Schools killing creativity! What can we do? The case of enhancing creativity and inquiry based learning in teaching science

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Abstract: This article explored the existing learning environment to enhance creativity as an integral component of 21st century skills that our students need to acquire in order to compete with other students in global setting. The article tried to answer the following main question: What changes do we need to implement to boost creativity? The main answer to this question derived from real classroom setting and experienced chemistry and physics educators. The article approached teaching science from the perspective of creativity and its relation to inquiry based learning. These methods include means of teaching such as Inquiry Based Learning, teaching outside the textbook where the book becomes a reference and not the curriculum, also accepting unexpected answers from their students and build on it to deliver knowledge. The findings highlighted the importance of teaching science in a way that can affect students' understanding and attitudes toward science in a positive way. It shaded the light on the relationship between Inquiry Based Learning and the 21st Century skills.

Keywords: 21st Century skills, creativity, creativity learning environment, inquiry based learning, teaching science.

Introduction

Creativity is that intrinsic human ability that needs to be nurtured and strengthened especially in youngsters who need to adapt with the complexity of our current lives and prepare for the unpredictable future (Turner, 2013). Creativity was identified as one of the essential 21st century skills needed to equip the future generations

with to become successful 21st century citizens (Saaverda and Opfer, 2012; Kharbach, 2014). The Pacific Policy Research Center (2010) has identified *creativity* as one of the 21st century skills that students must acquire thus negating the assumption that creativity is a gift of birth that only exists in artists and geniuses. Turner(2013) echoed Sak's (2004) emphasis that high order thinking skills involved in creative work are not exclusive to specific areas as creativity is not limited to one dimension only.

Studies conducted by (Jukic, 2011; Smears, Cronin and Walsh, 2011; Turner, 2013 and Davies, 2013) resonated in harmony with the notion that schools share a great responsibility in sponsoring creativity and fostering it starting from early years. This rises from an evident assumption that creativity is not just a gift from birth, but can be taught and nurtured as well (Pollard, 2012). Yet, the "spoon feeding" strategy adopted by most of the schools for the purpose of better exam results (Alshannag, Schreier, Abdel-Fattah, and Alshaya, 2015), are actually accused of killing the opportunities of creativity inside the classroom (Shaheen, 2010 and Turner, 2013). Oral (2006) identified the integration of creative thinking skills in the educational system as one of the factors that developed countries share. Jukic (2011) narrowed the study by suggesting that if creativity is to be nourished, it better start in schools as early as possible. Jukic's proposal was then supported by Smith, Walker and Hamidova (2012)where they highlighted that students' engagement level and attitude towards learning is best catered for at early stages, especially when addressing science and mathematics subjects. However, Lucas (2001) as cited by Lin (2011) emphasized that creativity can manifest itself in all aspects of school and life regardless of the subject, grade level or field. Lin (2011) identified three important conditions for creativity to flourish inside the classroom: teaching, environment and teacher ethos. The *teaching* in Lin's (2011) approach focuses on the teaching activities and strategies that stimulate creativity. This was in line with Longo's (2010) and Brookhart's (2013) proposition of Inquiry Based

Learning (IBL) as an effective strategy to inspire and encourage the creative side of students.

In addition to IBL, Turner (2013) and Brookhart (2013) proposed a set of activities that can promote creativity such as the ones listed in Figure1 below:

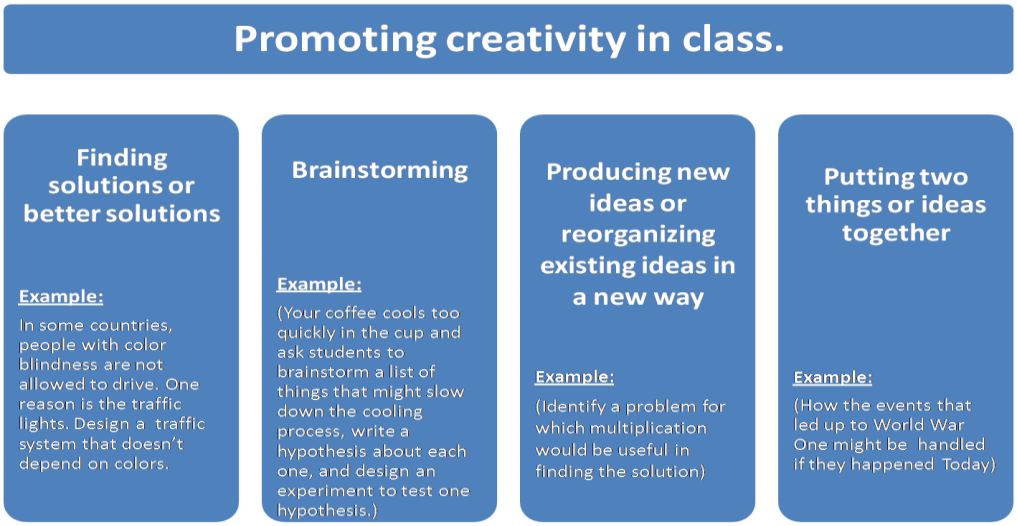

Figure1. Turner's(2013) and Brookhart's(2013) suggested activites to promote creativity.

The importance of a stimulating and supporting *environment* wasn't only addressed by Lin (2011), but also Amabile (2012) and Pollard(2012) affirmed the need of a motivating environment suitable for creative behavior. For creativity to be at its best, it should be cultivated in an open space that supports new ideas, criticism and skills (Scardmalia, 2002; Amabile, 2012; Mahaux, Gotel, Mavin, Nguyen, Mich, & Schmid, 2013).

An important component of a creativity supporting environment is the *teacher's ethos*, where the teacher flexible, reacts positively to new ideas and welcomes independent thinking (Lin, 2011). Trilling & Fadel (2009) as cited by The Pacific Policy Research Center (2010) explained that creativity and innovation are not

something a person is born with or without. They stressed that creativity and innovation can be developed by teachers through encouraging open-mindedness and acceptance of new ideas, learning from failure and effective inquiry.

Students are born curious, and without any preconceptions about science, their experience with science education is what builds their attitude towards it (Bakken, Smith and Fulk, 2010; Downing, 2011). Science is best taught through engagement (McCrory, 2010) inside practical classrooms, where teachers create opportunities for inquiring, searching for information and concluding scientific concepts (International Council for Science, 2011). Alshannag et al. (2015) found that teaching science in KSA mainly is knowledge-based instruction which might contradict with fostering creative think abilities among students. In addition, Erol, Boyuk, Sahingoz, Harrison and Costa (2012) pointed out that there is an alarming tendency to drop science subjects that has been developed at stages as early as grades 8 and 9 due to students' negative attitude towards those subjects (Smith et al., 2012).

To consider effective teaching in the context of 21st century skills, it would probably be useful to focus on the constructivist approach of teaching. In the process of constructivist teaching students are active, engaged and thinking at higher levels to develop their learning (Dada, 2012; Muijs and Reynolds, 2011). According to Fisher & Kim (1999), Aldridge et al (2000) and Hand et al (1997) as cited by Oh and Yager (2004), there is a relationship between constructivist teaching and students' attitudes. Approaching science subjects from a constructivist teaching perspective increases the chances of students developing more positive attitude towards these subjects (Oh and Yager, 2004). Moreover, De Jager (2002) and Kim (2005) as cited by Muijs and Reynolds (2011), shed light on the encouraging impact of constructivist teaching on students' performance in questions that require metacognitive skills and deep grasp of concept.

