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Effective use of Science Inquiry-based Teaching on Student Achievement and Engagement

Hind A. Kassir[1] & Sufian A. Forawi[2]*
[1]*Liverpool University*
Liverpool, UK
[2]*The British University in Dubai*
Dubai, UAE

Abstract: Guided scientific inquiry investigations are designed to have students reach particular answers through the thinking processes and activities of scientists. This paper investigates the impact the science-inquiry teaching approach and evaluates its effectiveness on the students' achievement and engagement level over four months and a half. Subjects were 52 girls from a UAE public school following the science reform. The sample is divided in two: the first group sample n=26, was the experimental group receiving science inquiry-based instruction, while the controlled group (n=26) followed non-inquiry-based instruction(traditional strategy).The dependent variables were the students' achievement and engagement which were measured through the mixed-method approach: 1) quantitative data was collected using a pre- and a post-test to assess the students 'science achievement. 2) Qualitative data was noted using an observation tool designed for the study and entitled EIT 2013 to evaluate the students' engagement. The T-test revealed that the science-inquiry teaching approach produced significantly greater achievement among 6th grade students than the traditional teaching approach. Also, students in the experimental group developed positive attitudes toward science than did those in the controlled group.
Keywords: Science education; inquiry-based teaching; student achievement and engagement

Introduction

In its general sense, a curriculum is all principles that underline the educational goals, content, philosophy and how to approach them in the classroom. In 1972, the Ministry of Education (MoE) of the United Arab Emirates (UAE) is established to function as a central education authority to oversee and develop education documents for all schools in the country (Ridge, Kippels & Farah,2017). From the year 1972 until the present moment, the Ministry of Education of the UAE has developed its education documents and improved its educational practices. Assigned professionals are assigned to evaluate the efficiency of the pedagogical instructions, and carefully monitor classroom practices. Further, students' outcomes and performance skills are assessed to highlight students' learning and what skills they develop throughout their journey. In the UAE context, the word "curriculum" is equal to textbook and with the centralized assessment requested by high leadership, teachers find themselves following the "curriculum" page by page to ensure their students' success and do not try to use any other resources. This attitude reduces their feeling of accountability while facing school principals, parents and society (Johansson, 2005).

The Ministry of Education of the UAE launched in the year 2007, The Madares Al Ghad (MAG) project which targets improving Emirati students' academic achievement in international assessments TIMSS and PISA after scoring below international levels (Layman, 2011). Education policy makers have developed curricula with specific learning outcomes aligned with science international standards (Hathorn & Dillon, 2018). The project is the cornerstone to elite model of the new education system in the MOE that targets with reference to Bronfenbrenner's Ecological Systems model (1979), the exosystem, macrosystem, mesosystem and microsystem in the MoE learning environment.

The mixed-method study purpose is to empower critical thinking and scientific literacy in foreign language (Ridge, 2017). MAG schools are an answer to the inability of public schools to equip students with a functional level of English proficiency, restricting them from accessing world's knowledge and technology (Raddawi & Meslem, 2015). A very challenging context yet promising that entails a shift in the curriculum approach from a knowledge based to a skills-based curriculum in a second language instruction. A project that needs an innovative teaching approach based on inquiry hands-on that offers a promising opportunity for greater student engagement in science (Pennington, 2015). The Emirati public schools chosen random from Dubai and Northern Emirates will adapt English as a medium of instruction for science and math.

This paper is concerned with exploring the microsystem of teachers' classroom practices with education reform of MAG education system model along with the efficiency of these inquiry practices on students' academic achievement. This study examines to what extent can effective inquiry based learning – used in MAG

curriculum implementation- improve students' achievement in science. The current study will not evaluate the efficiency of the intended curriculum documents but its implementation and the quality of the students' attainment (Van den Akker, 2010).

