was inefficient at the starting point, the students approached to effectiveness in the next observation session and finally they were effective. Research has shown that students are highly engaged when they work in a well structured science-inquiry with a cooperative-learning environment than in an individual setting of work, yet the observation did not find all the items of the cooperative learning required. The written trace of the controlled group showed no creativity neither colors in the written expression which could infer some demotivation in the subject, on the other hand the written trace of the experimenal group showed engagement and commitment form the students' part (Table 12- 13 appendices).

b- Explain

The Chart 17 below shows the number of occurrence of the “explain” item during the seven observation sessions. The first one relates evidence and conclusion trough writing or drawing, and the second one is communication by oral and/or written trace. In both cases students did not reach the highly effective level. This result is normal as for the explain items are more related to cognition and to verbalization, and in a way considered a challenge for Arabic and non-native english speakers to express themselves orally or even written.

The “ Explain”’ percentage engagement item shown in the Chart 17



	relate evidence-conclusion & write/draw	communication by oral wrtiten trace
ineffective	1	1
approaching the goal to effectiveness	3	3
effective	2	2
Highly effective		

The Chart 17 above shows that students were progressing in parallele with their ability to communicate orally and written as well as by the way they wrer relating evidence to conclusion and then writing it down without however reaching the highly effective result.Both items were ineffective and approaching effectiveness in three observation sessions and effective in the last observation sessions. In the “explain” item, students should prove a specific kind of higher level of thinking that includes internalizing knowledge and facilitating science understanding. Moreover, the results showed that the level of effectiveness of the mentioned item improved but did not reach the perfect result. This kind of outcome would have been expected when it comes to non-native speakers that use the English language to express a complicated scientific concept (NGSS 2013). On the other hand, during the inquiry-based teaching approach, the teacher was continuously scaffolding and orienting his students towards autonomy, and students were at a certain level able to demeanour the scientific investigation and to collect the evidence from a variety of sources, through individual or peers work. Students were empowered to develop certain explanations from the data collection, and had to communicate and defend their conclusions in front of others, but yet did not reach the total independence required as per Dean (2012) and Windham earlier in (2005). The redundant result with the “engage” analysis infers that these students need to be followed during a whole year for a perfect improvement of their engagement level.

The results given by the observation tool are group work results and can not give us a transparent and an honest look on the students’ individual work, unless the students are going to be interviewed on one to one basis or video-taped, and in both cases some cultural facotrs restreined the researcher from doing this move yet it could have been very usufual for results’ interpretation. On the other hand, these results gave us an idea that with regular follow-up and with an effective implementation of the science-inquiry teaching approach, students could make a progress in the engagement level towards effectiveness and this is the main purpose of a science reform in schools.

In addition, science-inquiry teaching approach could have been in a certain way a vehicle for teaching science and improving the english language as well, as according to earlier researches, the learner during these seven observation sessions had to go through a complex thinking process to try to convert the researchable question into applicable science knowledge in a different language finding the right vocabulary words so he could be able to explain the scientific concept through a written trace.

IV. 4-Quatitative Analysis of Both Engagement Items

The quantitative analysis of the engagement items such chosen for the case study "Engage" item and "Explain" items will give the research' results more accuracy and significance. The items were gathered and percentage was calculated to check in percentage the frequency of occurrence of each sub-item. Most of the "Engage" sub-items as shown in table18 were approaching to the effectiveness with 85.7% and some others were effective with the same percentage 85.7%, compared to a percentage of 71.4%. The table 18 below shows only that each sub-item of the "Explain" item was at a 100% at all moments: ineffective, approaching and effective. These results quantitatively does not reflect the students' improvement and not even the students' interaction in the classroom, therefore, the engagement item is better described qualitatively.

Tab 18. Engage Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
engage item qual 2	7	100.0%	0	.0%	7	100.0%
ineffective	5	71.4%	2	28.6%	7	100.0%
approaching the goal to effectiveness	6	85.7%	1	14.3%	7	100.0%
effective	6	85.7%	1	14.3%	7	100.0%
Highly effective	0	.0%	7	100.0%	7	100.0%

Tab 19. Explain Case Processing Summary						
	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
explain item qual	2	100.0%	0	.0%	2	100.0%
ineffective	2	100.0%	0	.0%	2	100.0%
approaching the goal to effectiveness	2	100.0%	0	.0%	2	100.0%
effective	2	100.0%	0	.0%	2	100.0%
Highly effective	0	.0%	2	100.0%	2	100.0%

To conclude, Lam & Wong (2004) affirm in their research that the inquiry-based strategy increases the students' engagement, diminishes their frustration, and improves later their scores as per the analysis of the current case study. On the other hand, Yair (2000) argues that some other multitude aspects could influence on students' overall engagement such as external contexts, students' background, and instructional variables. These items could be the topic of a future study.

Chapter V
Discussion and Limitations

V-1 Discussion

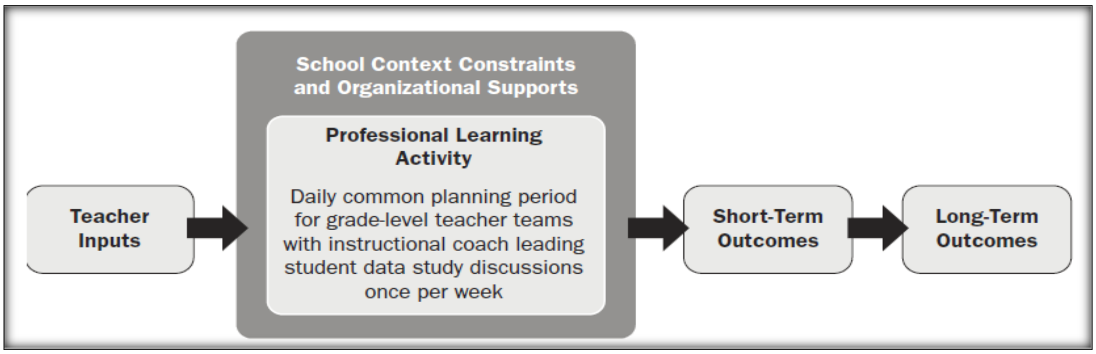
The purpose of the study is to examine the effects of science-inquiry-teaching approach on adolescent UAE students' science achievement and engagement in science in a four months period of effective teaching throughout the academic year in a governmental school following the reform in science and applying the science-inquiry teaching approach as the only instructional strategy.

Considering in the current study, the dependent variables as of the students' achievement and their engagement level, the study passed by several steps such as testing the students' level with a pre-test about the content and skills that students possess, later on a post-test done in two rounds to assess quantitatively the effectiveness of the science-inquiry teaching approach on the students' achievement. The study evaluated the engagement level of the students through classroom observation and using the EIT tool designed for the present study, tested and retested before being used in the classroom observation on a qualitative level.

Most of the emirates government schools' students are emirates nationals and used on direct instruction or on teacher-centred approach. The transition from teacher-centred towards student-centred approach in an inquiry-based teaching process seems difficult for both students and teachers in the study without an intensive teacher professional development preceding the case study actual field work. Despite of all the professional development that might teachers do and attend, those teachers might go through an uncertainty that all of these professional sessions are not applicable in their classroom (OCED 2009). Therefore, guided inquiry seemed a better approach for the teachers in the government schools who are not experienced in leading a scientific approach full of hands-on activities (National Research Council, 2000). Because the teacher's role in this case study is very important, somehow his role is mandatory in causing the required change and to facilitate it. This direct contact with the students has a certain impact on the students' cognition as well as considered an effective characteristic to empower students' inquiry-skills (Koskal 2012). In addition, considering the 6th grade students' age ability, they are considered at some degree incapable when it comes into dealing with abstract concepts, and have a partial attention span; therefore 6th graders need direct guidance (Igelsrud & Leonard, In Brickman1988). For this reason, the guided-inquiry seems to be a convenient teaching strategy for the novice teachers taking the science-inquiry teaching approach training for the first time and for the students since most of them might be in their concrete operational phase (Turgut, Baker, Cunningham, & Piburn, 1997 in Ayavaci 2012). At the long term, the science-inquiry teaching approach might be a transition to open the path to a greater interdependence promoting positive engagement attitudes and improving their overall achievement (Germann et al., 1996).

The results of the students' engagement in the current study were not very promoting at the beginning of the case study, neither the teacher's performance in the teaching and learning process. The professional development program designed for the teacher had specific goals oriented towards the progression of the science-inquiry and enhancing the way teachers could give out the science concepts in order to improve the understanding of the science content without any misconceptions. The teachers' attitudes towards the case study as well as their conviction about the science-inquiry teaching approach's efficiency could be one of the main influencing factors on the students' engagement as well as on their final achievement. Therefore the teachers' affective domain and their attitude towards the science-inquiry teaching approach was not considered as a variable in this current study yet it could be a major barrier towards the completion of the research and a major barrier towards the outcome desired by the study. The earlier study realized in Qatar in 2012, had deceiving results regarding the engagement of the students in the science classes and in the students' science achievement; in the discussion section, the author mentioned that one of the major factors that influenced the unexpected results could have been the teachers' attitude towards the science approach used to teach the students. The model below (F.1) shows that in order to evaluate the teachers' professional development tools and programs; it all begins with his personal input within the science lesson (Santoro 2011).

