A Study of the Effectiveness of the Next Generation Science Standards Implementation at a Private US Curriculum School in Dubai, UAE

دراسة لفعالية تطبيق معايير العلوم الجيل القادم في مدرسة خاصة تعتمد المنهج
الاميريكي في دبي ، الإمارات العربية المتحدة

by

HANADI AHMAD SALEH

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Abstract

This study aims to evaluate the implementation of the Next Generation Science Standards, the latest science education reform in the United States, in order to determine its effectiveness in one private US curriculum school in Dubai, UAE. The school has been chosen based on its good KHDA reputation and low students' achievements in external examinations. Mixed methods approach of both quantitative and qualitative instruments have been adopted. Twenty science teachers have been purposefully selected and participated in the close-ended teachers' questionnaire to evaluate their receptivity and perceptions of the NGSS. Then, nine science teachers have been interviewed and observed in their classrooms to assess the extent of accommodations between the intended, perceived and operated curriculum. The quantitative data from the questionnaire has been analyzed using SPSS while the qualitative data from the interviews and observations have been analyzed using the thematic content analysis. The results reflected that the science teachers were convinced about the NGSS curriculum despite the encountered challenges during its implementation. Teachers' descriptions of their instructional practices were compatible with the components and demands of the NGSS though few teachers have ignored the integration of the cross cutting concepts in the teaching practices. However, the classroom observations have showed that despite well- informed understanding of the NGSS content and structure, the teachers were not able to completely shift their classroom instructions as what they have described. This has suggested the presence of gaps between the perceived and implemented NGSS in the classrooms. The results could be utilized for planning professional development sessions to better understanding the changes in science teaching that the NGSS are trying to offer and thereby support the science teachers to shift instructions towards the three dimension model of learning of the NGSS. Lastly, this study would be a precursor for a variety of following research in evaluating the implementation of NGSS from different perspectives in the context UAE.

Key Words: NGSS, Curriculum, Science, Effectiveness, Implementation, UAE

ملخص

تهدف هذه الدراسة إلى تقييم تطبيق معايير العلوم للجيل القادم (NGSS) ، وهو أحدث إصلاح لمناهج تعليم العلوم في الولايات المتحدة الامريكية، من أجل تحديد فعاليتها في إحدى مدارس المناهج الأمريكية الخاصة في دبي ، الإمارات العربية المتحدة. تم اختيار المدرسة بناءً على تقييمها الجيد في هيئة المعرفة والتنمية البشرية (KHDA) وإنجازات الطلاب المنخفضة في الامتحانات الخارجية. إن المنهجية المتبعة في هذا البحث عبارة عن مزيج بين المنهجين الكمي والنوعي. تم اختيار عشرين من مدرسي العلوم بشكل هادف وشاركوا في استبيان المعلمين لتقييم تقبلهم وتصوراتهم عن معايير العلوم للجيل القادم. بعد ذلك ، تم إجراء مقابلات مع تسعة من مدرسي العلوم كما تم مراقبتهم في فصولهم الدراسية لتقييم مدى التوفيق بين المناهج الدراسية المقصودة والمدروسة والمدارة. وقد تم تحليل البيانات الكمية من الاستبيان باستخدام SPSS في حين تم تحليل البيانات النوعية من المقابلات والملاحظات باستخدام تحليل المحتوى الموضوعي. عكست النتائج أن معلمي العلوم كانوا مقتنعين بمنهج NGSS على الرغم من التحديات التي واجهتهم أثناء تنفيذه. كانت أوصاف المعلمين لممارساتهم التعليمية متوافقة مع مكونات ومتطلبات NGSS ، على الرغم من ان القليل من المعلمين تجاهلوا دمج المفاهيم الشاملة في ممارسات التدريس. ومع ذلك ، فقد أظهرت ملاحظات الفصل أنه على الرغم من الفهم الواعي لمحتوى وهيكل NGSS ، فإن المعلمين لم يتمكنوا من تحويل تعليمات الفصل الخاصة بهم تمامًا كما وصفوها. وقد اقترح هذا وجود فجوات بين NGSS المتصورة والمنفذة في الفصول الدراسية.هذه النتائج يمكن استخدامها للتخطيط لجلسات التطوير المهني لفهم التغييرات في تدريس العلوم بشكل أفضل والتي يحاول NGSS تقديمها وبالتالي دعم معلمي العلوم لتحويل التعليمات إلى نموذج الأبعاد الثلاثة لتعلم NGSS. أخيرًا ، ستكون هذه الدراسة مقدمة لمجموعة متنوعة من الأبحاث التالية في تقييم تنفيذ NGSS من وجهات نظر مختلفة في سياق دولة الإمارات العربية المتحدة.

الكلمات المفتاحية: NGSS ، المناهج ، العلوم ، الفعالية ، التنفيذ ، الإمارات العربية المتحدة

Dedication

This thesis is dedicated to my brilliant and outrageously loving, supportive and always encouraging, ever faithful **family**. A special feeling of gratitude to my loving parents, **Ahmad Saleh** and **Fatima Saleh**, whose words of encouragement and push for tenacity rings in my ears. My little brothers, **Mohammad** and **Mohannad** have never left my side and are very special. My sister **Hiba Saleh**, her husband **Raed Hamza** and their daughter **Teya** and their son **Mohammad** have always motivate me to be more persistent towards achieving my goals.

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List of Acronyms and Abbreviations

CCCs	Crosscutting concepts
CCSS	Common Core State Standards
DCIs	Disciplinary Core Ideas
IB	International Baccalaureate
KHDA	Knowledge and Human Development Authority
MENA	Middle East North Africa
NGSS	Next Generation Science Standards
PEs	Performance Expectations
PISA	Programme for International Student Assessment
SEPs	Science and Engineering Practices
SPSS	Statistical Package for Social Sciences
TIMSS	Trends in International Mathematics and Science Study
UAE	United Arab Emirates
UK	United Kingdom
US	United States

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Chapter 1: Introduction

1.1. Background of the Research:

The economic and social development of countries and individuals depend on well-educated citizens in mathematics and science as agreed in international education literature (Almomani 2016; Alqasemy 2013; Binkley et al. 2012; Peters et al. 2012; NRC 2012). In this regard, the educational national priorities focus on actions to lift mathematical, scientific and technological literacy (Kang and McCarthy 2018; Malkawi and Rababah 2018; Richmond et al. 2016; Klein et al. 2012). According to the National Research Council (2012) "Science, engineering, and technology permeate nearly every facet of modern life, and they also hold the key to meet many of humanity's most pressing current and future challenges" (p.1). In this light, the Next Generation Science Standards (NGSS) were the end outcome of the latest science education reform in the United States (NRC 2012). These international benchmarked standards were released in 2013 and adopted by selected states and US curriculum schools abroad since 2014 including the Middle East North Africa (MENA) region (Archive Inc 2014).

The NGSS are a bit different than the preceding state standards in terms of the buy-in from so many stakeholders and their structure and content considering the three dimension model of learning as a transition in the science education (Archive 2013). These standards were built up as Performance Expectations (PEs) that reflect what students should be able to demonstrate at the end of a grade level band. These PEs demonstrate the Disciplinary Core Ideas (DCIs) along with the Crosscutting Concepts (CCCs) and the Science and Engineering Practices (SEPs) resulting in three dimensional model of science learning. The latter intends to aid learners build a cohesive understanding of science over time (NRC 2012).