The sample of the present study is fifty-two girls' students from the sixth grade, from the selected Madares Al Ghad (MAG) public school in the western educational zone of the UAE following the reformed MAG curriculum. Teachers participating within this study are two groups: the first one is trained teacher that we will code as (TT). The TT is a teacher who masters both the scientific content and the local context, and is currently following a continuous professional development by outstanding science trainers for four months. The TT will be working with one group of students of twenty-six students. The second teacher is the one who feels that his comfort zone is mainly with a teacher has centred approach. The teacher is coded (LT). The LT will not follow any future professional development courses throughout the course of the study. the lecturer teacher (LT), will be working with the other group of students of twenty-six students. 6th graders, girls, from the same school and from the same educational zone. This second study sample is called the controlled group.

This present mixed-method is an approach to research that involves data collection, analysis, and integration of quantitative and qualitative data (Creswell & Plano Clark, 2011).It 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 - within a project that focuses mainly on language acquisition –students' achievement and engagement level". Research papers reflected on the MAG project and focused on the language acquisition yet did not evaluate quantitatively or qualitatively the scientific literacy, and the functional language use in science classroom. The current study aimed to investigate classroom practices and the students' outcomes and evaluate the inquiry-based approach and its direct effect on students' achievement and engagement.

The evaluative mixed-method approach study set to answer the following two questions:

1) Can the effective science-inquiry teaching approach based on hands-on approach improve students' achievement?

2) Can effective science-inquiry teaching approach based on hands-on practices improve students' engagement level?

Conceptual Framework & Background

What is inquiry?

Science inquiry interrelates to four factors such as teachers' belief, teachers' explicit and implicitsocial knowledge and practices(Bryan, 2000). Teachers need to be more acknowledged in inquiry practices and finally know how students should learn via the science-inquiry teaching approach (Richardson 2008).

Using science inquiry-based strategies for science teaching and learning dated backto the nineteenth century with Kropotkin (1885: 944). Kropotkin advocated that rote-learning method of teaching should be coupled with independent inquiry and discovery-based problem solving instead of a didactic one.

As a part of the constructivist theory, the science inquiry-teaching approach emphasized that knowledge is constructed by in the student's mind as a part of his/her active thinking, organization of information and integration and knowledge replacement. Therefore, students need to be actively engaged in the science learning process in both behavioural and mental so the learning could take place (Cakir, 2008; Mayer, 2004). Therefore, as a constructivist and a teaching approach, the focus of the science-inquiry permeated much of educational, particularly, in science education.

The main goal of the inquiry is giving the students the opportunity to adapt and retry their investigations and problem solving efforts and skills. In fact, national reforms in science education recall for inquiry as a main instructional strategy that contributes to students' own meaningful learning. Science-inquiry-teaching approach is a way students could explore the working world. Historically, inquiry is defined at the wisdom of the world that requires a curious explorer able to make connections between unexpected items (Roseberry, 1996).

Inquiry is a teaching approach to help 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 their own 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).

Science Inquiry Instruction and the 5E Model

The science-inquiry instruction uses the 5Es' model Figure 2 *that* involves students and develops skills such as analyzing, evaluating evidence, experiencing and discussing. This kind of instruction as laid out could empower the students' critical and logical thinking through an auto-evaluation and a peer communication in the same group or from different groups competing together: cooperative learning strategy. It is a constructivist environment, which allows the students to construct their scientific concepts over time and to think critically and reflect on their own misconceptions (Kyriacou 2007)

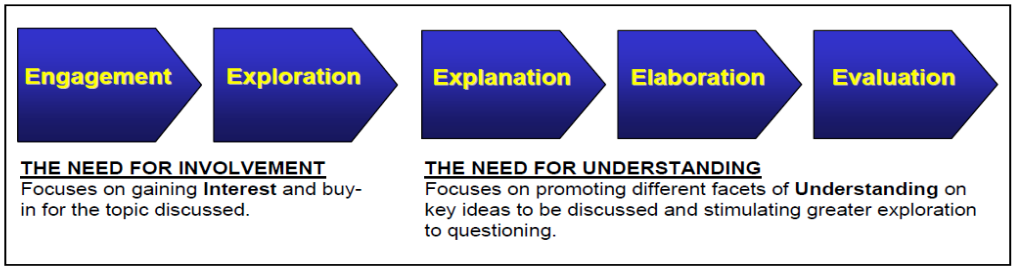


Figure 1. The five stage inquiry teaching approach model

Science Inquiry Instruction and Standards

The National Science Teachers Association (NSTA) recommends that all teachers embrace the science-inquiry as the center piece teaching approach of science teaching from K–16, because the science-inquiry could provide students with the opportunity to express their ideas by participating actively within the lesson in an effective science-inquiry framework applied by the teacher (Slavin 2012). 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).