When putting constructivism into practice, Trumbull (1999), as cited by Garbett (2011), clarified that there are no specific steps to be applied in a certain sequence. The aim is to provide an opportunity for open inquiry that stimulates students' curiosity for questions (Muijs and Reynolds, 2011). Constructivist teachers are well aware of their targets and confident of their leadership ability to manage an effective learning environment inside the classroom and deal with any unpredicted question or comment (Garbett 2011).Inquiry - based learning (IBL) emerged from the constructivist teaching approach that provides an opportunity for students to build their knowledge in science instead of receiving it directly (Buckner and Kim, 2014). Through IBL, children become more involved with their own learning (Touhill, 2012) and their sense of creativity and wonder will not fade as they grow up (Carson, 2011).

Berger's (2014) surprising findings revealed that even though children start out asking hundreds of questions a day, questioning "falls off a cliff" as kids enter school. In an educational and business culture devised to reward rote answers over challenging inquiry, questioning isn't encouraged-and, in fact, is sometimes barely tolerated. As figure2 shows, the percentage of children questions fall after age 4through 18 years from 95% to 24%. This huge difference in percentages dropdown through age has a negative impact on students' curiosity, higher level thinking skills, and creativity and innovation.

Land and Jarman (1993) found that 98% of kindergarteners were classified as geniuses when it came to divergent thinking. They found that this percentage dropped dramatically by the age of ten to 32% and by the age of fifteen it was only 10%. When they tested 200,000 adults, only 2% were considered divergent thinkers. These consequences have been confirmed by Tairab's (2015) secondary study analysis to TIMSS2011 data in the Gulf Region. He found that Grade 8 students' achievement in science, specifically in the reasoning and advance

thinking skills, were away from the international average. The same results were also confirmed by Alshannag et al. (2015) within KSA context.

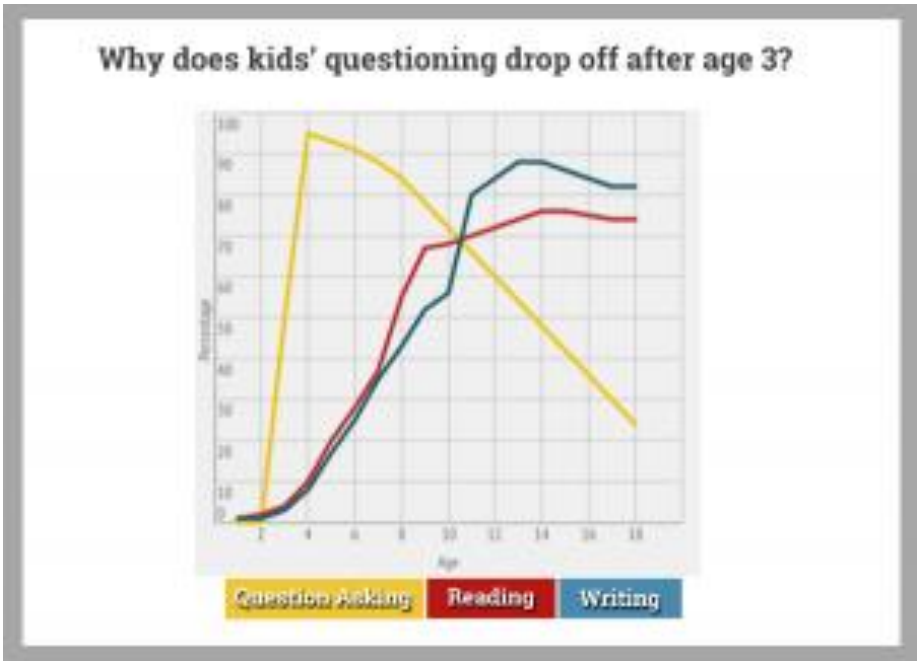

Figure2. Level of children questions through time, Berger (2014) is the source of this image.

In their study, Bocconi, Kampylis and Punie (2012) described the essential elements of *Creative Classrooms* (CCR) putting a great emphasis on the importance of providing for inquiry, collaboration, critical thinking, real life context and evidence-based research. Such elements are the main constituents of the 21st century skills and the basis of implementing IBL (Buckner and Kim, 2014; Chiarotto, 2011).

By combining the highlights of Chiarotto (2011), Bocconi et al. (2012) and Buckner and Kim (2014), a descriptive picture can be painted showing IBL as a considerable effective tool to promote the *creativity and innovation* aspect of the

21st century skills. By doing so, IBL also has the potential to cause a positive influence on students' attitude towards learning in general and STEM subjects in particular.

Research questions:

Our study aimed to answer the following main research questions with its sub-questions:

What changes do we need to implement to boost creativity?

- What teaching strategies do teachers use at present in their science lessons that enhance creativity?
- What are the teachers' perceptions of Inquiry Based Learning (IBL) as a teaching method for science subjects?
- To what extent are teachers willing to adopt IBL as a potential method to help promote 21stcentury?

Data Analysis Methods

One of the unique features of qualitative analysis is approaching data with open mindedness about the themes and categories that might emerge and accept what the data has to say without imposing any explicit theories (Bapir 2012; Denzin and Lincoln, 2009). Suter (2012) summarized the process of handling qualitative data into three steps: *noticing*, *collecting* and *thinking*. He explained that *noticing* involves recording information and then coding it based on a specific framework, while *collecting* is the process of sorting the information and codes, and finally *thinking* is the process of finding patterns and making discoveries. These steps were the ones followed in this research starting with coding the information gathered, then sorting and representing it using visual aids and tabulations which simplified the process of analyzing.

The coding process was based on detecting common themes and patterns, and sometimes based on the number of occurrences of a certain word or idea in a response or group of responses (Zhang and Wildmuth, 2009). Although data was mostly collected through open-ended questions where different participants had difference responses, the coding process was still possible through detecting answers falling under the same criteria or expressing the same idea. The coding and categorization were done over two stages, the first was breaking down the transcripts from interviews, notes from observations and feedback from teachers on some methods for IBL implementation into open codes which is a form of writing headings that describe the aspect pointed (Elo and Kyangas, 2008). Those headings were then grouped and categorized based on their theme and frequency of occurrence. The second stage was using visual aids like tables and diagrams as a powerful means to sort out and present the codes in an organized manner (Suter, 2012).

The data analysis was done using two methods that were found most suitable for the conditions and context of this study: *Template Analysis* and *Content Analysis.* The analysis was done and presented in reference to the research questions and demonstrated how each piece of data fit in to answer a specific research question.

Template Analysis

Cohen, Manion and Morrison (2007) stressed that the process of analyzing data is as important as the methods collecting it. Suter (2012) emphasized that the findings of one data collection method can continuously be compared and weighed against the following one for the sake of obtaining data of reasonable integrity.