F.1. Simple Logic Model for Use in Evaluating Teacher Development Approaches, Tools, or Programs (Santoro 2010).



To sum up, high quality teachers are required to implement the teaching and learning process especially when it comes to reform, therefore they are the ones who need to understand more than others , how children's cognitive abilities develop, and how modelling and experiments could be used in science to help building correctly the science concept (Harlow 2010). Seeking for quality in teachers is important in shaping the learning growth in the students' minds across the educational system (Ingersoll 2007). Hence, first by increasing the number of science teachers across UAE with the positive willingness and the confidence to be fully engaged in model-based inquiry in their classrooms may enhance the students' development, conceptual science content knowledge and will help the students to acquire the critical thinking of science and the science skills and by consequence a higher engagement level as well as scores.

The other significant finding of the study indicates that science teaching and learning have a substantial positive effect on the students' science achievement as well as their engagement once effective, based on models and applications and hands-on, congruent with the findings of Bunce &Gabel (2002) and Kenyon et al. (2008). Earlier studies results on the same topic showed that there is a relationship between the increase of the level of engagement and the cognitive involvement of the students in different ways which affect their achievement on the long term (Harlow 2010); The NSTA (2011), states that to evaluate the efficacy of the science-inquiry teaching approach each evaluation tool should pass by the following process: first adapt the evaluation tool used in the classroom observation according to the local context expectations. Second do the post- evaluation of the tool to avoid any kind of discrepancies between the observation and the results that means check the coherence and the reliability of the tool. Moreover, Taylor (2011) writes that historically, the improvement of the students' academic achievement is related to their high engagement in their own learning, their positive social behaviours, as well as their sense of belonging (Willms, Friesen, & Milton, 2009) & Windham (2005).

Furthermore, Willms & Milton (2009) list five elements necessary to increase the students' engagement : 1) the creative environment ; 2)the teaching practices; 3)make the learning meaningful for students; 4) increasing the quality of the teaching & learning; 5) assessing the learning choice of the instructional strategy and apply it effectively. For this reason, The EIT tool will concentrate on the environment that should be creative, the choice of each task that is aligned with the objective of the lesson to improve the teaching quality, and with this adequate follow up, students will be assessed continuously by a written trace by the end of each session.

Traditionally the students' engagement is a term that equals: "hands-on" and minds-on". In the NGSS (2013), it involves the language use as well as the scientific sense making. During their transition from the inexperienced scientific conceptions to the scientific sense-making process, the students need to be engaged in an intense language-based communication process that requires their participation in science discourse in their classroom (NGSS 2013); for this reason, they need to read, write and visually represent their explanations and models. The case study evaluated the effectiveness of the students' level of engagement, by checking mainly both items engage and explain. These two items could evaluate not only the hands-on or the minds-on, but hands-on coupled with the speech and the listening pushing students to be fully engaged in reasoned argumentation with peers so they could refine their ideas, and reach the required shared conclusions.

Moreover, the results of the case study showed that the written trace and the engaging factor both were improving after the 3rd session of effective teaching and learning. In other term, students who followed the science-inquiry teaching approach performed higher and reported high structured skills in the class material, even deeper interest in all the strategies used in the classroom of science and preference in the academics more than other students from the same grade level not following the science-inquiry teaching approach. Students who had high achievements looked more motivated and avoided looking academically incompetent, and showed higher cognitive abilities that were reflected on their science achievement and their level of engagement within the classroom. These findings are similar to those reported in studies of college students (DeBacker & Crowson 2006 in Ayvaci H.S., & Bakirci H. 2012). Arguably, this pattern could suggest a future orientation towards a well-ordered and predictable educational environment that could infer a range of positive behaviours with the fact of being a good student learner, and performer. It could also suggest somewhat a simplistic stand towards learning in more adaptive strategies ($pt<.001$). Findings were largely consistent with the case study expectations. It inferred that the null hypothesis in this case study is rejected and the data supported both questions given by the study, despite the fact that this school may lack the equipment and resources to offer the perfect scientific inquiry experiences to their students toward schooling (OECD, 2006).Despite the small sample chosen for the present case study, the results were consistent with previous research (Lee et al., 2004; Wu & Hsieh, 2006 in Wells 2009), and most of the results pointed out on the effectiveness of the science-inquiry teaching approach on improving the students' achievement and their level of engagement in the science classes. Some further research could investigate the influence of other pertinent factors on both the students' achievement and their level of engagement such as class or teacher, and school level, gender and parents' educational background and preferences even the socioeconomic background that could be one of the main variables that could influence on scientific literacy for future generations. An earlier study in Turkey showed that students' attitudes toward science were found to be a significant predictor of students' science achievements (Sabah & Hammouri 2010).

To conclude, UAE students had a quite low achievement in science in their last international test compared to their peers in different western countries (TIMSS, 2006) with the highest performance between the countries of the Middle East (OCED 2009). Thus, science-inquiry teaching approach might be a way to improve the students' learning if it becomes a prevailing strategy in the science classes on the long run in the United Arabs Emirates. The finding of this study could be a good starting point to implement the inquiry-based as teaching practices in the Unites Arab Emirates educational system. From education policy perspective, the inquiry-teaching approach could be a main topic to consider in the teachers training institutions as well as in the in-service training programs of the Ministry of Education in the UAE.

V-2-Limitations

As a part of the federal government, public schools in the UAE are not easily cooperative when it comes to taking part of a research study. For instance, for cultural and ethical reasons, men do not have the permit to observe a girls' classroom and vice versa. This is the major reason why the present study has chosen the girls' schools as the research sample. Some solutions could have been videotaping or a gender related observer, yet videotaping was not an option for cultural reasons.

Science achievement is typically measured quantitatively by standardized tests administered at national and international levels for several reasons (NGSS 2013): First, standarized tests are designed by professional tests' developers in order to produce reliable results in the specific science content the teacher is exploring with the students, and covers a wider range of students' demographics regardeless the type of textbooks the teacher is using. Second, standraized tests measure students' achievement and performance, and these measures provide a strong access to large data-sets for powerful reliable and valid statistical analysis and research purposes. Third,The standarized tests can cover the three content areas of science : physical, life science and earth and space sciences as they are designed in a multiple-choice test (Mujis & Reynolds 2012).Fourth, the standarized tests will allow comparison of the results with the national norms. Yet, standarized tests have disadvantages such as they only provide a general picture of how demographic variables are related to science achievement, and ignore students with individualized program (IEP), or learning disability or emotionnaly disturbed (ED), therefore the study tried as much as possible to have a sample of classes with no students with (IEP) which means that the results of this study could not be a proof on the effectiveness of the science-inquiry teaching approach on the students with special needs regarding acheivement progress . In addition, these types of tests have the potential to reinforce positive and negative stereotypes of certain demographic groups (Rodriguez 1998). Finally, these standardized tests will not analyze interactions between variables of race/ethnicity and socioeconomic status, which is not the purpose of the study so ignoring this factor won't influence on the data collection results.

Therefore, despite the positive findings of the study it is necessary to underline the fact that in order to have a higher science achievement in a disadvantaged school, the government needs to provide all the support needed which, in turn, may help the students to succeed academically. The nature of instruction in inquiry-based science is considered a decent approach for non-native English learners, regardless of classroom type. Students can explore, using specifically chosen materials and could be able independently manoeuver their scientific investigation and work in small groups.
The diversification of the science-inquiry activities provide a diversity of approaches that can benefit students who learn linguistically in different ways. Students learning English and science could share their experiences and findings orally if the time provided for them is enough, because science is one of the areas considered conductive of English language development (Chamot &O'Malley 1994).

Through the process of exploration, students have opportunities to discuss and learn about the context for content learning, this combines with the practice of explaining the process during an experiment or explicitly students' can expose their logical thinking process about how a conclusion was reached, and it combines to further development of their cognitive abilities and linguistic proficiency at all levels. An integration of science and language learning (Fathman, Quinn, & Kessler 1992) is viewed as one way to enhance overall skills of English language in science. The Cooperative learning used in this present study as a part of the science-inquiry teaching approach, opens the opportunity for students to work in pairs or in small groups, empowering their expressive skills. In addition by working with others in hands-on activities students feel comfort and confidence with peers rather than dealing with a facilitator teacher. Working with peers could even empower the questions and answers and could help translating the scientific concept and making the learning process a team effort (Rosebury, Warren, & Conant 1992).

Chapter VI
Conclusion

Conclusion and Study Recommendations

In conclusion the science-inquiry was effective in improving both the students' achievement as well as their engagement level because students reached their comfort level. First, they explored, defined and tested their hypothesis, second they tried more than one probable answer through the cooperative learning work strategy; therefore their attitudes were positive regarding the science concept as well as the learning process.

The results of this study were encouraging, and demonstrated that science-inquiry teaching approach promoted effectively both research items. Students were more able to ask effective questions and able to plan and begin a scientific investigation. The intervention with the trained-teacher's work was positive and guided the teacher to student-initiated inquiry continuum and improved their cognitive ability particularly from low achievement to higher achievement regardless their low English proficiency. Yet it is important to note that data was collected from one point of view. The main issue of this study is to assess its sustainability over time in order to be able to generalize its results on the local level, so further studies on students' achievement could be done in the field, further research may remedy this kind of concern.