The incorporation of the engineering education with the science content was completely new to a science classroom. In response, the NGSS concentrates on an inter-disciplinary approach to problem-solving and experiencing science as it is in the real life and relevant to everyday living to replace the "inch deep and a mile wide" and "memorization" approaches of the preceding standards in which students learn a little about a variety of topics without any depth of knowledge as well as without making connections between the contents and without applying the knowledge and the skills outside the classroom context (NRC 2012).

The need for the educational shifts presented in the NGSS is firmed in the performance on the international exams such as PISA and TIMSS which provide an opportunity for countries to globally compare students' achievement over time and reform their education systems accordingly (Marlaine et al. 2015; Mullis et al 2015). In the US, the performance of students in the international exams have been maintained since 1995, however, many other countries have showed improvement and outperformed the US (Marlaine et al. 2015; Mullis et al 2015). Interestingly, in the TIMSS, for example, the performance in physics and Earth Science has been progressed since the NGSS implementation in the US schools. However, in the United States, the dropped placement on the same TIMSS tests matched to Asian and European countries have necessitated the re-evaluation of the realities of the science teaching (English and King 2015).

In the United Arab Emirates, a fast growing gulf country, education is a particularly important concentration of its Vision 2021 National agenda that underlies the development of a first-rate education system (Alqasemy 2013). In this light, the UAE aims to be among the twenty highest performing countries in PISA and to be among the fifteen highest performing countries in TIMSS (First- Rate Education System |

UAE Vision 2021). Thus, the US and UK schools in the UAE, for example, need to outperform their home-grown average PISA and TIMSS countries for the same curricular. In response, as a step of educational reform towards achieving the targets of the UAE National agenda by 2021, the UAE's US curriculum schools have adopted the NGSS since 2014. Though PISA and TIMSS results for the students revealed progress in science performance in 2015 compared to 2012 (for PISA) and 2013 (for TIMSS), but they have remained considerably below the global rating and noticeably, the latest scores have showed that students in US curriculum schools in UAE got lower scores than those of their peers in the UK, Indian and IB schools (Marlaine et al. 2015; Mullis et al 2015). As well, those students got lower scores than those of their peer in the United States schools (Marlaine et al. 2015; Mullis et al 2015).

This low performance of students in the US curriculum schools in the international exams can be traced back to the failure of the NGSS implementation as planned and destined. Therefore, there is a calling alarm to evaluate the realities of the NGSS implementation and science teaching in the US curriculum schools in the UAE context especially there is lack of empirical studies that have directly handled the examination of the gaps between the intended and the implemented NGSS in the UAE schools as it is evident on the literature. Actually, the frontline for any curriculum implementation is represented by teachers who receive the receptivity of the curriculum and plan to enact it in their classrooms, with their students. A wide range of subfields of education researches have been focused on the teachers' use of curriculum. These studies have showed the presence of gaps between the intended and implemented curriculum (Isabelle 2017; Drake and Sherin 2009; Schneider and Krajcik 2009). Additionally, the culture and society differences must be considered during the adoption of curriculum from a western country and implementing it in an eastern country (Alshammari 2013; Dagher and BouJaoude 2011; Bashshur 2009). Thus, as a moderate advancement to fill the research gap about the implementation of the NGSS in the UAE context, this study has been carried out in one private school in Dubai, which has adopted the NGSS and scored below the average records on PISA and TIMSS.

1.2. Problem Statement:

In line of low achievement of students on the international exams like PISA and TIMSS, examining and evaluating school curriculum implementation is necessary to increase test scores (Marlaine et al. 2015; Mullis et al 2015). The NGSS focuses on "how knowledge and practice must be intertwined in designing learning experiences in k-12 science education" (NRC 2012). Given the rigor of the NGSS, there is the possibility that some educators may not fully understand the intent and they may not shift their science classroom instructions into three-dimensional approaches. Therefore, the teachers' receptivity, understanding and their enacting of the educational shifts presented in the NGSS must be perceived so teachers' professional development will be accordingly designed for a complete and successful implementation of the NGSS from kindergarten to grade 12. The necessity for this condition has been emphasized in the international assessments results where the students who enrolled in US curriculum schools in UAE got lower scores compared to their peers in US schools (Marlaine et al. 2015; Mullis et al 2015).

1.3. Aim and Objectives of the Study:

The aim of this study is to evaluate NGSS implementation in order to determine its effectiveness in one private US curriculum school in Dubai, UAE. The objectives of this study are to:

- Evaluate the science teachers' receptivity of the NGSS.
- Evaluate the science teachers' perceptions of the NGSS.
- Assess to what extent the science teachers' observed instructional practices accommodate with their described instructional practices under NGSS.

1.4. Research Questions:

This research study frames one main research question and three sub-questions:

Main Research Question:

- What is the overall effectiveness of the Next Generation Science Standards implementation in a private US curriculum school in Dubai, UAE?

Sub-Questions:

- To what extent do science educators feel convinced about, or challenged by, the implementation of the Next Generation Science Standards?
- What are the science teachers' understandings of the NGSS in one private US curriculum school in Dubai, UAE?
- To what scope do the science teachers' observed instructional practices accommodated with their described instructional practices?

1.5. Conceptual Framework of the Study:

The term "Curriculum" has been defined a lot in educational studies. Simply, "Curriculum" is referred to as all the courses exhibited at a school for student learning (Kerr 1999). It comprises the sum of learning practices and expertise offered to students for achieving understanding and competences. Generally, the curriculum is displayed as a formal record which embraces details about goals, objectives, content, resources and teaching strategies. Porter (2002) and Van den Akker (2003) have viewed and broke the curriculum into three sequentially ordered types: (i) the

"Official" or "Intended" curriculum, (ii) the "Implemented" or "Enacted" curriculum and (iii) the "Achieved" or "Assessed" curriculum. While the "Intended" curriculum is the presented and described content standards for a specified subject and grade level, the "Implemented" curriculum is the delivered and the practiced content by teachers' classroom instructions and activities. However, the "Achieved" curriculum is the curriculum outcomes and the products that could be the learning outcome or a material product (Porter 2004). To relate it to this study, the intended curriculum is the NGSS document released by the United States as the latest science education reform. It is made up from the "Ideal" curriculum which is the logic and the vision underlying the curriculum along with the "Written" curriculum which is the real document (Archive 2013). Then, the teachers' views, understanding and beliefs about the NGSS document is the "Perceived" curriculum whereas the teachers' real practices of teaching and learning in the classroom form the "Operational" curriculum. Both "Perceived" and "Operational" lie within the "Implemented" curriculum (Van den Akker 2003). Lastly, the "Achieved" curriculum constitutes the "Experiential" results achieved by students such as the science and engineering practices in the three dimension model of learning in the NGSS and the "Learned" outcomes such as the disciplinary core Ideas. The focus of this study is on the "Intended" and the "Implemented" curriculum to determine the gaps during the transition from the "Ideal" and "Written" curriculum to the "Perceived" and "Operational" curriculum whereas the "Achieved" curriculum is beyond the scope of the study. Because teachers are the frontline stakeholders who receive, understand, and practice the curriculum, this research study pivots around all of these aspects.