Both opinions were considered and applied in this study to pave the road for *Template Analysis* to be conducted. Template analysis uses data collected from previous explorations to form a template that can be utilized in collecting further

data or analyzing the data obtained from different methods (Waring and Wainwright, 2008). Combining Caffarella's (2002) levels of learners' involvement with 21st century skills grouped by the Pacific Policy Research Center (2010) formed the reference against which the teaching strategies used by teachers were assessed. Also, the same reference was used to study and evaluate teachers' responses during the interviews, especially those related to suggested improvements on the current teaching strategies.

In summary, *Template Analysis* was applied in two different ways. The first one was by using one collection method to collect and analyze data, then use the results in the next collection method (Waring and Wainwright, 2008). The second was by using literature and published ideas to compare and assess data from observations and interviews (Suter, 2012).

Content Analysis

Hsieh and Shannon (2005) argued that text data obtained from qualitative collection instruments such as interviews, questionnaires or observations can be analyzed and studied using *Content Analysis*. Spencer, Ritchie, Ormston, O'Connor and Barnard (2013) in concurrence with Onwuegbuzie, Dickinson, Leech and Zoran (2009) described this as a process where themes are not only created, but also counted to figure out the number of times they have been used. This study used *Summative Content Analysis* where the analysis goes beyond the quantitative nature of counting the number of occurrences and describes the meaning hidden inside the theme and what it might indicate within the context producing it (Hsieh and Shannon, 2005; Zhang and Wildemuth, 2009). Tables and cross tabulations were created systematically in order, where individual tables containing the identified themes and how many times they were utilized, were created first. Then selected tables were combined to reveal the meaning of each theme and help answering the research questions related to it.

One-on-one structured interviews with the teachers observed

The interviews were conducted in the school's library or in an empty classroom away from any distractions that might happen. This arrangement provided a comfortable and natural environment that increased the possibility of getting high quality information from the interviewees (Hancock and Algozzine, 2006). The researchers made sure to carry out each interview either directly after the observation or during the same day to reduce the "memory" factor. Delaying the interview will increase the risk of losing information and details due to the teacher's inability to recall what happened during the lesson and therefore affect the validity of the data obtained. Furthermore, to ensure that the effect of any potential bias was minimized, the researchers adhered to the questions prepared for the interview. These questions were validated by scholars of science education for clarity and relevance to the research questions as well as to eliminate any possibility for bias (Bashir, Afzal and Azeem, 2008).

Data from the interviews' note sheets were first sorted in the following form shown in Table1.

This arrangement simplified the comparison between the teachers' responses on the same interview question and made it easy to discover the frequency of occurrence of a particular word, phrase or idea. After detecting the patterns and overlapping ideas another

Table1.
First step in organizing data from interviews

Interview Questions	Teacher 1	Teacher 2	Teacher 3
Interview Question 1			
Interview Question 2			
Interview Question 3			

arrangement of data was made through combining each interview question with the percentage of occurrence of each factor in the answers on that question. This arrangement helped facilitating the analysis of the data obtained against the research questions; each interview question or set of questions provided the information needed for a specific research question. This analysis processes were conduct by the two researchers. The agreements on their analysis in most cases were above 90%. This percentage is acceptable among scholars of qualitative research to guarantee inter-analyzer (rater) reliability.

Semi-Structured questionnaire for Teachers

An IBL implementation document was given to the participating teachers in the form of a semi-structured questionnaire. The document explained in details the process of applying IBL inside a classroom without any judgment favoring the application of IBL or not. The document was developed by summarizing and combining information from books and articles taking into consideration the interviews done and classroom observations done, to make it relevant to the teachers' context. The document was check by an educational expert who confirmed the relevance of the information to the UAE educational environment as well as the absence of any signs of biased opinions.

The information obtained from the teachers' feedback was first organized in a table showing each teacher and his comments. The focus was on the teaching practice and the data revealed was categorized in three sets:

SET 1 – Existing

It indicated that the teachers are already doing this particular step mentioned in the IBL implementation document, as part of their daily practice.

SET 2 – Can be done

It indicated that teachers think they can do this part under the present circumstances.

SET 3 – Can be done with conditions

It indicated that teachers showed willingness to apply this particular step, if certain conditions are satisfied like resources, time…etc.

A second round of analysis produced two new groups: Indicators of willingness and Indicators of Potential. *Indicators of willingness* reflected the teachers' readiness to implement IBL in their teaching. Comments that were placed under this category were from SET 1 and SET 2 and contained phrases such as:

- *"It is already done…"*
- *"It is implemented…"*
- *"We do that…" or " we can do that "*
- *"It helped…"*
- *"Can easily be done…"*
- *"Applicable to high extent…"*

Indicators of Potential pointed out the unwillingness of teachers to implement IBL in their teaching UNLESS some conditions are satisfied. Comments that were placed under this category were from SET 3 and contained words like *Unless*, *Such that*, *If* or the phrases:

- *"Applicable to a limited extent..."*
- *"Students are not trained to…"*
- *"Out of question because…"*
- *"No way because…"*

Issues with Trustworthiness

Researchers such as Cook and Beckman (2006), Jonsson and Svingby (2007) and Kember and Leung (2008) have addressed the issue of trustworthiness in qualitative research from different perspectives and angles, but they all agreed on

the importance of enhancing the validity and reliability of a qualitative study for the sake of increasing its rigorousness.

Drost (2011) looked at reliability as the capability of research to produce similar results using the same instruments but in a different context. Drost (2011) also brought into spotlight the effect of random errors that might influence the reliability of the study due to factors like time or health or any condition that might cause the participant not to present the performance he/she normally does. Drost (2011) also agrees with other scholars such as Cook and Beckman (2006), Jonsson and Svingby (2007) and Shuttleworth (2008) that even though it is difficult to eliminate such elements that can affect the reliability of a study, certain steps can be done to bring their effect to minimum.

This research tackled the issue of reliability in different attempts for the purpose of keeping it at an accepted level. Inter-rater reliability was one of the methods applied where the assistance of an external educational specialist was used to confirm the legitimacy of the findings and the consequent conclusions in addition detecting any signs of bias (McMillan and Schumacher 2006 cited in Bashir et al, 2008; Drost 2011). Another step towards improving reliability was the selection of sample (Morse, Barrett, Mayan, Olson and Spiers,2008). Since the study converges towards the teaching of science in grades 8 and 9, and its effect on students' attitude, only science teachers for those grades were selected for this study. Eight teachers of mixed genders (three males and 5 females) working in two different schools and from different nationalities (India, Pakistan and Lebanon) were observed, interviewed and given an IBL implementation document to study and comment on. Although they teach different curricula (California State Board of Education and English National Curriculum), all teachers were bounded by the same frame of work set by the Abu Dhabi Educational Council. The academic year for both schools, compromises 177 teaching days divided into three terms with six periods per day. Different subjects meet for different number of periods a

week where each period is 50 - 55 minutes. The diversity of nationalities among the science teachers who participated in this study gave the data a wider perspective and depth since the opinions and practices reflected their different backgrounds and experiences (Cohen et al., 2007; Morse et al., 2008 and Drost, 2011).