The sample chosen for this current study is considered a small sample; yet it showed positive improvement of the students' engagement level therefore, a larger pool of students should be added to collect more data and for more accuracy in the results, and further research could prove even stronger the students' ability to conduct inquiry in an elicitation context.

Future studies could also shed more light on the relationship between language development in the areas of reading, language arts and writing and science- inquiry teaching instruction. Studies already examined the relationship between teacher's professional development, students' assessment, science notebooks writing and students' improvement. Further studies could be on the correlation between science-inquiry teaching approach and the science achievement in the boys and the girls as well as the difference between both scores or to what extent science-inquiry teaching approach could decrease the level of drop-outs in the boys' government schools.

References

References

- ADEC foot print recruiting hiring (2013). Available online **:**http://www.footprintsrecruiting.com/forum/adec/7245-adec-now-hiring-up-to-1200-teachers-for-august-2013
- American Association for the Advancement of Science (1993). Benchmarks for science literacy. New York: Oxford University Press.
- American Association for the Advancement of Science (AAAS) (1990). Science for all Americans. Washington, D.C.
- American Association for the Advancement of Science (AAAS) (1965). The science technology engineering and Mathematics (STEM) Education and Skills in Queensland. Accessed on 23rd August 2008 and available online: http://education.qld.gov.au/projects/stemplan/docs/stem-discussion-paper.pdf
- Anderson, R. D. & Mitchener, C. P. (1994). Research on science teacher education. In D. L. Gabel (Ed.), Handbook on Science Teaching and Learning pp. 3-44. New York: MacMillan
- Anderson, R.D. (2002). Reforming Science Teaching: What Research says about Inquiry. *Journal of Science Teacher Education, Vol 13*(1). pp.1-12.
- Anderson, R. D.,&Helms, J. V. (2001). The ideal of standards and the reality. *Journal of Research in Science Teaching,* Vol 38 (1). pp. 3-16.
- Archibald, S. & Coggshall, J.G. & Croft, A. & Goe, L. (2011).ETS High-Quality Professional Development for All Teachers: Effectively Allocating Resources. Policy review.
- Areepattamannil,Sh. (2012). Effects of **Inquiry**-Based **Science** *Journal of Educational Research* **Instruction** on **Science Achievement** and Interest in **Science**: Vol. 105(2). pp.134-146.
- Atar, H. Y.& Atar, B. (2007). Examining the Effects of Turkish Education Reform on Students' TIMSS 2007 Science Achievements. Vol 1. pp. 2632-2366.
- Ausubel, D. (1988). An Approach to Teaching Higher Order Thinking Skills of Stanley Ivie. *Journal of Educational Psychology*, Holt, Rinehart & Winston, New York, Vol 82(1). Pp.1-10.
- Ayvaci, H.S. & Bakirci, H. (2012). Analysis of Science and Technology Teachers' Views about Science Education Process in Terms of 5E Model. *Journal of Turkish science education*. Vol 9(2) .pp.132-151.
- Barnett, R. (2005). Linking research and teaching: exploring disciplinary spaces and the role of inquiry-based learning. Reshaping the University: New Relationships between Research, Scholarship and Teaching. McGraw Hill / Open University Press, pp.67-78

- Bligh, D. A. (2000). What's the use of lectures? Jossey-Bass publishers. San Francisco- New York.
- Bloom, B.S. (Ed.) & Engelhart, M.D. & Furst, E.J.& Hill,W.H. & Krathwohl, D.R. (2012). Taxonomy of educational objectives.[Accessed on 12th August 2013]. Available at: http://www.icels-educators-forlearning.ca/index.php?option=com_content&view=article&id=52&Itemid=67.
- BouJaoude, S. & Dagher, Z. (2009). Status of Science Education in Arab Countries. Paper presented at the International Science Education Conference 2009, Singapore, from Nov. 24-26
- Bransford J.,& Brown A. & Cocking, R. (1999). How People Learn: Brain, Mind, Experience and School. Washington DC: National Academy Press.
- Bransford, J.& Brown, A. & Cocking, R. (Eds.) (1999). How People Learn: Brain, Mind, Experience and School. Washington DC: National Academy Press.
- Bonwell, C.& Eison, J. (1991). Active learning: Creating excitement in the classroom. ERIC Higher Education Report Vol 1. Washington, DC: George Washington University. [Accessed on July 25th 2013]. Available at: http://www.ed.gov/databases/ERIC_Digests/ed340272.html.
- Brickman, P. (2009).Effects of Inquiry-based Learning on Students' Science Literacy Skills and Confidence. *International Journal for the Scholarship of Teaching*. Vol. 3(2). Available at: http://www.georgiasouthern.edu/ijsotl
- Brown, H. (2004). Walking into the unknown: Inquiry-based learning transforms the English classroom. *The English Journal* Vol 94(2). pp. 43-48.
- Browne, M. N.& Keeley, S.M.(2012).Asking the Right Questions: A Guide to Critical Thinking, 10/E. Longman. Bowling Green State University.pp.1-192
- Chalufour, I. & Worth, K. & Clark-Chiarelli, N. (2003). Science teaching and environment rating scale*.* Unpublished manuscript.
- Chalufour, I. (2010). Learning to Teach Science: Strategies that Support Teacher Practice Education Development Center, Inc. Newton, Massachusetts.[Accessed on July 2012].Available at: http://ecrp.uiuc.edu/beyond/seed/chalufour.html
- Chalufour, I. & Worth, K. (2005). Exploring water with young children. St. Paul, MN: Red leaf Press.
- Chamot, A. U. & O'Malley, J. M. (1994). *Implementing the cognitive academic language learning approach. Reading, MA: Addison-Wesley*.
- Chatterji, M. (2004). Evidence on "What Works": An Argument for Extended-Term Mixed-Method (ETMM). *Evaluation Designs Educational Researcher*. Vol 33. pp. 3-13.
- Chickering, A.W. & Gamson, Z.F. (1987). Seven principles for good practice in undergraduate education. *Washington centre news.pp.1-7*

- Clarke, A. (2005). Evaluation research: an introduction to principles methods and practices. Great Britain. [Accessed on 24th September 2012] available at: http://books.google.ae/books?hl=en&lr=&id=4_FTxELbSbwC&oi=fnd&pg=PR6&dq=descriptive+evaluative+research+method&ots=g8aYQKFZlL&sig=WkirifWsWIbDH9rDW6yP3EcvPqY&redir_esc=y#v=onepage&q=descriptive%20evaluative%20research%20method&f=false
- Cohen, J.W. (1988). Statistical Power Analysis for the Behavioural Sciences. Hillsdale NJ: Lawrence Erlbaum. *Department of Education, Training and the Arts (2007).*
- Dahmashi, M. (2007). Guide for the students and staff working in the Field of special education. Jordan. Dar Al-Fikr.
- Al Muhairi, J. & Al Karam, A. (2010). Dubai school of inspection report bureau .DSIB
- Enger, S. K. & Yager, R. E. (2001). Assessing student understanding in science: A standards-based K-12 handbook. Corwin Press, Inc. Thousand Oaks, CA. English learners, grades 4–8. NCBE Program Information Guide Series.
- Fathman, A. K.& Crowther, D. T. (2006). Science for English language learners: K–12 classroom strategies. Arlington, VA: NSTA Press.
- Fathman, A. K. & Quinn, M. E. & Kessler C. (1992). Teaching science to English learners, grades 4-8.*NCBE program information series*. No 1. [Accessed on 30th September 2013]. Available at: http://www.ncela.gwu.edu/files/rcd/BE018764/PIG11.pdf
- Federal Law No. 29/2006 on the Rights of Persons with Special Needs (2006). United Arab Emirates
- Fielding-Wells J., & Makar. K. (2008). Using Mathematical Inquiry to Engage Student Learning within the Overall Curriculum. 11th International Congress of Mathematics Education, Monterrey, Mexico.
- Greene, J.C.& Caracelli, V.J. & Graham, W.F. (2011) . Toward a Conceptual Framework for Mixed-Method Evaluation Designs Educational Evaluation and Policy Analysis. From 1989 first version. Vol 11.pp.255-274.
- Atar H.Y. & Atar.,B (2012). Investigating the multilevel effects of several variables on Turkish students' science achievement in TIMSS. *Journal of Baltic science education* Vol II (2).
- Harlow, D. B. (2010). Structures and Improvisation for Inquiry-based Science: A teacher's adaptation of a model of magnetism activity. Science education, Vol 94(1).pp.142-163. [Accessed on 28th August 2013]. Available at: http://www.citeulike.org/user/dharlow/article/6386707
- Harmer, A.J.& Cates, W.M.(2005).Designing for Learner Engagement in Middle School Science: Technology, Inquiry, and the Hierarchies of Engagement. Lehigh University, 5th ed.