1.6. Theoretical Framework for Curriculum Implementation Evaluation:

The study has been built up on a theoretical framework for curriculum implementation evaluation which has been designed and used by researchers at the Faculty of Education at the University of Auckland for the Ministry of Education to evaluate the New Zealand National curriculum in a project called Monitoring and Evaluating Curriculum Implementation (Ministry of Education 2007). According to the framework, attention must be given to four elements during evaluation. The first element is "Support" which encompasses the backup types presented to facilitate the implementation of a new curriculum. This element considers the type, quantity, quality and the value of the support. The second element is "Receptivity" of the curriculum which refers to the scope to which teachers and leaders consider and value the curriculum, and their trust in practicing it on their own state. As well, receptivity includes the degree to which teachers view the curriculum as practical and suitable to the national context. The third element is "Understanding" which focuses on the evaluation of the teachers' and leaders' views and understandings of the key components and vision of the new curriculum and the range of educational shift enforced with it. It is the "Perceived" curriculum by the teachers. Lastly, the fourth element is "Practice" which evaluates the scope to which the intended curriculum becomes the taught one in the classroom instructions. This element is dictated to collect data about the teachers' practices in their classes which reflects whether the intentions of the curriculum are translated into reality and became evident or not. The four elements in the framework are found feasible and encircle all the key aspects required to evaluate curriculum implementation. To relate this framework to this study, the four elements have been used to design a questionnaire to evaluate science teachers' receptivity and perceptions of the NGSS. As well, these elements have been referred to build up the interview questions and the checklist for classroom observations to assess the extent of accommodations between the intended, perceived and implemented curriculum by the science teachers.

1.7. Significance of the Study Scope and Delimitations:

This study is appropriate and timely because all schools in UAE have desire for enhancing the performance of students in the international exams and fulfilling the National Agenda targets. In addition to that, the attitudes and views of students towards science and careers involving science are highly affected by the ways of conveying science knowledge in the classroom (Yoon et al 2014; Bennett and Hogarth 2009; Cerini et al. 2004; Osborne and Collins 2001). This reinforces the importance of figuring out the manner of the NGSS implementation in the classrooms. Furthermore, understanding how teachers view and comprehend the standards and the challenges they face during implementation is important to supply adequate support and resources for successful implementation. Therefore, despite the limitation of the scope of the results as the study has been conducted in one school only, the findings might assist educational leaders and policymakers befit more purposed when they plan, design and prepare for pre and in-service professional development, courses and programs to guide and train the science teachers for the purpose of ensuring that the intended curriculum becomes the taught one. Furthermore, no authoritative data presently occur for UAE that investigates the implementation of NGSS. Thus, this study will be a precursor for following research studies of as an area of research has been unfolded in the UAE for future interested researchers.

1.8. Study Outline:

The study consists of five chapters. Chapter 1 directs the readers into this research by introducing the background of the study, problem statement, purpose, the conceptual and theoretical frameworks, the research questions of the dissertation, the significance of the study scope and delimitations. Chapter 2 presents detailed knowledge about the NGSS curriculum and literature review about teachers' receptivity of a new curriculum, challenges for curriculum implementation and the best teaching and learning methods for science education generally and for NGSS specifically. Chapter 3 illustrates the methodology of the research in which the research approach is discussed and the data collection and analysis methods are described taking into consideration the validity, reliability, ethical issues and researcher bias. Chapter 4 displays the main findings and analysis. Then, Chapter 5 provides discussions of the results on behalf of the study purposes. In addition, it frames the conclusions, limitations and recommendations.

Chapter 2: Literature Review

2.0. Introduction:

This literature review is divided into three main sections. The first section views the "Intended" curriculum of the NGSS. It unfolds these latest educational science standards for the US. It pivots on the NGSS development, and its structure and content. In addition to that, it frames the requirements for a complete and successful implementation of the NGSS and lays the goals and demands towards achieving the NGSS vision. The second section examines the literature about the "Perceived" curriculum regarding the teachers' receptivity and support of a new curriculum through covering the theoretical and empirical studies that address teachers' perspectives, understanding and interpretation of the NGSS. It considers the support and the challenges for the implementation of a new curriculum. Lastly, the third section spots the light on the "Operational" curriculum by illustrating the realities of teaching and learning science and discussing the best ways for practicing NGSS in the classrooms.

2.1. A Glance at the Next Generation Science Standards:

NGSS are different from the preceding standards in their buy-in from so many stakeholders, their rigor structure, sequencing of content and incorporating engineering practices. This part briefly displays the stages of NGSS development, and its structure and content as well as the three dimension model of learning as an education shift in the NGSS.

2.1.1. NGSS Development Stages:

NGSS has been developed by two-stage processes. The first stage has been led by the National Academy of Science in 2010, in which the National Research Council

(NRC), the operational arm of the National Academy of Science, have hold a committee of eighteen experts including practicing scientists, two Nobel laureates, cognitive scientists, science education researchers and science education standards and policy experts and have developed a framework for k-12 Science education (NRC 2012). The developed framework has three parts in which the vision for science education, the content for science and engineering education, and the means to realize the vision including content integration, implementation, equity and guidance for the NGSS have been addressed. Noticeably, the framework has showed guidance for standards development as three dimensions learning in which science and engineering practices, crosscutting concepts and disciplinary core ideas are to be intertwined.

The second stage has been directed by Achieve during which twenty-six states engaged their commitment to give serious consideration to adopting NGSS. A broad-based team comprising K-12 representatives such as science teachers, scientists and engineers from the business community, employers and education leaders have been created by each state for the purpose of providing feedback on standards drafts and delivering updates for key constituents within their states. This collaborative effort of the twenty six lead states in cooperation with stakeholders in science, science education, higher education, and business and industry have finalized the NGSS document. Next, multiple reviews have been done for the draft standards via the publicly released drafts thereby an opportunity has been given for the interested and involved individuals to provide their feedbacks. Lastly, NRC reviewers have used the vision and content of the framework to evaluate the consistency of the draft NGSS compared to the framework. Then, the final NGSS document has been published by the National Academies Press in April 2013 (NGSS Lead States 2013).

2.1.2. NGSS Structure and Content:

The NGSS standards have been built up as performance expectations using three important dimensions of learning. The first dimension is the disciplinary core ideas that are divided into four basic sciences: Life Sciences, Physical Sciences, Earth and Space sciences, Engineering and Technology. These DCIs stand for the basic knowledge to be gained by students from each discipline. The second dimension is the crosscutting concepts that relate the scientific topics in all the science disciplines. The third dimension is the science and engineering practices (SEPs) which provide opportunities for students to encounter conceptual development as scientists and engineers and thereby offering a new approach to build their scientific knowledge. In addition to the three dimensions, the PEs are connected to the Common Core State Standards (CCSS) in mathematics and language arts as well as they are discontinuously connected to the nature of sciences. As well, DCIs are linked to other DCIs at the same grade level and other DCIs for younger and older learners. This reflects an idea of the prior knowledge for each grade level band.

2.1.2.1. Disciplinary Core Ideas:

The core ideas cover topics linked to societal or personal interests and distributed over four science disciplines: physical, life, earth and space, engineering and technology (Appendix E | NRC 2012). These DCIs show coherent and progressive levels of depth and complexity to be taught over many grade levels. For example, in the elementary school grade bands, the recognition of patterns and the elicitation of answers to questions about the world start in the early grades then the demonstration of grade-suitable proficiency in collecting, characterizing and using information about the world will be achieved by the end of grade five. Then, these achieved DCIs will be used for the explanation of more complex phenomena during the progression into the middle and high school.

2.1.2.2. Crosscutting Concepts:

A coherent and scientifically based view of the world will be achieved from the knowledge connection of the various disciplines. The DCIs are bridged by the crosscutting concepts as an organizational framework (Appendix E | NRC 2012). Patterns, cause and effect, scale, proportion and quantity, systems and system models, energy and matter, structure and function, stability and change are the seven CCCs that are embedded to the classroom instructions.