The Next Generation of Science Standards (NGSS)

The next generation of Science standards (NGSS) 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),and the national science teachers association (NSTA) 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), identifying what the 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 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 the 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 effectives strategies advised by the writers for the effective implementation of the new framework. The science-inquiry teaching approach is considered as a vehicle for crosscutting between disciplines, not only in the science classroom, but also at the school level, home and community levels to improve students' science literacy.

The NGSS (2012) redefined the science inquiry as follows:

"Scientific inquiry", as 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 refined and deepened the "science-inquiry teaching strategy explicitly by adding the eight scientific engineering practices that include all the students' groups (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 analyzing 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, 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 these 6th grade students

Science-Inquiry and Student's Achievement

An article in press published by Lee & Luykx (2006) discusses issues that could influence on the students' achievement following the science-inquiry teaching approach as a hands-on teaching approach. The three main concerns that could have a direct influence in the students' achievement is the appropriate curricula, materials and pedagogy chosen for the students, and the teachers' quality. The third issue that could affect the students' achievement is the students' attitude towards science and their level of engagement.

The curricula and the materials if chosen adequately may decrease science achievement gaps. Most of the curricula used in the UAE are imported from western science foreign to many students and non-relevant to the students' culture to the mainstream students 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. Quality teachers' influence much on the variation in student achievement in science that is attributable to teacher characteristics. In reform-oriented practices in order to be able to provide effective science instruction it is always better that teachers come from the same students' background to teach effectively, because they understand the students' culture and understand it and could establish the code for mutual respect. Moreover, because science is not a school issue it is a community literature, 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). Science assessment may become more valid and equitable by making it relevant to student and community knowledge and what students experience so they could demonstrate 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.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 studies investigating aspects of science- inquiry instruction and students' achievement (Minner 2009).

Science Inquiry and Student Engagement

In our twenty first century technological facilities, capturing the students' attention 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 are thought form 92.7% of students that understood the basic scientific principles, and barely 10.9% could analyze procedures and data. Authors such as Torp & Bybee (2003) wrote that offering students engaging opportunities in real-world situations which involve science could help them construct their knowledge through active authentic experiences. The National Academy of Science suggested in (1995) that the intent of the science-inquiry as a teaching approach is to engage students as the main ingredient of the science-inquiry model as recognized in the 5Es model (Bybee1989). However, it is hard to define engagement as it is related to emotions and commitment: 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 using technology in a meaningful assignment and allowing students for experimentation and investigation. The engagement is mainly defined as the intrinsic motivation that immerses students totally in a certain activity. This

activity should be balanced between the challenging and the skilful and confidence-building in a fun context. Engagement within the inquiry allows freedom of exploration within a meaningful assignment such as problem-solving per example, yet the students as well as the teacher facilitating 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 to invest energy and time in science (Joseph & Daniels 2005).

The first appearance of science-inquiry instruction is difficult to trace in the longstanding dialogue of teaching and learning. Piaget and Vygotsky as well as David Ausubel 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.

Methodology

The main purpose of this case study was 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. The sample of the study is fifty two grade 6 girl students from public schools, located in the eastern educational zone of the United Arabs Emirates (UAE), who participated in a four months and a half period time 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 MAG.

The present study is using concurrent procedures, in which both quantitative and qualitative data converges and go together to provide a comprehensive analysis of both questions asked in the introduction section. In this type of design, data was collected from both tests and class observations were done at the same time during the study timeline and the interpretation was integrated with the overall results (Johnson, 2005). 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 will be received the science-inquiry –teaching approach by an effective teaching and learning approach by and a well-trained inquiry teacher entitled in the study as (TT). The other sample is the controlling group made of 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. The students of the second sample are 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 dependent variable is the level of engagement evaluated for both students' samples through classroom observation using the EIT (2013) tool designed specifically for the current study after being tested.