- Harrow, A.J. (1972). A taxonomy of the psychomotor domain: A guide for developing behavioral objectives.New York: David McKay.
- Hart, K.& Schumacher, R. (2005).Targeting investments with children. Fighting poverty when resources are limited. *National Bureau of economic research.Ptintes in United States. Available at:* http://books.google.ae/books?id=YKrbp2II8MC&pg=PA55&lpg=PA55&dq=%E2%80%A2%09Hart,+K.%26+Schumacher+R.+(2005):+Making+the+Case&source=bl&ots=0sXg8xUr9f&sig=SCzF_ei8KFp2LN3DPjwYfSxslUA&hl=en&sa=X&ei=c7JiUr_AN4PZtAba3oAI&ved=0CC4Q6AEwAA#v=onepage&q=%E2%80%A2%09Hart%2C%20K.%26%20Schumacher%20R.%20(2005)%3A%20Making%20the%20Case&f=false
- Hodson, D. & Hodson, J. (1998). From constructivism to social constructivism: A Vygotskian perspective on teaching and learning science. *School Science Review*. Vol 79(289).pp. 33-41. [Accessed in July 30th 2013]. Available at: http://www.cpre.org/images/stories/cpre pdfs/sixnations final.pdf.
- Hudson, R. (2007). Language networks: The new Word Grammar. Oxford: Oxford University Press. Improving Head Start Teacher Qualifications Requires Increased Investment. Center for law and social policy: head start series. Vol 1. pp.1-16. Available at: http://www.leg.state.vt.us/PreKEducationStudyCommittee/Documents/hs_policy_paper_1.pdf.
- Ingersoll, R. M. (2007). *A comparative study of teacher preparation and qualifications in six nations*. (CPRE Research Report RR-57). Retrieved from Instruction: A teacher's adaptation of a model of magnetism activity. *Journal of Science Education*, Vol 94.pp.142–163.
- Johnson, D. W. & Johnson, R.T. (1999). Making Cooperative Learning Work, Theory into Practice. Vol.38(2). pp. 67-73
- Johnson, D. W.& Johnson, R. T.& Smith, K. (2007).The State of Cooperative Learning in Postsecondary and Professional Settings," in Svinici, M., & Sweet, M. (Eds.), *Educational Psychology Review.*
- Johnson, D. W. & Johnson, R. T. & Holubec, E. J. (2004). Cooperation in the Classroom: Relationships between Engineering Student and Faculty Demographics and Stakeholders Working to Affect Change. *Journal of Engineering Education*. Vol 93 (2). pp. 139-151.
- Johnson, D. W. & Johnson, R. T. & and Smith, K. A.(1998). Cooperative Learning Returns to College Change. Vol 30 (4).pp. 26-35.
- Kemnitzer, S. (2005). Working to Affect Change. Journal of Engineering Education. Vol 93 (2).pp. 139-151**.**

- Kern, A. L. & Moore, T.J. & Akillioglu, F. C. (2007)**:** Cooperative Learning: Developing an Observation Instrument for Student Interactions. Vol 1. pp.1-17
- Kessler, C.(1992). Cooperative Language Learning: A Teacher's Resource Book. *RELC Journal* Vol 25. pp. 150-155
- Krathwohl, D.R.& Bloom, B.S. & Masia, B.B. (1964).Taxonomy of educational objectives: The classification of educational goals. Handbook 11: The affective domain. New York: David McKay.
- Kuh, G. D. (2003). What we are learning about student engagement from the NSSE. Change. Vol 35 (2). pp. 24-35.
- Kuh, G. D. (2007). What student engagement data tell us about college readiness? Peer Review, Vol 9(1) .pp. 4-8. Available at: http://www.aacu.org/peerreview/pr-wi07/documents/PRWI07_Kuh.pdf
- Kuh, G. D. (2009). The National Survey of Student Engagement: Conceptual and empirical foundations. *New Directions for Institutional Research.* Vol141.pp. 5-21.
- Kyriacou, Ch. (2009).Effective teaching in schools theory and practice 3rd ed. Nelson Thornes publication. United kingdom
- Lam, E. (2004). Promoting Inquiry Based Learning: Strategies in the Classroom. Amdon consulting.pp.1-6
- Liang, L. & Richardson, G. M**.** (2009).Enhancing Prospective teachers' science teaching efficacy beliefs through scaffolded, student-directed inquiry. *Journal of Elementary Science Education* Vol 21(1). pp. 51-66.
- Makar, K. (2008). A Model of Learning to Teach Statistical Inquiry. Paper presented at the Joint IASE/ICMI-18 Study, Monterrey, Mexico.
- Marzano, R.J.& Pickering, D.J.& Pollock, J.E. (2001). Classroom instruction that works research-based strategies for increasing student achievement. United States of America. High impact Available at: http://tedd.net.au/pdfs/Chapter_9_Science_teaching_strategies1.pdf
- McCarthy, C. B. (2005). Effects of thematic-based, hands-on science teaching versus a textbook approach for students with disabilities. *Journal of Research in Science Teaching,* Vol 42*(3)*.pp.245-263
- McLoughlin, C.& Lee, M.J. W. (2008). The Three P's of Pedagogy for the Networked Society: Personalization,Participation, and ProductivityInternational. *Journal of Teaching and Learning in Higher Education 2008*, Vol 20(1).pp. 10-27.Available at: http://www.isetl.org/ijtlhe/
- Minner, D.D & Levy, A.J.& Century, J. (2009). Inquiry-Based Science Instruction—What Is It and Does It Matter? Research synthesis Years 1984 to 2002. *Journal of research in science teaching*. Vol 20. pp.1-24.

- American Association for the Advancement of Science (1993). *Benchmarks for science literacy*. New York: Oxford University Press.
- Mujis, D. & Reynolds, D. (2011).Effective teaching evidence and practice 3rd ed. Sage publication Los Angeles.
- Mujis, D.& Reynolds, D. (2012) : effective teaching evidence & practice . 3rd ed. sage publications los Angeles.
- National Research Council (1996). National science education standards. Washington, DC: National Academy Press.
- National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.
- National Research Council (2000). Inquiry and the national science education standards: A guide for teaching and learning. Washington, DC: National Academy Press
- National Research Council (2004). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: National Academy Press.
- National Research Council (NRC) (1996). National science education
- National Research Council. (2007). Taking science to school: Learning and teaching science.
- National Survey of Student Engagement (NSSE) (2008). National Survey of Student Engagement: Quick facts. Retrieved from the National Survey of Student Engagement website available at: http://nsse.iub.edu/html/quick_facts.cfm
- Next generation of science standards (2013). [Accessed on June 2013]. draft available at: http://www.cesa7.org/science/documents/DesigningProfessionalDevelopmentfortheNGSS.pdf Designing Professional Development for the NGSS J:\Assessment\Science\2012-13\Science Advisory Council\Feb. 14\Designing Professional Development for the NGSS.docx
- No Child Left Behind Act (2001), P.L.107-110.
- OCED (2009). Cambridge, UK: Cambridge University Press of schools: Needed research. *Journal of Research in Science Teaching of education.*Vol 38, pp.3–16.Available at: http://www.oecd.org/newsroom/43125523.pdf

- Onwuegbuzie, A.J. (2007). Students' Perceptions of Characteristics of Effective College Teachers: A Validity Study of a Teaching Evaluation Form Using a Mixed-Methods Analysis. *American Educational Research Journal*. Vol 44. pp. 113-160.
- Piaget, J. (1952). The Child's Conception of Number. *London: Routledge & Paul Press: psychological bases of Science—A Process Approach (SAPA)*.Washington, DC.
- Richardson, G. M. & Liang, L. (2008).The use of inquiry in the development of preservice teacher efficacy in mathematics and science. *Journal of Elementary Science Education* Vol 20(1). pp.1-16.
- Rodriguez, A. J. & Berryman, C. (2002). Using socio-transformative constructivism to teach for understanding in diverse classrooms: A beginning teacher's journey. *American Educational Research Journal* Vol 39 (4).pp. 1017–1045.
- Rosebery, A. S. & Warren, B. & Conant, F. R. (1992). Appropriating scientific discourse: Findings from language minority classrooms. *The Journal of the Learning Sciences*. Vol 21.pp. 61–94.
- Rosebery, A. S. & Warren, B. (2008). Teaching science to English language learners: Building on students' strengths. Arlington. VA: NSTA Press.
- Rosebery, A.S.& Puttick, G.M. (1998). Teacher professional development as situated sense-making: A case study in science education. *Science education journal.* Vol 82 (6).pp.649-677
- Sabah, S.& Hammouri, H. (2010). Does subject matter matter? Estimating the impact of instructional practices and resources on student achievement in science and mathematics: Findings from TIMSS 2007. *Evaluation & Research in Education, Vol 23*. pp.287-299.
- Sadowski, M. (2006). Core Knowledge for PK-3 Teaching: Ten Components of Effective Instruction FCD Policy Brief. Vol 5. pp.1-11.
- Santoro, D. (2010). Teaching to Save the World: Avoiding Circles of Certainty in Social Justice Pedagogy. *Philosophy of Education 2009. Urbana, IL: Philosophy of Education Society*.pp. 241-249.
- Santoro, D. A. (2011). Good Teaching in Difficult Times: Demoralization in the Pursuit of Good Work. *American Journal of Education*. Vol 188 (1). pp.1-23.
- Schwartz, D.L. & Bransford, J.D. (1998). A time for telling. Cognition and Instruction, Vol16 (4).pp 475-522. American Educational Research Association.New York.
- Slavin, R. (2012).Educational psychology theory and practice 10th ed . Pearson New jersey standards. Washington, DC: National Academy Press.
- Slavin, R. E. (1991). Synthesis of Research on Cooperative Learning. *Educational Leadership*. Vol 48 (5).pp.71-82.