2.1.2.3. Science and Engineering Practices:

The curiosity, interest and motivation of the students can be piqued by the SEPs (Appendix F | NRC 2012). These SEPs lead to the foundation, extension and refining the scientific knowledge by the actual doing of science or engineering to consider the current understanding of the world. Thus, a way to experience conceptual development through the scientists and engineers lens will be offered in NGSS. Eight SEPs are incorporated, these are: (1) asking questions and defining problems, (2) development and using models, (3) planning and carrying out investigations, (4) analyzing and interpreting data, (5) using mathematical contents and computational thinking, (6) constructing explanations and designing solutions, (7) engaging in argument from evidence, and (8) obtaining, evaluating and communicating information. The challenges that confront society today can be viewed via the contribution of the SEPs.

2.1.3. Three Dimension Model of Learning as an Education Shift in the NGSS:

Under NGSS, all students must demonstrate and perform the disciplinary core ideas and crosscutting concepts by exercising the science and engineering practices. According to the National Research Council (2012a, p.1), the contemporary science vision is as follows:

> "By the end of 12^{th} grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have skills to enter careers of their choice, including (but not limited to) careers in science, engineering and technology".

The NGSS vision emphasizes several educational shifts for science teaching and learning for a successful curriculum implementation. Its three dimension model of learning necessitated the vigorous integration of the SEPs during grasping the DCIs along with the CCCs linkage. This three dimension leaning model enforces the instructions of "Doing and Practicing Science" and it is opposite to the separation of the "scientific method" and "science content" lessons and lock-step labs as were done in the preceding standards. Furthermore, the NGSS contain learning goals that are centered on engineering practices to serve human interests and solve societal issues. This reflects the pivot of science education on engineering, technology and application. In this light, NGSS replaces the fact-based memorization lessons approach in which the educators identify students' misconceptions and plan to fix them (Krajcik et al. 2014). The new standards favor instructions that build on the students' prior knowledge, identity and experiences of the world as they grow conceptual understanding. This helps all children from all cultural backgrounds to learn the ambitious science and solve problems and reinforces equity (Krajcik et al. 2014). For instance, teachers have to establish the situation of the integrated process skills in which their students must be able to observe, infer, explain and predict in the early elementary grades. Furthermore, students must be able to determine the characteristics of objects utilizing convenient tools as well as they must be able to compare and contrast during classifying objects. Noticeably, the students' development of the basic skills as were called in the past science standards, must be considered during the enforcement of the SEPs in the NGSS. If the NGSS vision is to encourage students to think and act as scientists and engineers beginning in kindergarten, then the basic skills must turn into essence in all children. The elementary and middle school teachers are responsible for transiting their students' thinking into the kingdom of scientific reasoning and critical thinking which results in efficient integration of SEPs and thereby successful implementation of the NGSS.

2.2. Support and Challenges for New Curriculum Implementation:

There is an agreement in the literature that supporting and considering the challenges for a policy implementation is essential for achieving success (Fowler 2009; Spillane and Callahan 2000; Spillane et al. 2002; Isabelle 2017). The actual influence of the curriculum document will be determined according to the degree to which the vision of the NGSS is brought into reality which means the extent of the transition from the "Intended" to the "Implemented" curriculum. The NGSS framework has identified the curriculum materials, teacher understandings, teacher professional development, and classroom instructions as key elements for supporting the implementation (NRC 2012). These elements are discussed below.

2.2.1. Curriculum Material:

The shortage of curricular material that fosters the three dimension model of learning is considered as an obstacle for effective NGSS implementation (NRC 2012; Roseman et al. 2015). Remillard (1999) proved that the reconstruction of the teachers' teaching practices to be aligned with particular curriculum vision is supported by curricular materials. Krajcik et al. (2008) showed that the availability of curriculum materials supports the teaching process towards the learning progression. Haag and Megowan (2015) and Pruitt (2015) found that most teachers addressed time and resources as obstacles for implementation. This has been built up on the artifact that the process of doing inquiry correctly needs more time than is allotted. Therefore, the shortage of the resources aligned to the NGSS and the allotted time largely hinders teachers' practices towards practicing the new educational shifts.

2.2.2. Teachers' Perspectives, Understanding and Interpretation:

According to Fullan (2001) and Fowler (2009), the success of curriculum implementation depends mainly on teachers' actions and thinking about the educational change. Research literature has documented the reactions of teachers and their resistance to curricula change (Pajares 1992; Gurses and Helvaci 2011; Terhert 2013). Actually, teachers' understanding, perspectives and interpretation of a new curriculum affect the extent to which the new curriculum is operated in the classrooms as suggested by Spillane and Callahan 2000. They advocated that teachers interpret new ideas according to their personal experience as successful science students, their experts and beliefs about teaching and learning science, (Benjamin 2004), their content and pedagogical knowledge (Roehrig and Kruse 2005) and the school environment in which they work can be accounted as an obstacle for a successful policy implementation (Woodbury and Gess-Newsome 2002; Roehrig et al. 2007). Fowler (2009) concluded that if teachers unsuccessfully understand the difference between NGSS and earlier science standards, they will likely fail in successfully implementing the NGSS in the classrooms. Moreover, the default of understanding about the importance of educational change that is presented in the new curriculum hinders the execution (Fowler 2009). Moreover, Donnelly and Boone (2007) found that teachers' attitude towards the standards is related to their use of them which means that the way of practicing the standards could be affected by the teachers' concerns about the standards.

2.2.3. Teacher Professional Development:

Despite the teachers' positive belief and feeling about their possession of skills necessary for standards implementation, Haag and Megowan (2015) and Pruitt (2015) showed that professional development is highly needed for a successful curriculum implementation. Banilower (2013) showed that the science professional development usually lacks specific support for teachers' development which puts challenges for effective implementation. Wilson (2013) proved that the most professional development concentrated mainly on growing isolated skills and techniques. The National Research Council (2012) particularly suggested the conduction of professional development sessions that concentrates on the teachers' understanding of the three dimensional model of learning to provide teachers with comprehensive support for implementation. The science background for teachers is not enough without have experienced actual fulfillment that were similar to the integration of the three dimensions of learning.

2.2.4. Classroom Instructions:

The NGSS framework does not specify a certain instructional approach however, the use of a variety of instructional approaches are suggested which could enforce the scientific literacy (NRC 2012). The science and engineering practices as well as the social and collective engagement with these practices must be integrated and promoted by the teachers during classroom instructions (Reiser 2013). In addition to that, making learning relevant to the students and curricular coherence must be considered during planning and adapting materials (Reiser 2013). Banilower et al. (2013) found that the importance of science practices are not emphasized in the instructions as teachers are familiar with the approach of "learn about" a certain topic then "engage the students in activities" that might permit the students to "figure out" the concept.

2.3. Best Methods for Teaching and Learning Science:

All of science cannot be explained by one method as displayed in the science textbooks. Scientific content is just not enough. Indeed, research now indicated the essence of math and technology in the actual practice of science (Houseal and Ellsworth 2014; Krajcik 2013). For NGSS in particular, activities with three spheres are required to understand the practices and the work of scientists and engineers (NRC 2012). Investigation and empirical inquiry are the essence activities of the first sphere. Then, the construction of explanations or designs using reasoning, creative thinking and models are the dominant activities in the second sphere. Lastly, the analysis, debates, argumentation and evaluation of the ideas and findings are the dominant activities of the third sphere which is the most worthy one as it relates the first and the second spheres together. According to the NRC (2012), evidence-based argumentation is highly followed by scientists and engineers to apply their ideas.