Cook and Beckman (2006) stressed on the tight relation between the reliability of research and its validity, they considered reliability an essential step towards validity, but not the only one. Validity is another dimension of trustworthiness that focuses on the confidence and reliance that can be given to the results obtained in terms of serving the purpose of the study (Cook and Beckman, 2006; Drost, 2011). The study took validity into consideration starting from the designing stage and made sure that the internal validity (Drost, 2011) was satisfied to a large extent through choosing the proper and convenient timing to conduct the interviews and observations. Moreover, conducting the pilot study added to the strength of the research's validity as it was useful to reduce potential threats due to possible faults in the designing stage (Cohen et al., 2007). The pilot study also had a positive impact on building a good rapport with participating teachers and students, which reduced the alteration that can be caused by the presence of an external observer (Cohen et al., 2007 and Drost, 2011).

Validity and reliability complete each other to increase the credibility and trustworthiness of the research. Morse et al. (2008) and Suter (2012) underlined the importance of checking the dependability and steadiness of data as we collect it. They both agree that the researcher must oscillate continuously between the tools designed for data collection and their implementation to ensure harmony with the data obtained and the usability of it. In the pilot study, lots of aspects were detected and adjusted before the main study was conducted. Moreover, the researchers were also checking and reading through the data as they were collected to maintain its fitness to serve the research questions and fine-tune any step that

required so. Trustworthiness was also supported in this research using triangulation that helped increasing confidence in the data obtained and ensured that the findings and the analysis were supported by the necessary evidence (Guion, Diehl and McDonald, 2011).

Ethics

Before the interviews were conducted, a detailed explanation of the ethical aspects of this research was provided for all the teachers involved through an information sheet given prior to the study, which clarified and assured the anonymity of the interviewees. In addition to that, a consent form was voluntarily signed by the contributors which gave them the freedom to withdraw from the study anytime they feel uncomfortable proceeding with it. The ethical procedure had a positive impact on the teachers as they felt more relaxed and open during the interviews and expressed their opinions freely, hence giving a higher sense of validity to the data obtained (Cohen et al, 2007).

Moreover, the pilot study and coordination visits to the school made the teachers more familiar with the researchers. This contributed to the comfortable feeling needed in the interviews to obtain real and valid data (O'Connor & Gibson, 2003). Another aspect that increased the trust level between the researchers and teachers during the interviews was honoring the teachers' request not to audio tape the interviews. Replacing the audio recording with handwriting notes gave teachers a higher sense of security as it decreased the chances of recognizing their identity. The researchers made sure that the teachers were able to see and read what was written during the interview, which increased the validity of the data obtained since it gave them the opportunity to comment on and confirm what was noted (O'Connor & Gibson, 2003; Bashir et al, 2008).

Results & Discussion:

Classroom Observations

The pilot study conducted favored the unstructured free recording method of observation where the researchers notes down what he/she observes without being restricted by a fixed observational form. As a nonparticipant observer, the researcher attended and observed twelve lessons, each lasting for one period of 50 – 55 min duration. The observations took place in gender segregated classrooms where boys and girls were separated in different classes. Teachers were observed conducting normal classes during regular school hours, some were observed twice, once in a "boys" class and another in a "girls" class. Teachers were not informed about the observation schedule to guarantee that the classes observed were reflective of what happens on daily basis, and no adjustments were made because of the observation. Additionally, during the pilot study, the researcher made sure to pass by all the classes that were going to be observed during the main study and made himself frequently visible for a long period of time to all students. This was done to make students more familiar with his presence and reduce the external observer effect that might affect students' behavior during observation (Cohen et al., 2007).

Even though the unstructured observation style was adopted, the observations were still compassed by two main aims that determined how the data was sorted and tabulated. The first aim was to identify the teaching strategies used by the participating teachers while conducting their science lesson. The second aim was to study the level of students' engagement by observing their behavior, facial expressions, level of participation, and willingness to contribute in discussions or give answers to teacher's questions (Johnson, 2013).

Data from observation sheets were sorted and organized in three steps. The first step was tabulating the different note sheets in one table containing the teacher's code, as per the coding system explained in the ethical part of the methodology, in addition to the basic comments and remarks observed during their lesson. The second step was highlighting with color codes all phrases and words referring to the teaching strategies used, skills promoted and students' behavior and reactions as a result of these strategies. The final step was creating two separate tables as follows:

A) Table2**.**Sorts out the percentage of the classes observed where that particular strategy was used.

Table2

Percentage of occurrence of each strategy among all the classes observation

	Teaching Strategies Observed- Common Strategies					
	Presenting the objectives	General questions and answers sessions/ Discussions	Solving exercises from the book	Solving exercises from the worksheet	Promoting collaborative work (Groups/Pairs)	Presenting information through ICT (Videos, Slides)
% of occurrence among observations (Rounded)	60%	100%	25%	75%	25%	40%

For example, 60% of the classes observed had the objectives presented clearly to students, while approximately 25% of them promoted or showed signs of group work.

B) Table**3** highlights the basic and common behavioral signs of students' engagement observed in about 90% of the classes observed.

Table3

Behavioral signs of students' engagement

Students' Engagement	Common notes observed
Observation notes	In almost 90% of the lessons observed, at least 50% of students showed the following signs: • Yawning • Playing • Chatting • Sleeping • Or neutral signs
Notes	- In one of the girls' classes, the girls clearly express their negative attitude towards physics specifically due to its large involvement with math.

The two tables were created to simplify the comparison between the data obtained from the different data collection methods used in this study and to enable the researchers to analyze the findings in focused and systematic manner.

Table4 shows that "Classroom Walls", for example, was mentioned 7 times as something already being used in regular practice and once as something that can be done. On the other hand, "Resources" was mention 2 times as available and being used, 3 times as can be used better and 3 times as a need to enable the implementation of IBL.

After collecting the data needed, a systematic approach to data analysis was

conducted where the Content and Template analysis methods were used to correlate and combine the different data obtained in one picture (Cohen et al, 2007;

Newby, 2010). Specific pieces of data were combined together and investigated to find a satisfactory answer to the targeted research question.

Table4

Positive and Negative Indicators of two rounds of data analysis

			SET 1	SET 2	SET 3
Domain	Environment	Classroom walls	7	1	0
		Seating configuration	3	4	1
		Resources	2	3	3
		A gathering place	8	0	0
		Sub total	20	8	4
	Implementation	Planning	5	1	2
		Retrieving	4	2	2
		Processing	1	5	1
		Creating	1	5	2
		Sharing	1	4	2
		Evaluation	2	5	1
		Sub Total	14	22	10
	Assessment	Assessment FOR Learning	2	6	1
		Assessment AS Learning	1	7	1
		Sub Total	3	13	2
	Total for Each Set		37	43	16
	Total positive indicators		*80*		
	Total negative indicators		*16*		

What teaching strategies do teachers use at present in their Science lessons that enhance creativity?