The Design of the Quantitative Tool

The study is going to assess the students' achievement based on the 6th grade standardized tests from California, Tennessee, and the University of New York as well as Virginia, writers and inspirers of the NGSS; and the Ministry of Education in the United Arabs Emirates (2009).

The assessment of the students' knowledge is a two phase's process: phase I is the phase to administer the pre- test to place all students' and check their level regarding the science content as well as their attainment in inquiry-skills, phase II is the final test to 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 like the TIMSS: 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 using the final test part II, that covers the Earth science and Geology content. 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).

The Qualitative Tool

The EIT (2013) used for the present study- Engagement Inquiry Tool-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 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 being a positive independent learner.

Results

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 10 years old students, Arabic native speakers went through the pre-test and the post- test according to the schedule mentioned in the methodology procedures. 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's and data classified. After the students did the pre-test and the post-test part 1 and later on the post-test part 2, data was collected and analyzed. The post-tests part 1 and posttest part 2 were added and the mean was taken from both posttests 1 and 2 as they are only one test that has been given in two rounds. 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

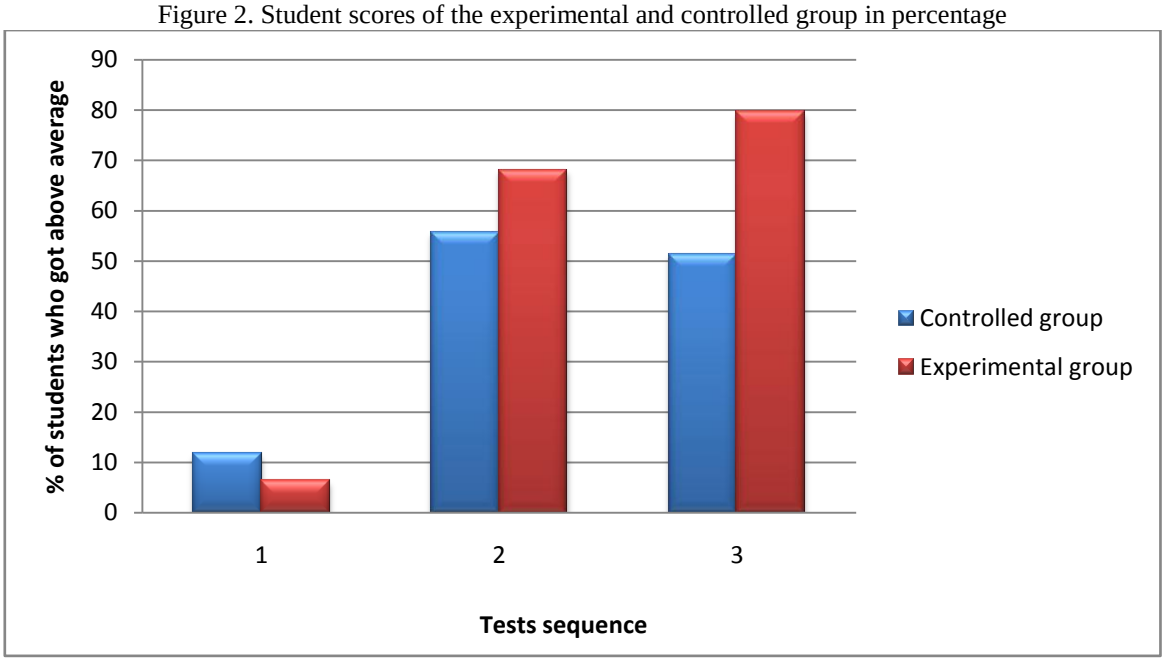
Student achievement

The percentage results are shown in Table 1and Figure 2 for both group samples: the controlled group taught by the teacher who didn't receive any of the new science –inquiry teaching approach training and was teaching using the traditional ways of teaching and the experimental group where students were receiving the science instruction as an inquiry-teaching strategy.