Thus, it is very important to spot the light on the "role of evidence" in SEPs. "Evidence" is involved in the empirical inquiry and in the construction of explanations and designs as well as "Evidence" is important to underpin the analysis and argumentation of the activity. This part of the study is dictated to display the literature about the best ways and methods of teaching and learning science in the 21st-century with particular attention is given on the best ways of implementing NGSS in the classrooms as well as to the examining the realities of teaching and learning science.

The key of teaching science in the professional world is practicing the scientific content in the context of "doing" which is known as "Inquiry Based Learning". This method of teaching science is often depicted as complex, flexible and creative. Under inquiry, students are asked to define a problem, form hypotheses, do an experiment, collect and analyze data, draw conclusions and share their findings. Interestingly, inquiry is not only "doing", but also it is "reasoning" which requires a classroom talk during which the teacher is a facilitator (Abd-El-Khalick et al. 2004; Hackling et al. 2010). Therefore, the complex state of science in the real life is best imitated and closely tied in inquiry which results in forming new meanings depending on experiences. Inquiry is a constructivist education method which wants the students to apply what they are doing to what they already know. The appropriate use of inquiry in the science teaching and learning reinforces its effective implementation across the curriculum. As shown in research studies, inquiry is considered advantageous in building and mastering concepts as students are taking charge of their learning while being guided by the teacher (Skoda et al. 2014). However, class management issues and the lack of training and quality resources that accompany textbooks have promoted the teachers' resistance to exercise inquiry full in the classroom (Lux et al. 2014).

2.4. Literature Review on the NGSS Implementation in Science Classrooms:

Traditional, teacher-centered methods of an instruction are still predominantly used by many science teachers disregarding the decades of effort educating teachers on a student-centered approach (Banilower et al. 2013; Woodbury and Gess-Newsome 2002). Research studies have suggested that helping science teachers to increase their content and/or pedagogical knowledge might change the practices of the science teachers (Terhert 2013; Gurses and Helvaci 2011; Darling-Hammond et al. 2009). On the other side, other studies have showed that beliefs about teaching and learning that stand with reform based practices are held by most teachers but not applied in their classroom instructions (Savasci and Berlin 2012; Pimentel and McNeil 2013). A novel opportunity to trigger science teachers for shifting their practices toward more reform-based teaching practices has been provided with the release and adoption of the NGSS due to the plentiful differences of NGSS compared with the past standards (Reiser 2013). This has necessitated the integration of the engineering in science education as a central element in science teaching along with the digital revolution and the four pillars of communication, cooperation, creativity, and critical thinking. NGSS force teachers to teach outside their content expertise and provides them with the flexibility for content bundling and meeting the instructional goals.

Many previous researchers have inspected the NGSS practicing in the classrooms. Osbourne (2014) and Pruitt (2014) revealed that teaching and learning of the NGSS must be adjusted and adapted with the new framework (NRC 2012). Osbourne (2014) showed the quality of student learning can be improved by enforcing practices in classroom instructions which promote a deeper and broader understanding of science literacy. Pruitt (2014) indicated that designing models, arguing, and applying concepts have to be performed and demonstrated by students to grasp the science content under NGSS. In addition to that, Pruitt (2014) noted that the goals of the NGSS can be adequately met as well as the intertwined nature of the content and practices can be truly understood by bundling the topics and ideas together according to their relatedness.

Kloser (2014) utilized the Delphi method designed by Dalkey and Helmer (1963) to indicate a core set of science teaching practices to improve science education. His findings showed that the instructional practices of a teacher can affect the students' engagement and achievement. Furthermore, the promotion of an 'interactive' and 'dialogic science classroom' can be attained by practices such as 'Engaging Students in Investigations' and 'Facilitating Classroom Discourse'. Noticeably, he emphasized on the importance of the ongoing assessment as a functional part of science teaching. Bismack et al. (2014) investigated teachers' practices in adapting and implementing curriculum materials that enforces the engagement of students in scientific practices. Their findings revealed that teachers have operated the science practices in ways different from the written curriculum.

Kawasaki (2015) attempted to find and compare the perceived and operated classroom instructions around the science and engineering practices for seven science teachers. He used an open ended questionnaire, open-ended interviews and field notes from classroom observations for the purpose of describing the set of objectives that the educators discuss in their classroom instructions and the set of strategies used to achieve these goals. The findings demonstrated the presence of diverse degrees of alignment between the depicted and the operated instructions as well as between the instructions and the NGSS intent. Morales (2016) used interviews and classroom observations and conducted a two-phased qualitative case study for investigating the weave of the three NGSS dimensions into a science classroom. The findings suggested that the teacher was tentative in selecting the right NGSS practices to support the three dimension model of learning as well as the science practices were used in restricted ways. In addition to that, the teacher was not aware about the importance of the crosscutting concepts in the NGSS (Morales 2016). Lastly, multiple ways such as teacher-directed, student-directed, over multiple days were used to weave the dimensions into a teaching unit (Morales 2016).

Noticeably, few researches on NGSS implementation in the Arab region have been found in the literature (Qablan 2016; Almomani 2016). To start with Qablan (2016), he conducted a qualitative design using inductive analysis to examine the effect of a subject specific professional development program on the ability of teachers in designing inquiry- guided classes and practicing them in their classrooms. The results showed that the teachers gained from their involvement in the program however, their lessons still are deficient in calling scientifically guided questions and 'designing and carrying out investigations'. In Jordan, Almomani (2016) suggested that more connection of science with mathematics and more interpretation and data analysis practices are required to ensure successful implementation of NGSS.

2.5. Summary:

The revolution of science teaching methods and raising up the US science scores in the international exams were the main concern of the NRC during the development of the NGSS that necessitated teaching and learning science in the same lens of scientists and engineers (NRC 2012).These demands of the NGSS can be met by emphasizing on "Evidence" to enforce the three dimensional model of learning. NGSS are still new standards and consequently there is death of research studies on teachers' adaptations and perspectives for the educational shifts presented in this latest science educational reform**.** Though, the NGSS and NSTA websites provide many resources to underpin the implementation of NGSS in a smooth and successful way. Curriculum resources, assessments, and professional development sessions are required meet the demands and the educational shifts promoted by NGSS.

Chapter 3: Methodology

3.0. Introduction:

The study has mainly focused on evaluating the implementation of the NGSS by exploring the gaps between the "intended", "perceived" and the "operated" NGSS curriculum and thereby highlighting the challenges and planning for improvement actions to raise the performance of students in the international exams. This chapter pivots on the methodology used in this research study. It discusses the research design, the context of the study, the population and samples selected for the study, instrumentations for data collection and data analysis. Furthermore, this chapter displays the trustworthiness issues, the ethical considerations of the research, the role of the researcher and bias.