- Strydom, J. F.& Basson, N. & Mentz, M. (2009). Effects of Inquiry-based Learning on Students' Science Literacy Skills and Confidence. *International Journal for the Scholarship of Teaching and Learning*.Vol 3 (2) .pp. 1-48. [Accessed on 29th August 2013]. Available at: http://www.georgiasouthern.edu/ijsotl
- Strydom, J. F.& Basson, N. (2010). CHE-UFS Student Engagement Research Project (Report for the Council on Higher Education. Bloemfontein, South Africa: University of the Free State.
- Taylor, L. & Parsons, J. (2011). Improving Student Engagement teaching science in grades K–8. *Current Issues in Education National Academies*, Vol.14(1). Available at: http://cie.asu.edu/
- Taylor, L.& Parsons, J.& Fielding-Wells, J.& Makar, K. (2011).Student (dis)engagement in mathematics. The University of Queensland University of Alberta.
- Thomson, S. & Fleming, N. (2004). Summing it up: Mathematics Achievement in Australian Schools in TIMSS 2002. *TIMSS Australia Monograph No 6.Camberwell, Victoria***.** Vol11, pp.1–25.
- Vincenti, G. & Braman,J. (2011). Work: Theory into Practice, Building Community through Cooperative Learning. Vol 38(2). pp. 67-73.
- Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.
- Wells, G. (1999). Dialogic inquiry: Towards socio-cultural practice and theory- Washington D.C.
- Wells, J. (2008). Affective, Behavioural and Cognitive Engagement in Primary School Mathematics: The Impact of Inquiry-Based Learning. Unpublished Master's Thesis. University of Queensland
- Wilkins, J. L. M. (2004). Mathematics and science self-concept: An international investigation. *The Journal of Experimental Education, Vol 72.pp.* 331-346
- Wilson, E. O. (1998). Consilience: The unity of knowledge. New York, NY: Knopf.
- Wilson, S. M. (2013)**.** Teachers' professional development .Vol. 340 (6130). pp. 310-313 available at: http://www.sciencemag.org/content/340/6130/310.abstract
- Windham, C. (2005). The student's perspective. In D. G. Oblinger & J. L. Oblinger (Eds.). *Educating the Net Generation* pp. 5.1-5.16. Washington, D.C.: EDUCAUSE.
- Yager, R.E.& Akcay, H. (2009). A Comparison of Student Learning in STS vs Those in Directed Inquiry Classes. Volume 13(2). pp.186-204
- Yair, G. (2000). Educational battlefields in America: The tug of war over students' engagement with instruction.*Sociology of Education,* Vol 73(4). pp.247-269.

Appendices

Appendices #1

Fig 3.What the teacher does for an effective science inquiry-based teaching strategy versus what the students do

What teacher do

Stage	That is *consistent* with the BSCS 5E Instructional Model	That is *inconsistent* with the BSCS 5E Instructional Model
Engage	• Piques students' curiosity and generates interest • Determines students' current nderstanding (prior knowledge) of a concept or idea • Invites students to express what they think • Invites students to raise their own questions	• Introduces vocabulary • Explains concepts • Provides definitions and answers • Provides closure • Discourages students' ideas and questions
Explore	• Encourages student-to-student interaction • Observes and listens to the students as they interact • Asks probing questions to help students make sense of their experiences • Provides time for students to puzzle through problems	• Provides answers • Proceeds too rapidly for students to make sense of their experiences • Provides closure • Tells the students that they are wrong • Gives information and facts that solve the problem • Leads the students step-by-step to a solution
Explain	• Encourages students to use their common experiences and data from the Engage and Explore lessons to develop explanations • Asks questions that help students express understanding and explanations • Requests justification (evidence) for students' explanations • Provides time for students to compare their ideas with those of others and perhaps to revise their thinking • Introduces terminology and alternative explanations after students express their ideas	• Neglects to solicit students' explanations • Ignores data and information students gathered from previous lessons • Dismisses students' ideas • Accepts explanations that are not supported by evidence • Introduces unrelated concepts or skills
Elaborate	• Focuses students' attention on conceptual connections between new and former experiences • Encourages students to use what they have learned to explain a new event or idea • Reinforces students' use of scientific terms and descriptions previously introduced • Asks questions that help students draw reasonable conclusions from evidence and data	• Neglects to help students connect new and former experiences • Provides definitive answers • Tells the students that they are wrong • Leads students step-by-step to a solution
Evaluate	• Observes and records as students demonstrate their understanding of the concepts and performance of skills • Provides time for students to compare their ideas with those of others and perhaps to revise their thinking • Interviews students as a means of assessing their developing understanding • Encourages students to assess their own progress	• Tests vocabulary words, terms, and isolated facts • Introduces new ideas or concepts • Creates ambiguity • Promotes open-ended discussion unrelated to the concept or skill

What student do

Stage	That is *consistent* with the BSCS 5E Instructional Model	That is *inconsistent* with the BSCS 5E Instructional Model
Engage	• Become interested in and curious about the concept or topic • Express current understanding of a concept or idea • Raise questions such as, What do I already know about this? What do I want to know about this? How could I find out?	• Ask for the "right" answer • Offer the "right" answer • Insist on answers or explanations • Seek closure
Explore	• "Mess around" with materials and ideas • Conduct investigations in which they observe, describe, and record data • Try different ways to solve a problem or answer a question • Acquire a common set of experiences so they can compare results and ideas • Compare their ideas with those of others	• Let others do the thinking and exploring (passive involvement) • Work quietly with little or no interaction with others (only appropriate when exploring ideas or feelings) • Stop with one solution • Demand or seek closure
Explain	• Explain concepts and ideas in their own words • Base their explanations on evidence acquired during previous investigations • Record their ideas and current understanding • Reflect on and perhaps revise their ideas • Express their ideas using appropriate scientific language • Compare their ideas with what scientists know and understand	• Propose explanations from "thin air" with no relationship to previous experiences • Bring up irrelevant experiences and examples • Accept explanations without justification • Ignore or dismiss other plausible explanations • Propose explanations without evidence to support their ideas
Elaborate	• Make conceptual connections between new and former experiences • Use what they have learned to explain a new object, event, organism, or idea • Use scientific terms and descriptions • Draw reasonable conclusions from evidence and data • Communicate their understanding to others	• Ignore previous information or evidence • Draw conclusions from "thin air" • Use terminology inappropriately and without understanding
Evaluate	• Demonstrate what they understand about the concept(s) and how well they can implement a skill • Compare their current thinking with that of others and perhaps revise their ideas • Assess their own progress by comparing their current understanding with their prior knowledge • Ask new questions that take them deeper into a concept or topic area	• Disregard evidence or previously accepted explanations in drawing conclusions • Offer only yes-or-no answers or memorized definitions or explanations as answers • Fail to express satisfactory explanations in their own words • Introduce new, irrelevant topics

Appendices #2

Table 5. The science teaching standards for the science inquiry for the 6^{th} grade (NSES 2000)

Science Teaching Standards

TEACHING STANDARD A:

Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- Develop a framework of yearlong and short-term goals for students.
- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.
- Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.
- Work together as colleagues within and across disciplines and grade levels.

TEACHING STANDARD B:

Teachers of science guide and facilitate learning. In doing this, teachers

- Focus and support inquiries while interacting with students.
- Orchestrate discourse among students about scientific ideas.
- Challenge students to accept and share responsibility for their own learning.
- Recognize and respond to student diversity and encourage all students to participate fully in science learning.
- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

TEACHING STANDARD C:

Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers

- Use multiple methods and systematically gather data about student understanding and ability.
- Analyze assessment data to guide teaching.
- Guide students in self-assessment.
- Use student data, observations of teaching, and interactions with colleagues to reflect on and improve teaching practice.
- Use student data, observations of teaching, and interactions with colleagues to report student achievement and opportunities to learn to students, teachers, parents, policymakers, and the general public.

Appendix # 3: Pre-Test used to assess students' prior knowledge

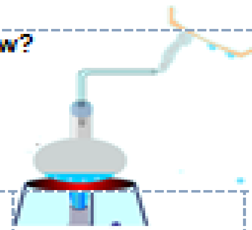
United Arab Emirates
Ministry of Education
Madares Al Ghad

دولة الامارات العربية المتحدة
وزارة التربية و التعليم
مدارس الغد

Question 1	20 marks

1- Circle the correct answer below.

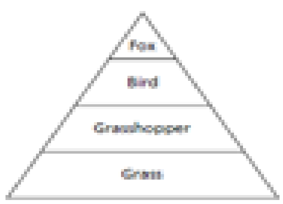
1. Which statement is correct about the experiment below?



16

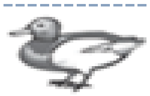
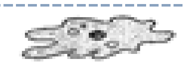
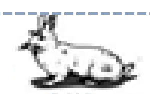
a. Evaporation & condensation	b. water cycle	c. infiltration	d. Temperature

2. Which organism in this energy pyramid is receiving the LEAST amount of energy?



a. Grass	b. bird	c. Grasshopper	d. Fox

3. The below ....picture is a Protist.

a.  duck	b.  plant	c.  Amoeba	d. 