To study the extent to which the 21st century skills were supported by the teachers observed, the teaching strategies used during the observed lessons must be identified and examined. To approach this research question, Caffarella's (2002) levels of learners' involvement were used to categorize the strategies adopted in the lessons observed into low, medium and high involvement. Also data from observation and from teachers' one-on-one interviews were combined to form the following tabloid (Table 5):

Table5

Identifying the teaching strategies

Interview Question: Can you identify up to three teaching strategies, which you already used in your lesson?				
Source of Data		Common answers		
		Discussion (General Questions and Answers session)	Problem Solving (Exercises were taken from the textbook and worksheets)	Presenting the information through ICT (Videos, Songs, Slides)
Interview	% of this Response	70%	90%	30%
Observation	Observed by researcher	YES	YES	YES
Caffarella's Involvement Criteria	Level of involvement	Low involvement	Low involvement	Low involvement

The combination of data in this way exposed a set of noticeable points to be discussed. First, it was possible to confirm that the teaching strategies identified by the teachers during the interviews were also observed during classroom observations. The second point was the high degree of unanimity among teachers in identifying "Discussion", "Problem Solving" and "Presenting Information using ICT" as good teaching strategies used, with "Problem Solving" having the highest

percentage of occurrence among the answers. The third point was revealed after classifying each strategy under the level of involvement it belongs to, which showed that all the teaching strategies acknowledged fit into the "Low Involvement" category.

In light of these points, further examination of data in Table 5tips towards suggesting that since the common strategies used yielded a low level of students' involvement, then according to McCrory (2010), the International Council of Science (ICSU) (2011) and the Partnership for 21st Century Learning (2015) these strategies might not be strong enough to promote 21st century skills especially creativity. This explains the observed behavioral signs of boredom like yawning and chatting, which reflect a low level of student engagement and lack of concentration (Marzano Center, 2012 and Johnson, 2013).

It is important to note that during the observation of two classes (one in each school) a considerable increase in willingness to participate was noticeable every time the teacher posts a question or a comment related to a session that included an experiment. This could strongly indicate that teaching strategies that involve students in experiments and demonstrations could provide a deeper understanding which will reveals itself in students' enthusiastic attempt to engage (Hackling, 2005).

The aid of graphical representations was also used to help simplifying the interpretation of the data obtained from the one – on –one teacher's interviews. Figure3 below shows clearly the suggested modifications proposed by the teachers interviewed to improve their teaching methods.

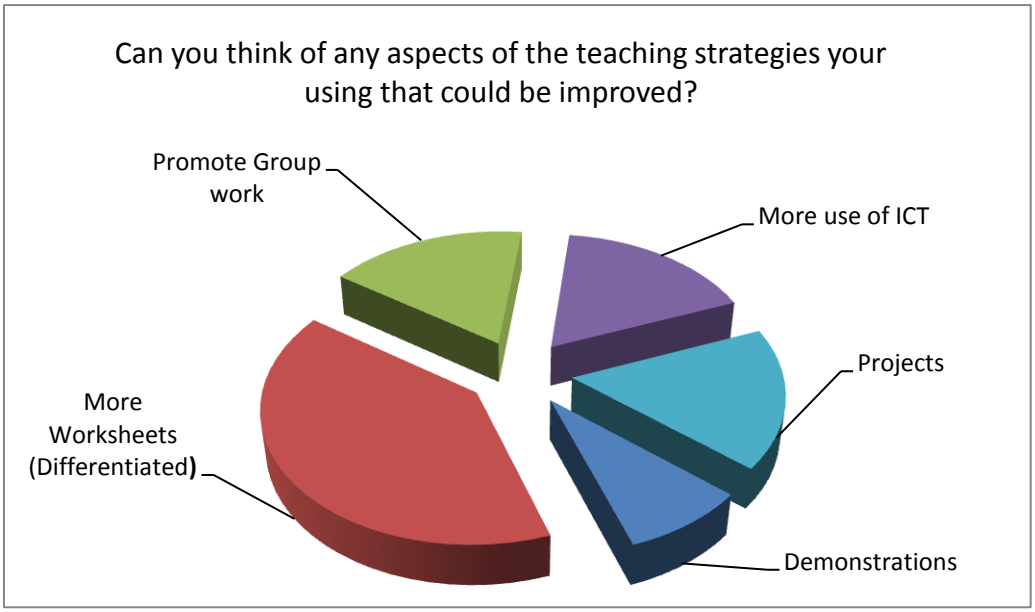

Figure3: Aspects of the teaching strategies that could be improved.

Figure 3 reflects clearly that increasing the number of worksheets was the most common idea among the suggestions followed by "Group Work", "Project" and "More use of ICT" with equal percentage of occurrence, which leaves "Demonstrations" to be the least suggested. When examined against the levels of learners' involvement, Table6was produced and showed that a high percentage of the improvement proposals were still in the "Low Involvement" category. A very small percentage had the potential to improve the involvement level reflecting an assumption that such suggestions don't mirror sufficient teacher awareness of high involvement teaching strategies which leads to positive attitudes that in turn nurtures students' creativity, especially that the majority of teachers thought that their observed lessons were effective and students were active and highly involved, while the observation notes didn't reflect that. Based on the information discussed,

it is highly probable that teachers might need to improve their lesson evaluation skills in terms of effectiveness and students' engagement.

Table6
Suggestions to improve the teaching strategies

Interview Question: Can you think of any aspects of the teaching strategies your using that could be improved?

Common answers

	Demonstrations	More Worksheets (Differentiated)	Promote Group work	More Videos and simulations using ICT	Projects
% of this Response	15%	70%	30%	30%	30%
Level of Involvement as per criteria	Low Involvement	Low Involvement	Medium Involvement	Low Involvement	High Involvement

An educational specialist not involved in the study and doesn't know any of the teachers involved, arrived to a similar conclusion when the observation notes and teachers' interview responses were presented to her. Ethical procedures were followed when presenting the information so that there was no possibility to identify the name of any of the teachers observed or interviewed.

What are the teachers' perceptions of Inquiry Based Learning (IBL) as a teaching method for science subjects?

It was important to see what teaching strategies were practiced in the context of this study and how do teachers evaluate these strategies in terms of students' engagement. This lead to a conclusion that, not enough effective teaching strategies were observed and therefore 21st century skills were not promoted enough. The study proceeded to examine the teachers' attitude towards IBL as a strategy that can promote 21st century skills and provide an opportunity to engage

students effectively thus affecting their attitude towards science and promoting their creativity (Craig, 2011; Blackboard, 2011; Hanover Research, 2011 and Hillman, 2012).

At first we needed to measure the teacher's knowledge of IBL as a teaching strategy and pedagogical method to promote creativity; 70% of the teachers involved were not familiar with IBL while 30% said they did but defined it as:

"Elicit the answers from students (Questioning method). It is applied to move from concept they know to complex ideas they don't know"

Or

"Learning by trial and error through research."

Both answers didn't reflect a satisfactory level of awareness of IBL.

Therefore, a brief explanation of IBL as a teaching strategy was given to all teachers interviewed to guarantee that they are acquainted with the topic being discussed so can establish common grounds and increase the reliability of answers. After that, teachers were asked to explain their feeling towards IBL and 70% expressed that it is a difficult strategy to implement, the term "NO WAY" was explicit enough to reflect how difficult one of the teachers thought it was to apply it. Figure4 shows the set of reasons why teachers thought IBL was difficult to put into practice?

The "attitude towards learning" was the factor that had the highest percentage of occurrence among the teachers' answers (35%). Teachers interviewed stated that most parents, students and school administrations consider summative assessments (quizzes, exams, tests…) as one of the most effective tools to measure effectiveness of teaching and learning. This opinion resonates with Brady's (2013) explanation that in some cases, good teaching is directly related to exam results and agrees to a great extent with Mercer's (2007) study on teachers' appraisal in United Arab Emirates where teachers expressed that the passing rate of students plays a big role in their evaluation as teachers.