3.1. Research Design:

The study has adopted a mixed methods approach using both qualitative and quantitative research instruments. Thus, more data has been obtained from a wide variety of resources which helps in thorough understanding of the research problem, lessens the drawbacks inbred in one method and builds on the vigor of the other (Creswell 2013). Indeed, mixed methods approach has been proven to be an efficient way of triangulating the results and validating the data (Yin 2011; Creswell 2013). Firstly, close-ended questionnaire has been provided to twenty science teachers in the selected school for the purpose of examining their views about support, receptivity, and understanding of the NGSS content and structure as well as their descriptions of their instructional practices of teaching science under NGSS. Secondly, semi-structured interviews have been carried with nine science teachers out to formulate detailed ideas about their perceptions and descriptions of the classroom practices and their efforts to implement NGSS curriculum in their classrooms as well as the challenges they are facing during implementation. Thirdly, nine classroom observations have been conducted with the interviewed science teachers for field note collection and comparing their described practices with the operated practices. Then, the collected data have been analyzed. The SPSS has been used for the analysis of the quantitative data collected from the questionnaire while the thematic analysis has been followed for the analysis of the qualitative data collected from interviews and classroom observations. Lastly, it should be noted that the ethical issues have been widely considered throughout the study. All participants have understood the purpose of the conducted research and the lack of any organizational staff partnership in the data collection and analysis processes and they have asked to sign a consent form of participation.

3.2. Context of the Study and Participants:

The study has been carried out in one private US curriculum school in Dubai, UAE from March 2018 through June 2018. The *purposeful sampling strategy* has been utilized to select the school and the participants (Shakir 2002). The selection of the school has been based on two elements: the Knowledge and Human Development Authority (KHDA) inspection reports and the students' scores in the international exams compared to the scores of their colleagues in other US schools in both UAE and US (Marlaine et al. 2015; Mullis et al 2015). In 2017-2018, a total of 29 US curriculum schools were inspected in Dubai. 57% of students who enrolled in a US curriculum school are in good or better schools (KHDA gives private schools six years to achieve UAE National Agenda goals 2016). Thus, the choice has been made purposefully for a school with a good KHDA reputation and their students achieved low scores in the international exams (PISA and TIMSS). This choice of this particular school serves the rationale and the purpose of the study to evaluate NGSS curriculum implementation in the US curriculum schools in the UAE context especially there is dearth of research about this issue. The chosen school was easily accessible geographically with almost 99% of its students were Emirati.

Concerning the targeted population in the school, twenty science teachers from all grade levels were the participants for the questionnaire. This forms a sample of twenty participants. Then, a sample of three science teachers from each cycle (Elementary, Middle, Secondary) has been selected for the semi-structured interviews and classroom observations. This selection has been based on their years of teaching experience with the priority for the most experienced teachers per cycle. Despite the reduction in the number of participants from twenty teachers who conducted the questionnaire to nine teachers who interviewed and observed due to the time limitation, the number of participants was feasible for contacting them and has resulted in collecting variable and dense data. The study has been executed over a period of six weeks from March 2018 through June 2018 in a private school in the UAE that has adopted the NGSS since 2014.

3.3. Data Collection Instruments:

The data has been collected using a mixed methods approach of both qualitative and quantitative instruments for the purpose of collecting data from more than one resource and thereby triangulating the results. Three instruments have been fostered: teachers' questionnaire, semi-structured interviews and field notes from classroom observations. This section has been charged to describe these instruments regarding their design, content, allotted time, participants, purpose, strengths and weaknesses.

3.3.1. Teacher Questionnaire:

Questionnaire has been found to be a feasible instrument in collecting a great extent of data within relatively short time interval (Creswell 2007; Zapier 2015). In this study, the teachers' questionnaire has aimed to gather data about science teachers' perspectives and understandings of the NGSS and their views concerning the support and challenges to evaluate the implementation of NGSS in one private school in UAE. Furthermore, the questionnaire has been concerned in assessing the extent of evidence for the science instructional practices in the classrooms as reported by the teachers themselves.

The questionnaire has been built up using the key aspects of the elements elucidated in the adopted theoretical framework for the evaluation of curriculum implementation (Ministry of Education 2007). In addition, statements and items specific for NGSS curriculum taken from the science instructional practices survey have been incorporated to enrich the developed questionnaire (Kathryn et al. 2016). Noticeably, the science instructional practices survey is a tool that has been developed and validated to be suitable for NGSS and other related science standards (Kathryn et al. 2016). Therefore, the integration of items from Kathryn's survey to the designed questionnaire is highly fitting the purpose of the study and the research questions. All items in the questionnaire have been assessed using the ordinal 6 point Likert scale as it allows the researcher to perceive the worth of the response and commonly it counters the questions of "To what extent" widely serve the purpose of the study (Zapier 2015).

The questionnaire has been divided into five parts (Appendix A). The first part has included 7 items specified for the demographic information of the participants with respect to age, gender, grade level taught, education qualifications, level of education, and the years of teaching experience. The second part has encompassed 7 items specified for teachers' self rate around the frequency of getting an opportunity to speak with/ look through/ utilize the supports during the implementation of the NGSS curriculum in the academic year 2017-2018 along a 6-point Likert scale (1= Not at all, 2= Few times per year, 3= Few times per semester, 4= Few times per month, 5= Few times per week, 6= Almost daily or daily). In addition, this part has included 6 items for teachers' views around the quality of the encountered supports for NGSS implementation along a 6-point Likert scale (1= Strongly Disagree, 2= Disagree, 3= Slightly Disagree, 4= Slightly Agree, 5= Agree, 6= Strongly Agree). The third part has encircled 16 items around the teachers' receptivity of the NGSS curriculum along a 6-ponit Likert scale with 1 for strongly disagree and 6 for strongly agree. These items have been designed to assess the scope to which teachers consider and value the NGSS curriculum, teachers' trust in practicing NGSS on their own state and the degree to which teachers view the NGSS curriculum as practical and suitable to the UAE context. The fourth part has contained 6 items that focus on the evaluation of the teachers' views around the educational change in their practices to meet the NGSS educational shifts along a 6-ponit Likert scale with 1 for strongly disagree and 6 for strongly agree. Lastly, the fifth part has constituted from 10 items that pivot on the science instructional practices used by teachers in the classrooms. These items have been adopted to assess the extent of evidence for these ten instructional practices according to teachers' perspectives of the NGSS curriculum. Similarly, a 6 point Likert scale has been used with 1= Not Evident, 2= Rarely Evident, 3= Sometimes Evident, 4= Frequently Evident, 5= Strongly Evident, 6= Very Strongly Evident.

The reliability of the items in the questionnaire has been measured by Cronbach's alpha. All items have shown a Cronbach's alpha equal to 0.70 or higher which reflects satisfactory consistency. “In general, the closer the value Cronbach’s alpha coefficient is to 1.0, the more reliable is the instrument” (Azmy, 2012:104). Once the approval has been received from the school principal to consider his school as a case study for this research, a sample of five science teachers who were experienced in UAE has been selected for a pilot questionnaire to check the suitability of the questionnaire content within the circumstances of the selected school. The finalized copy of the questionnaire has been distributed to the teachers of the study sample for the Pearson correlation calculation and thereby examining the construct validity. The latter has been found to be between 0.70 and 0.90 which is adequate to this research (Odeh 2010). Then, the finalized questionnaire has been shared with all participants by the researcher during his attendance of the weekly science department meeting. The researcher has clearly clarified the purpose and the process of the study. Then, he has distributed the questionnaire to all science teachers. The researcher has given them one week to respond to the questionnaire to be collected on their next department meeting.

3.3.2. Semi-structured Interview:

Qualitative semi-structured interviews have been carried out with nine science teachers, specifically three teachers from each cycle (Elementary, Middle, and Secondary). The interviewed teachers have been selected based on their years of teaching experience with the priority for the most experienced teachers from each cycle. The interviews have been aimed to gather detailed investigations of science teachers' perspectives and understandings of the NGSS. In addition, the interviews have been focused on the examinations of the science teachers' descriptions of their classroom practices under NGSS along with the challenges and difficulties they confront during curriculum implementation. This instrument of collecting data is suitable to this study as it permits the researcher to explore in details the participants' descriptions and plans of their classroom instructions for NGSS implementation (Seidman 2010; Kvale and Brinkmann 2015). In addition, it helps in the generation of unanticipated insights about teachers' views along with their social interpretations. In addition, the interview questions are open-ended allowing the participants to answer them freely and thereby the details of people's experiences from their perspectives could be fully understood and their lived experiences could be experienced (Seidman 2013).