4. The scientific method steps include questions, hypothesis and ....

a. record data	b. break	c. construct	d. classify

5. The table describes best the .... Biome

Rainfall	MORE than 100mm/year
Trees	Very tall
Plants	Some in the sun, some in the shade
Animals	High diversity

a. Rainforest	b. Desert	c. grassland	d. Taiga

6. The Clouds are the .... phase of the water cycle.

a. evaporation	b. Condensation	c.Eutrophisation	d. Precipitation

7. The natural recyclers are the ....

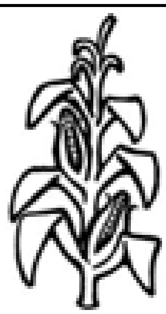
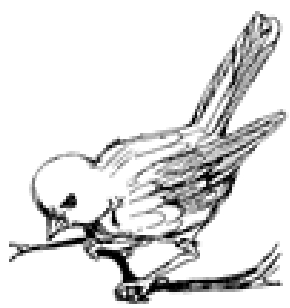
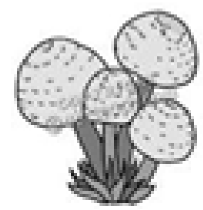
a. decomposers	b. herbivores	c. producers	d. carnivores

8. The .... is a step from the sewage water treatment

a. Aeration	b. Eutrophisation	c. predation	d. division

2- label the organisms of the Food chain using the words below:

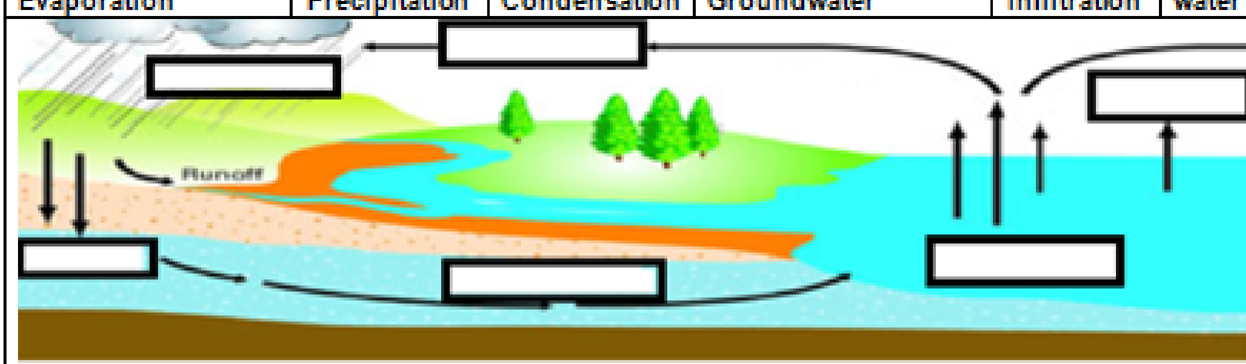
Decomposer -Primary consumer- Producer- Secondary consumer (4)

 Corn	 Bird	 Snake	 Mushroom

Question 2	20 marks

1- Complete the water cycle below with the word from the Box (12)

Evaporation	Precipitation	Condensation	Groundwater	Infiltration	Surface water



2- SAY if the underlined word is True or False by circling/ Give the correct word

8

a. The feature that helps an organism to survive is called <u>adaptation</u>. . ☐ True ☐ False

____

b. <u>The beaker</u> is a scientific tool to measure liquids' volume. . ☐ True ☐ False

____

c. An area with specific climate and diversity is called <u>community</u>. . ☐ True ☐ False

____

d. The percentage of Fresh water on Earth is <u>1%</u>. . ☐ True ☐ False

____

Question 3	20 marks

1- Use the words in the BOX below to complete the text

14

Non-living	groundwater	disappear	Water cycle	Scientific method	Populations	Characterisitcs

a. The hypothesis and the experiments are two parts from the ………………………….

b. Classification is grouping organisms with similar ………………………………………

c. The temperature and the water are two ………………………… factors.

d. If one living thing dies from the food web all the food web will ……………………

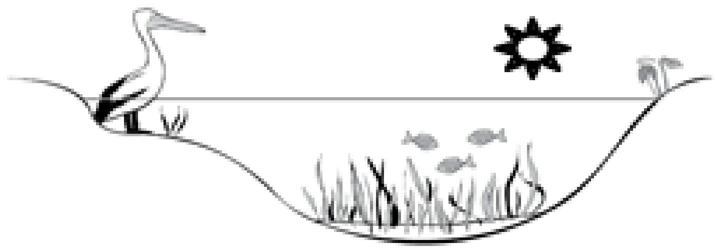
e. A community in an ecosystem is made of different ………………… living together.

f. When the water turns around the ecosystem it is called ………………..

g. The treatment of the water keeps the ……………………. Safe to use.

2- Give from the Diagram below 3 BIOTIC factors and 3 ABIOTIC factors and write them in the Table

6



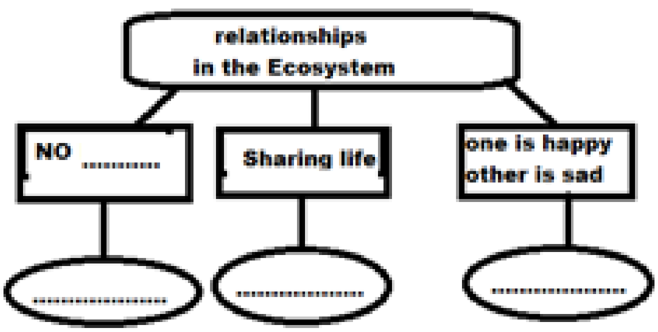
Biotic factors	Abiotic factors
1	1
2	2
3	3

Question 4	20 marks

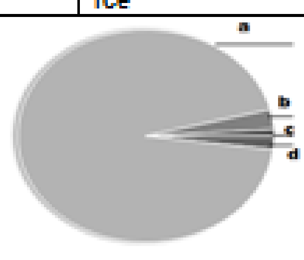
1. Complete each of the concept maps below with the words from the BOX

16

Box1: Competition	Symbiosis	Parasitism	Food



BOX 2: Ground water	Ice	Freshwater Lakes & rivers	Oceans and seas



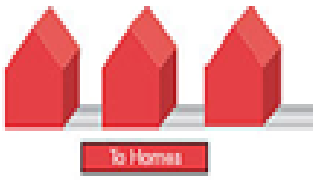
a- 97. 2% : ....

b- 2.14% : ....

c- 0.001%: ....

d- 0.6%: ....

2. Order the following steps for Rawwater Treatment by numbering 1-2-3-4

		Treatment	

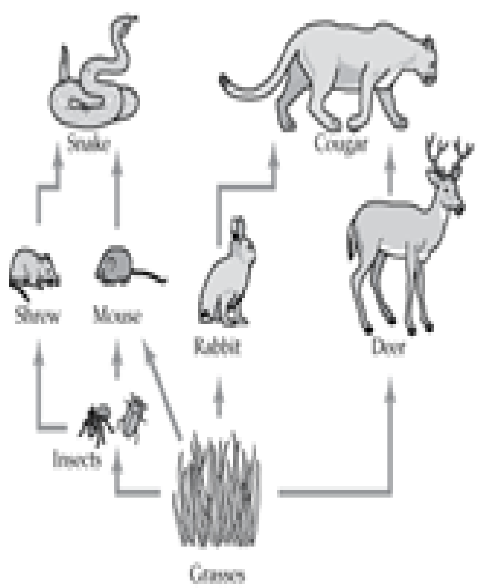
Question 5	20 marks

1. Give a "TITLE" to each of the diagram from the BOX below

12

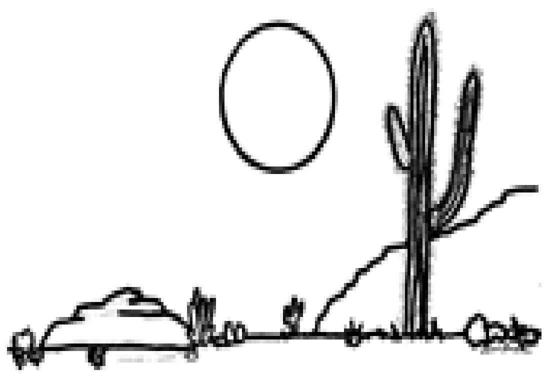
Energy pyramid	Food chains	Rainforest	Transpiration	Predation-prey	Desert habitat

Diagram 1

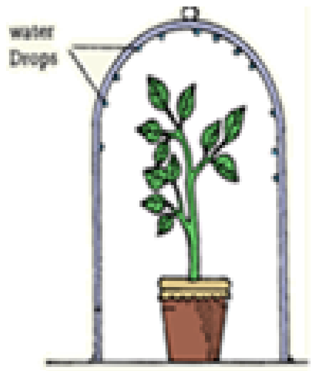
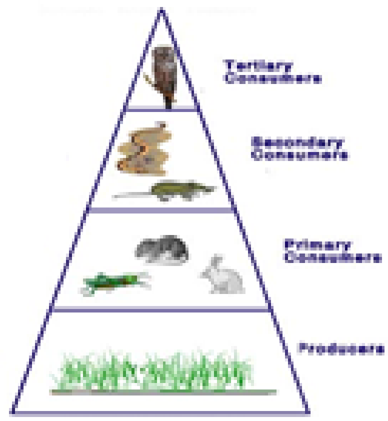
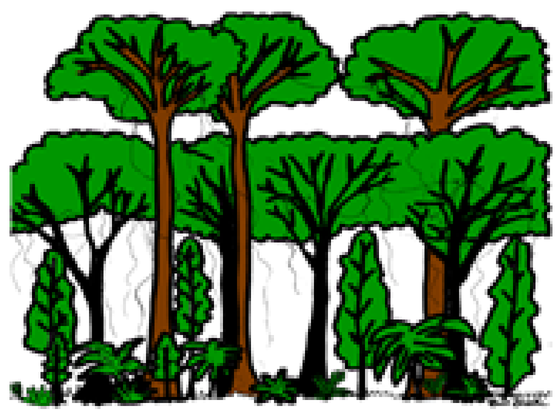