Table 1. Student scores of the experimental and controlled group

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 per class	626	2947	2718
	% students above average	11.8	55.6	51.2
Experimental group	Sum of the scores per class	343	3610	4223
	% students above average	6.4	68.1	79.6

Figure 2. Student scores of the experimental and controlled group in percentage



After doing the data collection and the data analysis using the percentage methodology, 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 having a higher level of success in the pretest 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 increase of the average higher in the last posttest designated for both students' samples. The final posttest 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 that indicates that students decreased in their engagement as well as 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 approachand students' science achievement. The chart M11 above shows explicitly the scores' improvement of the students following the effective science-inquiry teaching approach from 6.4% to 79.6 % 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 2. T-test result of both experimental and controlled group

			Bootstrap[a]			
					95% Confidence Interval	
		Statistic	Bias	Std. Error	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, Table 3 presented the t-test values for participating groups. 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; 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.

Table 3. One-sample test result

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 □ 0.005. So 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.

Students' engagement level

The researcher visited both teachers seven times, observing 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 table9 below.

Table 4. The students' qualitative engagement results

	Items	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	

In the EIT tool (2013) the four main items of engagement aligned with the 5E model engage, explore, explain are added to the tool yet the study timeline and capacity cannot assess 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. Therefore, this case study considered only two items of the (EIT) 2013 tool which are the "engage" and the "explain" items and during the classroom observation the researcher will be noting how many times they will occur in the observation session and the engagement results will be analyzed accordingly.

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 tools provided for each group, as well as the fact that there is always shortage in the staff supporting the science teacher such as the laboratory assistant. 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 being established and considered effective from the seating point of view, pushes the students to communicate, and enhances the

group work. The teacher's main task is the choice of the specific science-inquiry task that can't be accomplished unless the students are working in groups.

The positive interdependence is a key for the students to know their specific roles and divide the task in order and it is the way they could know how to divide roles in the society. It is the way that they use to depend on skills of each other and potentials to finish the given task on time.

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 month- 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 the level of engagement, the study tested first, 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 posttest done in two rounds to assess quantitatively the effectiveness of the science-inquiry teaching approach on the students' achievement. The study evaluates through classroom observation and using the EIT tool designed for the present study, tested and retested before being used in the classroom observation. The EIT tool is used in the present study to evaluate the effectiveness of the science-inquiry teaching approach on the level of engagement in the science class, on a qualitative level.

Most of the emirates government schools' students are emirates nationals and used on direct instruction or on teacher-centered approach. The transition from teacher-centered towards student-centered 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 a 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 as limited when it comes into dealing with abstract concepts, and have a limited attention span; therefore 6th graders need direct guidance. For this reason, the guided-inquiry seems to be a convenient teaching strategy for the novice teachers taking the science-inquiry teaching approach training and for the students since most of them might be in concrete operational phase (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.

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 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 his 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.

To sum up teachers are mandatory factors to implement the teaching and learning process, therefore they are the ones who need to understand more than others , how children's cognitive abilities develop, and how modeling 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 is 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 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 behaviors, as well as their sense of belonging (Willms, Friesen, & Milton, 2009).

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 the 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 will evaluate 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 behaviors 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 point 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, the UAE students have quite low achievement in science in their last international test compared to their peers in different Western countries (TIMSS, 2003) 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 major issue to consider as a main topic in the teacher training institutions as well as in the in-service training programs of the Ministry of Education in the UAE.

Conclusion

The results of this study are 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, guided the teacher to student-initiated inquiry continuum, and improves their cognitive ability particularly from low achievement to higher achievement regardless their low English proficiency. 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. This paper suggests as well that teaching science in foreign language is possible if the context considered (Raddawi & Meslem, 2015). The reasons behind the UAE introducing foreign language in the curriculum are sustainable as it needs to maintain good economic position, for foreign and local workers (Hopkyns, 2014).

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 dropouts in the boys' government schools.

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