The first part of the interview has been made up from open-ended questions regarding the participants' education and their teaching experiences as science teachers in UAE. Thus, a context for their emotions and beliefs related to their lives and profession could be easily established (Seidman 2013). Next, the second part of the interview has been consisted from in-depth, open-ended questions to assess teachers' descriptions of their classroom practices and instructions during NGSS implementation, and the challenges they might face during implementation. Thus, detailed information about the "Perceived" NGSS curriculum have been gathered. Each participant has been interviewed only once. Each interview has been lasted for 30 to 50 minutes and it has been taped with the participant consensus. Then, it has been transcribed after the interview by the researcher and the interviewees' answers have been confirmed by the interviewees. Indeed, the preparation of transcripts from the tapes was apparently time consuming.

Both potential strengths and weaknesses have been illustrated within qualitative interviews due to the fact that people generate sense and interpretation via their interactions with others as postulated by the social constructivism (Atwater 1996). One such strength is the opportunity to direct the course of the interview with follow-up questions by the interviewer (Seidman 2013; Kvale and Brinkmann 2015). Thus, the different experiences described by the participants could be connected and thereby the gaps in the data could be filled. On the other side, one potential weakness of the qualitative interviewing is related to the researcher biases, which could affect the findings. So, the researcher must be aware from this issue to avoid any effect of the participant responses (Seidman 2013; Kvale and Brinkmann 2015).

3.3.3. Classroom Observation:

Naturalistic approach for examining teachers' practices in teaching science in the classroom could be achieved via classroom observations (Reed and Bergmann 2005). The latter have been carried out for the science teachers who were selected to be interviewed for the purpose of examining the practiced curriculum and thereby exploring the gaps between what it was described with what being practiced. The total number of the visited teachers was nine teachers, specifically three teachers from each cycle (Elementary, Middle, and Secondary). Each teacher has been observed one time. Each observation has been managed for a full science class of 50 minutes. The time of classroom observations has been arranged between the teacher and the researcher in such a way the teacher has been asked to invite the researcher on days where the teacher was doing an activity he felt aligned with the goals and vision of the NGSS. The nine class observations have been conducted over three weeks, with an average of three class visits per week. According to Merriam (2009), observations are the major ways of gathering data in qualitative methods. They provide a first-hand account of the situation under study and result in a holistic interpretation when they are combined with interviews. During observations, the focus was on the instructional activities set by the teacher and the classroom discourse that happened in the activities during the classroom context. The researcher has sat in a corner of the classroom and took down his notes for the whole class activities whereas he has followed the teacher for the small group activities to listen to the discussions and debates then he has recorded the observations.

3.4. Data Analysis Methods:

Quantitative and qualitative data have been separately analyzed. The SPSS has been used for the analysis of the questionnaire while the thematic content analysis has been followed for the analysis of the interview results and field notes from classroom observations. Then, the findings from both methods have been compared and complemented to each other which have led to the validation and triangulation of the results.

3.4.1. Quantitative Data Analysis:

The 45 items of the questionnaire have been assessed on a 6-point Likert scale. Consequently, the instrument could count from 45 to 270. Proportional staging has been used to determine the categories of frequency and degrees of abundance, agreement and consideration have been calculated to realize the five categories: very low, low, moderate, high, and very high. The calculations have been done by subtracting the upper limit from the lower limit then dividing the answer by the number of the required categories. This has been added to lowest score for deciding the ends of each category. Consequently, 6 point Likert scale will have proportional computation as follows (6-1)/5 = 1.0. The five categories of frequency along with their degrees have been arranged in Table 1. In addition, a current version of SPSS statistical program has been used in the analysis of the questionnaire to do the reliability test by calculating Cronbach's alpha and to find the means and the standard deviations of each item in the questionnaire.

Table 1: Proportional Staging for Frequency Category

Degree	Category of Frequency
Very Low	1.0 – 2.0
Low	2.1 – 3.0
Moderate	3.1 – 4.0
High	4.1 – 5.0
Very High	5.1 – 6.0

3.4.2. Qualitative Data Analysis:

The analysis of the qualitative data has been done via the thematic content analysis method which concentrates on determining patterned meaning across a dataset. It allows researchers to analyze the qualitative data by studying documents, recordings, and other transcribed verbal material (Creswell 2014). It focuses on inductive reasoning by repeated examination and comparison of the data to reduce the collected data into set of themes and then generate the knowledge. This method is found to meet the requirements of research as few or no previous research is available around NGSS implementation in UAE. It has been shown to be flexible, easily accessible by the researchers and not constrained with any pre-determined information (Braun and Clarke 2006; Gratton and Jones 2009). However, it is time consuming process as it necessitates in-depth reading of the material.

3.5. Reliability and Validity of the Results:

Indeed, judging the effectiveness of a research study relies on both the reliability and validity of the results as they are contemplated as the roots of trustworthiness, rigor and quality of the study (Golafshani 2003). Noticeably, reliability and validity must be achieved for all data collection instruments. To start with the teachers' questionnaire, the finalized copy has been distributed to the teachers of the study sample for the Pearson correlation calculation and thereby examining the construct validity. The latter has been found to be between 0.70 and 0.90 which is adequate to this research (Odeh 2010). Regarding the reliability of the results, the Cronbach's Alpha has been used to calculate the internal consistency for each scale and for the total scale and it is found to be higher than 0.70 which is good enough to this study.

The participants have been given one week time to respond to the questionnaire while the interviews have been carried out according to the participants' schedule in their office or a vacant classroom. Both the pre-communication and the free location choice in the school provided a positive atmosphere to the interview and contributed in the validity and reliability of the results as the participants are not taken out of their context (Maykut & Morehouse 2002). Moreover, the audio records of the interview gives the true content of the participants responds which can be revisited at any time by the researcher and thereby misinterpretation of the transcripts can be avoided. Furthermore, "trustworthiness" could be increased by "member checking" during which participants review their comments and might be asked for clarification. As well, comparing the transcripts of the interview results of many participants could validate the findings (Seidman 2013). Similarly, the field notes from classroom observations have been checked by the observed teacher which might clarify a certain comment.

3.6. Ethical Consideration:

The top of any researcher's list of priorities is the ethical considerations of the research study (Fouka and Mantzorou 2011). The major ethical issues in carrying out research are the informed consent, beneficence, anonymity, confidentiality and respect for privacy (Fouka and Mantzorou 2011). In this research, ethical concerns around openness and honesty with participants and their treatment as worthy individuals have been widely identified through sharing of clarifications about the purpose of the research, privacy and confidentiality of data with the participants. Then, all participants have been asked to sign a consent form that included clarifications about the purpose of the study and the reason for choosing them as participants and emphasized on the confidential considerations regarding mentioning their names in the study. They were given the freedom to participate as volunteers in the study and they could pull out without penalties. All participants have been informed about the interview procedures and questions and they have been asked for the audio record which would remain confidential. After transcription and data analysis, all digital recordings have been deleted. In addition, the consent has contained statements about the participants' rights to review their transcripts through "member checking" and providing feedback and adding comments. This would result in accurate and honest analysis and presentation for the collected data. Concerning beneficence, the study did not hurt the participants in any way and their responses would be employed to serve the purpose of the research only. Similarly, the observed teachers have been informed about the classroom observation criteria and they have been asked to review the notes through "member checking".