Title:

Diagram 2



Title:

Diagram 3	Diagram 4
	
Title:	Title:
Diagram 5	**Diagram 6**
	
Title:	Title:

2- Match the correct number from column 2 to the correct number in column 1

8

	Column 1	Column 2
(..........)	a. Felis domesticus	1. Linnaean System
(...........)	b. classification	2. scientific method
(...........)	c. boiled water has a .... temperature	3. 100 °C
(......... .)	d. give conclusions	4. the cat

END OF QUESTIONS

Appendices #4

Tab 9. The total of items observed in the students' engagement after seven visits for the (TT) teacher is the following for each item*.*

According to the 5E's model of the science inquiry and (Yager &Enger 2012) model as well as the CLOP instrument.		Level of effectiveness 1	2	3	4
ENGAGE	1- Students are working in teams when they do science activities.			7	
	2- Students are positive interdependent in the same group.	2	3	2	
	3- Each student has a specific function in the same group.	4	2	1	
	4- Students ask questions and try to answer the hypothesis given by the teacher.	5	1	1	
	5- Students carry appropriate dialogue and peer communication to answer the questions assigned by the teacher		1	6	
	6- Students design their own investigation or give predictions about a certain appropriate investigation to answer the hypothesis .	5	2		
	7-. Students try effectively the investigation given by their teacher or the students try effectively the investigation they designed	5	1	1	
EXPLORE	8-. Students make observations and write them down		1	6	
	9- Students analyze their results according to their observation and their prior knowledge	3	3	1	
	10- Students have a clear goal in mind: testing the hypothesis	1	2	4	
EXPAIN-ELABORATE	11- Students relate between evidence and explanation to conclude, by using modeling, written, drawing trace.	1	3	2	
	12- Students communicate their results to each other and to the class, by using oral or written trace.	1	3	2	
EVALUATE	13- Students evaluate their own job	6	1		
	14- Students propose other alternatives for solving the same problem.	6	1		
	15- Students let other peers evaluate their job	1	2	4	

1: ineffective **2:** approaching the goal towards effectiveness **3:** effective **4:** highly effective

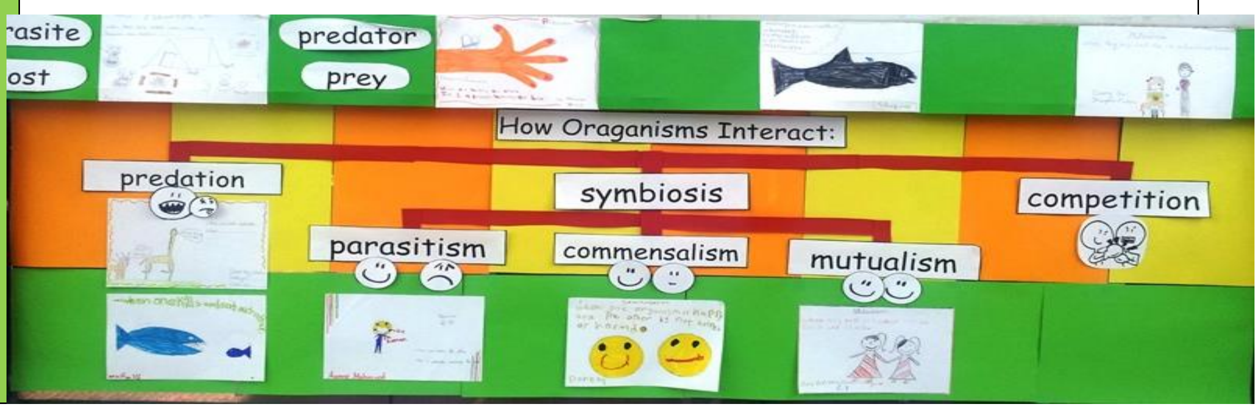
Appendices #5

Table 11. Some photos and samples of the science-inquiry teaching approach activities done by the students of the inquiry trained teacher.

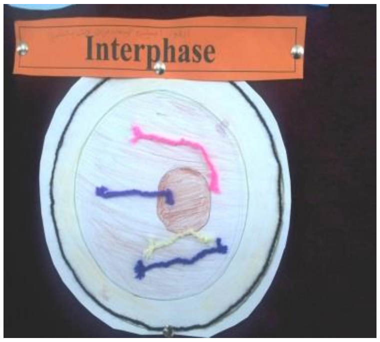
The water cycle	

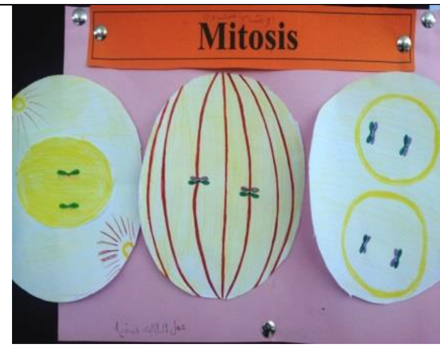
The scientific method

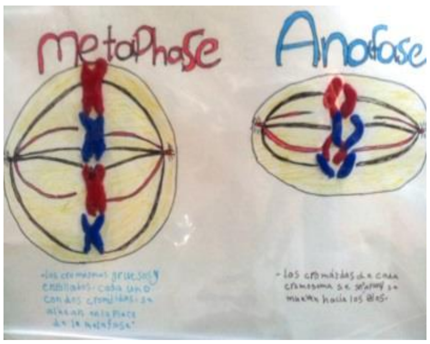
The Ecosystem

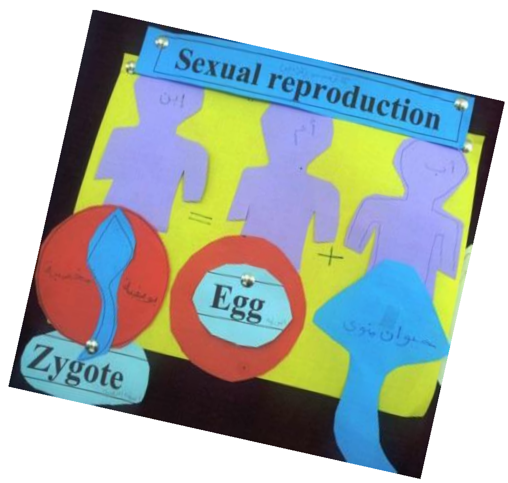


Cell division







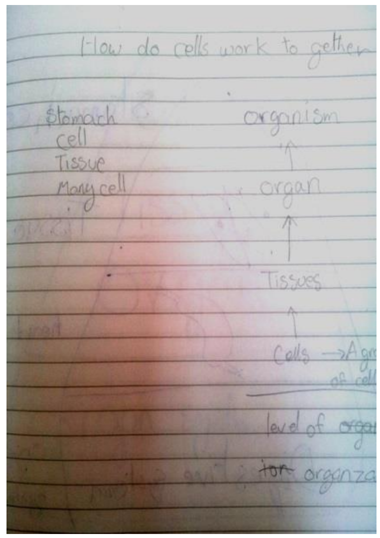


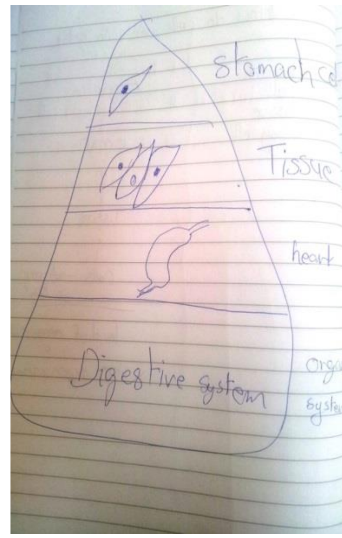
Appendices #6

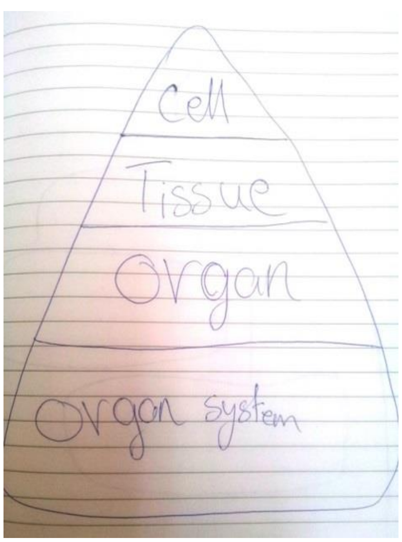
Table M3.professional development topics