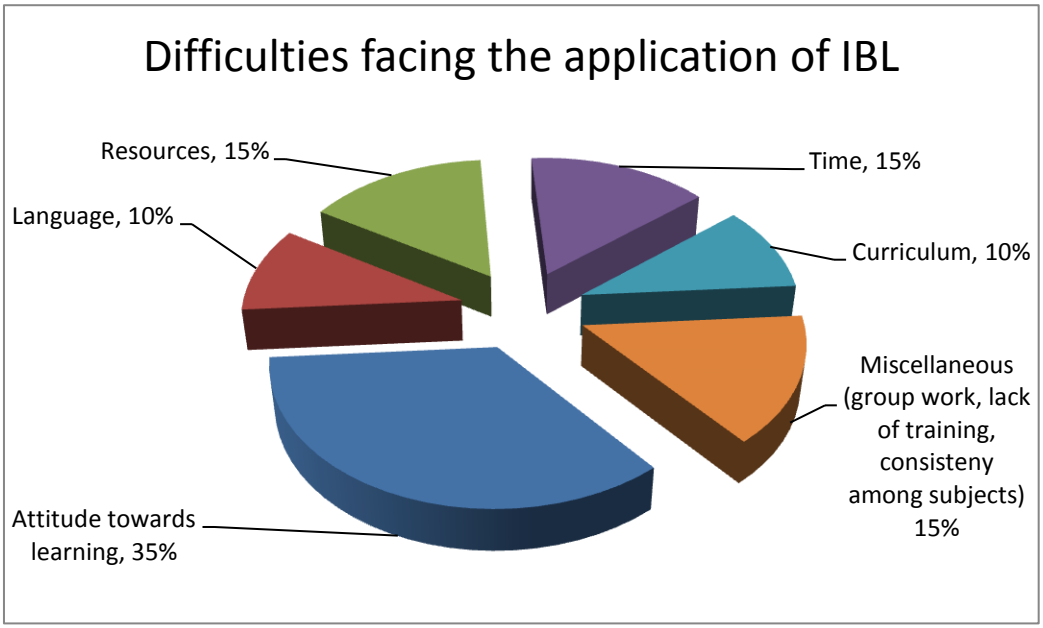

Figure4. Difficulties facing the applpication of IBL as per teachers' questionnaire

Since IBL depends mostly on formative assessment and day by day constructive feedback and evaluation, teachers were worried that such a new method of teaching might not be accepted by the stakeholders and reflect badly on their

evaluation as teachers. This explained the direct teaching observed during most of the lessons and resonates with the studies conducted by Fitzpatrick (1982), Gales and Yan (2001) cited in Muijs and Reynolds (2011) discovered a direct correlation between direct teaching and good exam results. This might also explain why the time factor was mentioned in 15% of the answers, as most of the teachers explained that they don't have enough time to go for strategies like IBL because then they won't be able to finish the curriculum and prepare the students for the tests. Although Snyder and Snyder (2008) emphasized that the content and the teaching methods are of equal importance to promote thinking and engagement, it might still be difficult in this context to support that with O'Neill and Polaman's (2004) suggestion to teach less scientific content for the sake of more opportunities for creative deeper understanding and student engagement.

Lack of resources was another major issue that teachers believe will face them should they adopt IBL as a teaching method. It must be noted that the phrase "lack of resources" mainly referred to not having enough access to the internet, or not enough space and equipment in the laboratory. Teachers seem to think of the internet as the main and maybe the only source of information, without considering other sources such as books, media and encyclopedia CDs that were available in both school's libraries. Although promoting effective use of ICT is one of the essential requirements of 21st century learning skills, yet the lack of the ICT resources shouldn't be a reason not to implement IBL as there are several ways to get the needed information other than the internet. Moreover, demonstrations and experiments are good sources of information even if they were done in a simplified manner inside the classroom. After checking the science curriculum for both schools, it was apparent that a lot of safe and simple experiments and demonstrations can be done for grades 8 and 9 without using sophisticated equipment. So the lack of space and equipment was also not convincing enough not to utilize engaging activities.

All this might suggest that "lack of training" might be a reason why some teachers couldn't see how to overcome some of the obstacles that might face them should they try to implement IBL. "Lack of training" was proposed by some teachers during the interviews and it is worth looking at to understand whether this can be considered a reason why teachers might avoid new creative methods (Tierney, 2004). This can be expected because up till now a bachelor degree is enough to be eligible to teach in United Arab Emirates, and this will remain the case till a new polices required teachers to have a teaching qualification (Dajani and Pennington, 2014). By no means was this presented to underestimate the capabilities of the present teachers, but it was only to indicate that the suggestion of more training is valid and might be highly beneficial for teachers.

To what extent are teachers willing to adopt IBL as a potential method to help promote 21st century?

The discussion done so far has led us to this question. To study to what extent teachers are willing to equip students with the skills believed to be critical is in fact to look into their willingness to promote 21st century skills and high student involvement strategies in their classrooms.

The analysis showed that the teachers' strategies selected and the proposed adjustments were mostly under the low involvement category, and when IBL was presented to them as a teaching strategy that can increase the level of learners' involvement and at the same time promote 21st century skills, they all agreed on its benefits but highlighted some difficulties that might face the implementation.

The IBL implementation document was an unbiased manual that only explained the steps to apply IBL in a simplified manner. The aim of this document was to measure how teachers will react towards IBL if the steps of putting it into practice were simplified, detailed and organized. Table 4before shows high scores for SET 1 and SET 2, which indicates that after studying the IBL implementation

document; teachers sensed that lots of aspects were already being practiced during their daily work like using the classroom walls, planning and retrieving (SET 1). Also, their comments indicated that, there are considerable steps that could be done under the present conditions such as seating configuration, processing and assessment AS learning (SET 2). When the scores of SET 1 and SET 2 were combined as "*Positive Indicators*" their total (80 points) was greater than the "*Negative Indicators*" of SET 3 (18 points). This could suggest that the teachers' attitude towards implementing IBL started to change when the process was elucidated. This could also indicate that effective training might boost the teachers' enthusiasm to try new strategies that can take their context into consideration and at the same time promote 21st century skills needed for student's future learning experience.

Conclusion

The skills required for students to have a successful journey in their higher education are ought to be tackled during their early school years, probably as early as grades 8 and 9 if not earlier (Smith et al., 2012). The high involvement level in science classes increases the possibility of establishing a positive attitude among students towards science. More studies are necessary to outline effectual methods to facilitate students' transition to their next level of education with a positive attitude towards science and science related majors.

Since the focus on students' creativity and attitude towards science starts from school, teachers are expected to effectively nurture curiosity and encourage the positive attitude towards science. This is demanded from them by various schools and parents without taking into account the possibility that teachers might not have enough knowledge about effective and engaging pedagogy and/or how to implement it within their context. This study pointed out that a number of teachers aren't well acquainted with motivating teaching methods and can't identify the

steps to improve their current practice. Therefore, more research needs to be done in order to find out and understand how much teachers *know* about high involvement teaching strategies and *to what extent* they are able to apply them.

In addition to that, it is important to train teachers not only how to conduct new teaching strategies, but also how to evaluate the effectiveness of such strategies. Teachers involved in this study ranked their methods highly in terms of students' engagement, but the class observations didn't reflect the same. Basic training might not be a problem in some countries where a teaching qualification is a must to practice teaching; this is not that case in United Arab Emirates, where a bachelor of science is enough to become a science teacher.

Inquiry based learning (IBL) was introduced in this study as one of the engaging methods that can generate high students' involvement in class and increase their intrinsic motivation and creativity (NRC, 2013). Teachers were reticent and reluctant to apply such strategy and a few of them declared that it can't be applied in their circumstances. A noticeable change in attitude occurred when a simplified and descriptive IBL implementation document was presented to them. This suggests that teachers might be willing to promote this strategy or similar ones if they know further about it and undergo the necessary training.

In conclusion, teachers *need to know how to do what they are expected to do*. Teachers' pedagogical subject content knowledge, pedagogical content knowledge (Shulman, 1986), and awareness of their context must be at a sufficient level in order to deliver effective lessons that promote students' engagement (Garbett, 2011; Muijs and Reynolds, 2011).

Moreover, the study presented by Blonder, Benny and Jones (2014), shows a positive correlation between the teacher's self-efficacy and his/her willingness to use new teaching methods such as inquiry and collaborative work. In the same

study, Blonder et al. (2014) accentuated the importance of training in lifting up teachers' self-belief thus causing a positive alteration to their teaching behavior.

The deeper students are engaged and motivated to ask high level thinking questions the more creative they can become and the more they will like the subject and develop a positive attitude towards it. Add to that the fact that effective lessons can promote 21st century skills that are essential for facilitating students' higher education.

References

Alshannag, Qasim, Schreier, Helmut, Abdel-Fattah, Faisal, Alshaya, Fahad (August, 2015). *The effect of KSA Teacher Assessment Practice on grade 8 Students' Achievement in Science: A Secondary analysis of TIMSS-2011.* ESERA Annual Conference, Helsinki, Finland.

Amabile, T. (2012). *Componential theory of creativity*.Harvard Business School.

Bakken, D., Smith, R.,& Fulk, J.(2010).Science. In: Boon, R. and Spencer, V. (eds.) (2010). *Best practices for the inclusive classroom.* Texas: Prufrock Press.

Bapir, M. (2012).*Is it possible for qualitative research to be properly valid and reliable*. Retrieved 01/07/2014 from: http://www.academia.edu/997438/Validity_and_Reliability_in_Qualitative_Researh

Bashir, M., Afzal, M. T., & Azeem, M. (2008).Reliability and validity of qualitative and operational research paradigm. *Pakistan Journal of Statistics and Operation Research*, *4*(1), 35-45.

Berger, warren (2014).*A more beautiful question: The power of inquiry to spark breakthrough ideas*. Blooms Burry, New York.

Blackboard. (2008). *Teaching in the 21st century: A review of the issues and changing models in the teaching profession*. Edu Views. Retrieved 24/07/2014 from: http://www.blackboard.com/resources/k12/K12_Teaching21st_Final.pdf.

Blonder, R., Benny, N., & Jones, M. G. (2014).Teaching self-efficacy of science teachers. In *The Role of Science Teachers' Beliefs in International Classrooms*, 3-15.SensePublishers.

Bocconi, S., Kampylis, P., & Punie, Y. (2012).Innovating teaching and learning practices: Key elements for developing creative classrooms in Europe. *E-Learning Papers*, (30).

Brady, L. (2013). Curriculum Evaluation: Where Are We Now?. *Curriculum and Teaching*, *28*(2), 61-72.

Brookhart, S. M. (2013). Assessing Creativity. *Educational leadership*, *70*(5), 28-34.

Buckner, E., & Kim, P. (2014).Integrating technology and pedagogy for inquiry-based learning: The Stanford Mobile Inquiry-based Learning Environment (SMILE). *Prospects*, *44*(1), 99-118.

Caffarella, R. S. (2002). *Planning programs for adult learners: A practical guide for educators, trainers, and staff developers. The Jossey-Bass Higher and Adult Education Series*. Jossey-Bass/Pfeiffer, Customer Care Center, 10475 Cross point Blvd., Indianapolis, IN 46256.

Carson, R. (2011). *The Sense of Wonder.* New York: Open Road Media

Chiarotto, L. (2011). Natural Curiosity: Building Children's Understanding of the World through Environmental Inquiry/A Resource for Teachers.

Cohen, L. Manion. L. and Morrison, K.,(2007). Research Methods in Education.

Cook, D. A., & Beckman, T. J. (2006). Current concepts in validity and reliability for psychometric instruments: theory and application. *The American journal of medicine*, *119*(2), 166-e7.

Craig, J. (2011) Six steps for implementing 21st century skills. *Impact on Instructional Improvement, 30*(1), 17

Dada, R. (2012). Training and development of educational staff. In: The Emirates Center for Strategic Studies and Research, *Essentials of School in the United Arab Emirates.* United Arab Emirates: The Emirates Center for Strategic Studies and Research.

Dajani, H. & Pennington, R. (2014).New licensing system for teachers in the UAE. *The National UAE*. 3 June. Retrieved 29/07/2014 from:

http://www.thenational.ae/uae/education/new-licensing-system-for-teachers-in-the-uae

Davis, J. M. (2013). Supporting creativity, inclusion and collaborative multi-professional learning. *Improving Schools*, *16*(1), 5-20.

Denzin, N. K., & Lincoln, Y. S. (2009).Qualitative research. *Yogyakarta: Pustaka Pelajar*.

Downing, C. (2011). *The number one reason your students hate science:* Engaged in Science. Retrieved 15/05/2014 from: http://engage-in-science.com/

Drew, C. (2011). Why science majors change their minds (It's just so darn hard). *New York Times*, 51-52.

Drost, E. A. (2011). Validity and reliability in social science research. *Education Research and Perspectives*, *38*(1), 105.

Elo, S., and Kyngäs, H. (2008).The qualitative content analysis process. *Journal of advanced nursing*, *62*(1), 107-115.

Erol, M. Boyuk, U., Sahingoz, R., Harrison, T.G, and Costa, M.F (2012). Energy Education Science and Technology Part B: Social and Educational Studies. *Developing experiment-based science teaching skills: A lifelong learning opportunity for teachers in a rural area of Turkey*, *4*(4), 2327 – 2338.

Garbett, D. (2011). Constructivism deconstructed in science teacher education. *Australian Journal of Teacher Education*, *36*(6), 3.

Guion, L. A., Diehl, D. C. and McDonald, D. (2011). Triangulation: Establishing the validity of qualitative studies. Sage Publications, USA.

Hackling, M. (2005). *Working Scientifically: Implementing and assessing open investigation work in science.* Department of Education and Training, Western Australia. Retrieved 01/08/2014 from: http://www.rhodes.aegean.gr/ptde/labs/lab-e/downloads/articles/workingscientifically.pdf Hancock, D. R., and Algozzine, B. (2006). *Doing case study research: A practical guide for beginning researchers*. Teachers College Press.