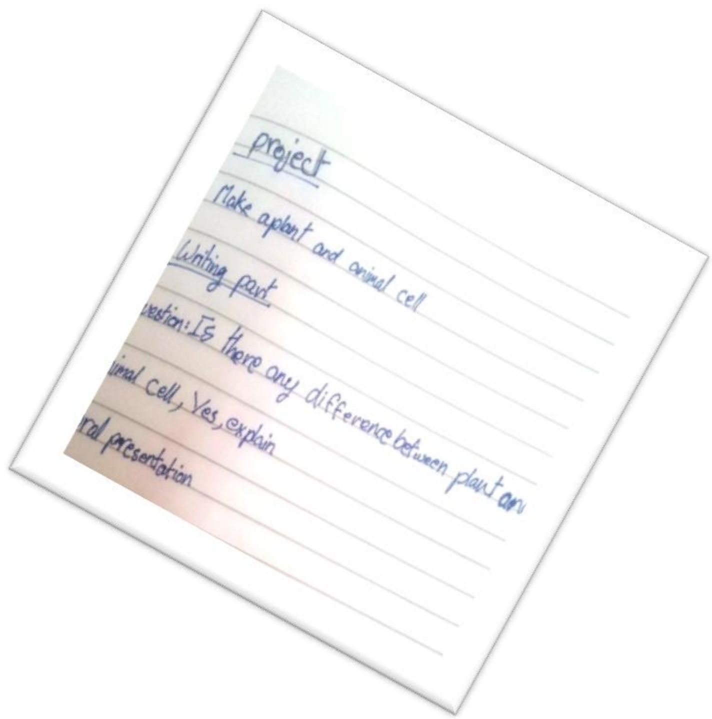
	Topic of the training	Objectives	Outcome
05th September 2012 - 16th February 2013	Introducing the standards the NGSS, and the science-inquiry	Teacher work per standards Teacher get familiarized to the science-inquiry	Teacher should know and understand a standard The teacher should know what is a science-inquiry
	Science-inquiry teaching approach	Teacher are students working in peers and being acknowledged about the rationale behind the science-inquiry teaching	Teacher should be able to design the science-inquiry teaching approach for each lesson he is teaching as a first step toward the discovery and the open-ended inquiry
	The Critical thinking through The choice of questions and answers.	Teacher should know how to ask their questions in the lesson in order to reach their inquiry objectives	Teacher is the critical thinking manufacturer in the science lesson
		Teacher should ask the effective questions to develop critical thinking and logical thinking.	Teacher is critical thinker and chooses their questions wisely to reach their assigned goal.
	Class observation and sharing of a science-inquiry prepared by the TT teacher	Teacher should be able to critically observe and comment a lesson without judging	Teacher should be able to know what could be the gaps in a science lesson-plan when they are designing it
		Teacher should be able to evaluate and auto-evaluate their own science lesson by looking at another science lesson	Teacher should be able to differentiate between the facilitator role of the teacher and the lecturer and make the appropriate intervention when needed
	Class observation in a private school following the science-inquiry hands-on teaching approach as a part of the reform in science.	Share knowledge and experience	Acquire the scientific attitude and be a fair observer open to more than one angle.
	Class observation in a private school having the same demographic profile and applying the science-inquiry hands-on teaching approach as a part of the reform in science	How to make the progress in the science-inquiry teaching approach	Acquire the scientific attitude and be a fair observer open to more than one angle.
	The science content knowledge And science textbooks	Teacher should be able to know the science content	Teacher should be able to detect any misconception found in their own science textbook.

Appendices #7
Tab 13 Controlled group trace.

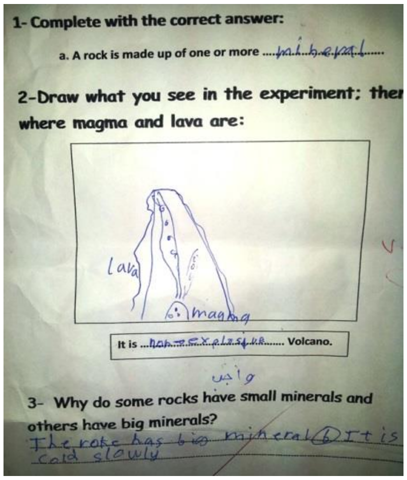


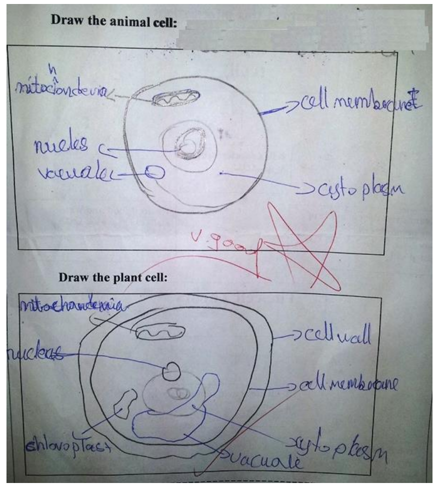


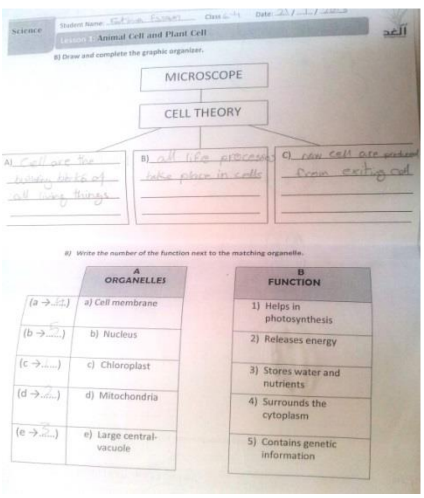


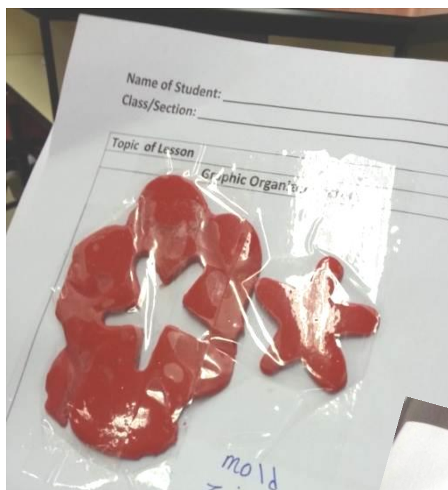


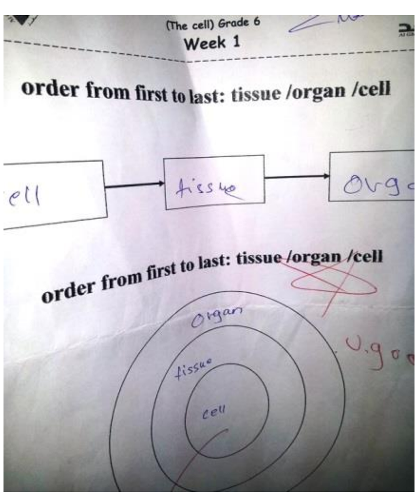
Tab.12 Some of the written traces coupled with the hands-on above.











Appendices # 8

السيد (ة) ولي أمر الطالب المحترم(ة)،

من خلال حرصنا على التواصل مع البيت و مدكم بكل ما يتعلق بالمناهج و محتوى مادة العلوم التي سوف يتلقاها ابنكم نود اعلامكم بأن مدارس الغد تعتمد على "معايير الجيل الجديد للعلوم" المعترف به عالميا و المعتمد في وضع اختبارات تحديد المستوى، الامتحانات الوطنية و الامتحانات العالمية (TIMSS) حيث يعتمد هذا الأسلوب على تعليم الطالب مهارات علمية محددة تساعده على الفهم و الاستيعاب و التعامل مع الآخرين، و فيما يلي لائحة المعايير لجميع مهارات مادة العلوم للفصل الأول التي سيتم تطبيقها على اولادكم ضمن احدث الوسائل التعليمية المعتمدة على الإسكشاف .

First month الشهر الأول

1. **Compare and contrast between two items and deduct their roles, their use and how can they be useful to their environment**

1. مقارنة بين أكثر من وحدة و استنتاج دور كل واحدة منها و كيفية الاستفادة منها و كيفية استعمالها في المجتمع

2. **Observe and infer documents, pictures and experimental protocols and identify their meaning and correlate between the observation and the use as well as the role of the item in the local context or area**

.2المشاهدة و التحليل لمضمون و لصورة أو لبروتوكول مخبري أو أعمال تطبيقية علمية و تحديد دور كل واحدة منها و معناها و التوصيل المنطقي بين المشاهدة و الدور ث اهمية الوحدة الواحدة و ربطها مع المجتمع المعروف و المألوف للطالب

Second month الشهر الثاني

1. Identify and explain a concept map and differentiate between several concept maps and diagrams and explain their use and their purpose and be able to analyze them and give a title and a conclusion and model a chart or graph from a grid or table

.1 تحديد و تفسير رسم بياني أو مجسم ثم تحديد الفرق بين أكثر من رسم بياني و مجسم و تفسير معنى الرسم ثم الهدف و القدرة على تحليله و تفسيره و استخلاص دوره و القدرة الى التفسير عنه بالكلمات أو تحويله الى جدول

2. Draw conclusions

.2 كتابة الاستنتاجات

Lab work and projects أعمال مخبرية و مشاريع

1. Apply the scientific method, Investigate, observe results, record data, and analyses using inquiry-skills and scientific investigation and experimental knowledge.

.1 تطبيق عملية البحث العلمي التحقيق، ومراقبة النتائج، تسجيل البيانات وتحليلها باستخدام مهارات الاستفسار والتحقيق العلمي والمعرفة التجريبية

مدرب العلوم حلقة ثانية