Hanover Research (2011).*Best Practices in Implementing 21st Century Skills Initiatives.* Washington: Hanover Research. Retrieved 02/06/2014 from:

http://www.hanoverresearch.com/wp-content/uploads/2012/05/Best-Practices-in-Implementing-21st-Century-Skills-Initiatives-Membership.pdf

Hillman, N. (2012). *Learning 21st century skills: Implementation of programs and* practices. University of Southern California.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288.

International Council for Science (2011).*Report of the ICSU Ad-hoc Review Panel on Science Education.* Paris. Retrieved 02/03/2014 from: http://www.icsu.org/publications/reports-and-reviews/report-of-the-icsu-ad-hoc-review-panel-on-science-education/Report%20on%20Science%20Education%20final%20pdf.pdf

Johnson, B. (2013) *How do we know when students are engaged?* The George Locus Educational Foundation. Retrieved 28/05/2014 from: http://www.edutopia.org/blog/student-engagement-definition-ben-johnson

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational research review*, *2*(2), 130-144.

Jukić, T. (2011).Implicit theories of creativity in early education. *Hrvatski Časopis Za Odgoj I Obrazovanje*, *13*(2), 38-65.

Kember, D., & Leung, D. Y. (2008).Establishing the validity and reliability of course evaluation questionnaires. *Assessment & Evaluation in Higher Education*, *33*(4), 341-353.

Kharbach, M . (2014). 10 teaching practices every 21st Century teacher should do. *Educational Technology and Mobile*. Retrieved 11/03/2014 from: http://www.educatorstechnology.com/2012/06/10-teaching-practices-every-21st.htm.

Land, G., & Jarman, B. (1993). *Breakpoint and beyond: Mastering the future--today*. HarperCollins.

Learning Sciences, Marzano Center (2012).Monitoring student interest by walking around – part 2: Strategies for student engagement. Retrieved 29/05/2014 from: http://www.marzanocenter.com/blog/article/monitoring-student-interest-by-walking-around-part-2-strategies-for-student/

Lin, Y. S. (2011). Fostering creativity through education–a conceptual framework of creative pedagogy. *Creative Education*, *2*(03), 149.

Longo, C. (2010). Fostering creativity or teaching to the test? Implications of state testing on the delivery of science instruction. *The Clearing House*, *83*(2), 54-57.

Mahaux, M., Gotel, O., Mavin, A., Nguyen, L., Mich, L., & Schmid, K. (May,2013). Collaborative creativity in requirements engineering: Analysis and practical advice. In *Research Challenges in Information Science (RCIS), 2013 IEEE Seventh International Conference on* (pp. 1-10).IEEE.

McCrory, P. (2010). Developing interest in science through emotional engagement. In Harlen, W. (ed) *ASE Guide to Primary Science Education* – New Edition. Association for Science Education.

Mercer, J. (2007).Challenging appraisal orthodox: Teacher evaluation and professional development. In The United Arab Emirates. *J Pers Eval Educ*, DOI 10.1007/s11092-007-9024-9.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008).Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 13-22.

Muijs, D., & Reynolds, D. (2011). *Effective teaching: Evidence and practice*. Sage, USA.

Newby, P. (2010). *Research methods for education*. Pearson Education, USA.

NRC (2013). *Next generation science standards*. Retrieved 12/10/2013 from: http://www.nextgenscience.org.

O'Connor, H., & Gibson, N. (2003).A step-by-step guide to qualitative data analysis. *Pimatisiwin: A Journal of Indigenous and Aboriginal Community Health*, *1*(1), 63-90.

Oh, P.S., and Yager, R.E. (2004). Development of constructivist science classrooms and changes in student attitudes toward science learning. *Science Education Journal*, *15*, 105-113.

O'Neill, D. and Polman, J. L. (2004). Why educate "little scientists?" Examining the potential of practice-based scientific literacy. *Journal of research in Science Teaching*, *41*(3), 234-266.

Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009).A qualitative framework for collecting and analyzing data in focus group research. *International Journal of Qualitative Methods*, *8*(3), 1-21.

Oral, G. (2006).Creativity of Turkish prospective teachers. *Creativity Research Journal*, *18*(1), 65-73.

Pacific Policy Research Center. 2010. *21st century skills for students and teachers.* Honolulu: Kamehameha Schools, Research & Evaluation Division

Partnership for 21stCentury Learning (2015).P21 framework definitions. Retrieved 27/04/2014 from: http://www.p21.org/storage/documents/docs/P21_Framework_Definitions_New_Logo_2015.pdf

Pollard, V. (2012). Creativity and education: Teaching the Unfamiliar Australian. *Association for Research in Education (NJ1)*.

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21stcentury teaching. *Phi Delta Kappa*, *94*(2), 8-13.

Sak, U. (2004). About creativity, giftedness, and teaching the creatively gifted in the classroom. *Roeper Review*, *26*(4), 216-222.

Scardamalia, M. (2002).Collective cognitive responsibility for the advancement of knowledge. *Liberal Education in a Knowledge Society*, *97*, 67-98.

Shaheen, R. (2010). Creativity and education. *Creative Education*, *1*(03), 166.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 4-14.

Shuttle Worth, M. *Validity and reliability*. Retrieved on Mar 03, 2013, from explorable.com: http. *explorable. com/validity-and-reliability*.

Smears, E., Cronin, S., & Walsh, B. (2011). A risky business: creative learning in education. *Teacher Advancement Network Journal*, *2*(1).

Smith, M. C., Walker, D. A., & Hamidova, N. (2012). A structural analysis of the attitudes toward science scale: attitudes and beliefs about science as a multi-dimensional composition. In *Annual Meeting of the American Educational Research Association*.

Snyder, L. G., & Snyder, M. J. (2008).Teaching critical thinking and problem solving skills. *The Delta Pi Epsilon Journal*, *50*(2), 90-99.

Spencer,J., Ritchie, J., Ormston, R., O'Connor, W. &Barnard, M. (2013). Analysis: practices, principles and processes. In: Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (Eds.). *Qualitative research practice: A guide for social science students and researchers.* Sage Publications, USA.

Suter, W. N. (2012). *Introduction to educational research: A critical thinking approach*. Sage Publications, USA

.

Tairab, H. (April, 2015). *What can we learn from 2011TIMSS' findings? Challenges for GCC countries*. International Conference on Education in Mathematics, Science & Technology (ICEMST2015) Conference Proceedings, Antalya, Turkey.

Tierney, B. (2004). *How to write to learn science*. NSTA Press.

Touhill, L. (2012). National quality standard professional learning program: Inquiry based learning. *Retrieved on January*, *6*, 2013.

Turner, S. (2013). Teachers' and pupils' perceptions of creativity across different key stages. *Research in education*, *89*(1), 23-40.

Waring, T., & Wainwright, D. (2008). Innovative developments in the use of template analysis: Two comparative case studies from the field. In *7th European Conference on Research Methodology for Business and Management Studies*, 293. Academic Conferences Limited.

Zhang, Y., & Wildemuth, B. M. (2009).Qualitative analysis of content. *Applications of social research methods to questions. In Information And Library Science.* Retrieved 03/08/2015 from: https://www.ischool.utexas.edu/~yanz/Content_analysis.pdf