3.7. Role of the Researcher and Researcher Bias:

The researcher has directed the research design and process, he has acted like an observer only and he was completely conscious to be objective and reflect the realities. The researcher was a science teacher, who had not practiced science under NGSS. Instead, the researcher has worked in IB schools in UAE over six years.

Noticeably, he did not practice science under NGSS and he did not have any empirical involvement with the implementation of the NGSS in a classroom. None of the participants was a colleague or a friend with the researcher. Thus, there is no bias to any of the participants which could decrease the clarity if it existed.

3.8. Summary:

This chapter has framed the methodology used in the study. Mixed methods approach of both qualitative and quantitative instruments has been embraced to triangulate the results and ensure their validity. The study has been conducted from March 2018 through June 2018 in a private US curriculum school located in Dubai, UAE. The selected school has good KHDA reputation and their students achieved low scores in the international exams. The targeted sample of participants was twenty science teachers. The data has been collected by questionnaire, semi-structured interviews and classroom observations. Firstly, teacher questionnaire has been developed and used to examine the teachers' views and understandings of the NGSS as well their views regarding the support and the challenges that might face during NGSS implementation. Secondly, semi-structured interviews have been carried out to explore the described practices of the teachers in their classrooms. Then, classroom observations have been conducted to examine the practiced curriculum and thereby explore the gaps between what it was described with what being practiced. Next, the collected data have been analyzed via thematic content analysis for the qualitative data and SPSS for the quantitative data. Noticeably, the ethical issues, researcher bias, and validation and reliableness of the results have been widely taken into consideration throughout the study.

Chapter 4: Findings and Analysis

4.0. Introduction:

This chapter displays the data collected through the qualitative and quantitative instruments. The results for each instrument have been shown and analyzed separately. Then, comparisons have been done for triangulation and thereby validation of the results.

4.1. School Background:

The selected school is a highly popular secondary school in UAE since 13 years. It follows a US curriculum and it has aligned to NGSS in science since 2014. It has a good KHDA reputation for three consecutive years. There are currently 102 teachers and 30 learning assistants of different nationalities working in the school. The total number of students on roll is 1735 in the academic year 2017-2018, with Emirati as the largest nationality group of students. The students have achieved low scores in the international exams compared to their colleagues in other US curriculum schools.

4.2. Quantitative Data Results:

The questionnaire has been divided into five parts. Each part has contained specified items to examine a certain aspect in the evaluation of curriculum implementation such as the support, receptivity, understanding and practice elements. Twenty science teachers have participated in the questionnaire. Teachers' self-reported responses and views have been analyzed using SPSS. The mean and the standard deviation for each item have been calculated. The degrees of abundance, agreement and consideration have been decided for each item according to the proportional staging described in

Chapter 3. Then, the findings have been arranged according to the parts of the questionnaire and displayed in tables as shown below.

4.2.1. Demographic Information:

Demographic Information about the participants has been collected from the questionnaire. The demographic has included teachers' age, gender, grade level taught, education qualifications, level of education and the years of teaching experiences (Table 2).

Table 2: Demographic Information for the Participants in the Questionnaire

Demographic Information	Items	Respondents	Percentage (%)
Gender	Male	5	25
	Female	15	75
Age Group	21-29	8	40
	30-39	8	40
	40-49	4	20
	50-59	None	0
	60 0r older	None	0
Grade Taught Level	High School	4	20
	Middle School	6	30
	Elementary School	6	30
	Kindergarten	4	20
Highest Level of Education	High School	None	0
	Bachelor	14	70
	Master	6	30
	PhD/ Doctorate	None	0
Education Background	General science	10	50
	Biological science	7	35
	Physical science	3	15
	Eng and Computer	None	0
Years of Teaching Experience	New teacher	2	10
	1-3	3	15
	4-6	7	35
	7-10	4	20
	Over 10	4	20

As indicated in Table 2, a total of 20 teachers, 15 females (75%) and 5 males (25%), have responded to the questionnaire. The age groups of most respondents were between 21 and 39 years. Most participants were holding bachelor degrees (70%) with 50% of them were having general science background. Noticeably, none of the teachers were having engineering and computer sciences background. The majority

(35%) was showing 4-6 years of teaching experience and only 10% were new teachers without any teaching experience. To sum up, this information has reflected the freshness and youthfulness of the science teachers.

4.2.2. "Support Encounters" for a Successful Implementation of NGSS:

"Support Encounters" encompasses the backup types presented to facilitate the implementation of a curriculum. The findings of teachers' views around the type, quantity and quality of teachers' support encounters for a successful implementation of NGSS in the academic year 2017-2018 have been summarized in Table 3.

Table 3: Teachers' Views around the Type, Quantity and Quality of NGSS Implementation Support

Element	Key Aspects	Item*	Mean*	SD	Degree
Support	Type and Quantity	Advisors	2	1.24	V. Low
		Private Consultants	2.65	1.04	Low
		School Leadership Team	4.15	1.00	High
		Colleagues from own school	5.55	1.46	High
		Colleagues from other schools	3.05	0.96	Moderate
		Ministry of Education	1.25	1.54	V. Low
		NGSS online website	2.7	1.03	Low
	Quality	Generous	3.55	0.93	Moderate
		Productive	3.55	0.93	Moderate
		Relevant	3.4	0.90	Moderate
		Stimulating	2.95	0.98	Low
		Sound	3.15	0.95	Moderate
		Challenging	2.95	0.98	Low

** The items have been adopted from the survey of the evaluation of curriculum implementation in New Zealand.*
**A 6 point Likert scale has been used to assess the type and quantity of support with 1= Not at all, 2= Few times per year, 3= Few times per semester, 4= Few times per month, 5= Few times per week, 6= Almost daily or daily. *A 6 point Likert scale has been used to assess the quality of support with 1= Strongly Disagree, 2= Disagree, 3= Slightly Disagree, 4= Slightly Agree, 5= Agree, 6= Strongly Agree.*

As it is shown, the science teachers have received different types of support from both inside and outside the school. The highest mean scores have been recorded for getting support from colleagues from own school ($\overline{X}$= 5.55) and the school leadership team ($\overline{X}$= 4.15) which has reflected the presence of teamwork between the staff members and regular communication within the school context during the weekdays. On the other side, the lowest mean scores have been recorded for getting support from the Ministry of Education ($\bar{X}$= 1.25) and advisors ($\bar{X}$= 2) which has suggested the presence of few external backing. Regarding the quality of the support, the responses of the teachers have shown scores with means between 2.95 and 3.55 which have reflected the "slightly disagree" and "disagree" views of the teachers around the qualities of the generosity, productivity, relevancy, challenging and stimulating of the received support. Thereby, these results have suggested the need to enhance the quality of the presented support.

4.2.3. The "Receptivity" of the NGSS Structure and Content:

"Receptivity" of the curriculum refers to the scope to which teachers and leaders consider and value the curriculum, and their trust in practicing it on their own state. As well, receptivity includes the degree to which teachers view the curriculum as practical and suitable to the national context. The findings for the teachers' receptivity for the NGSS content and structure have been summarized in Table 4. It is very clear that the teachers have viewed NGSS as substantially different ($\bar{X}$=5.60) and better than the previous standards ($\bar{X}$= 4.35). It is a reasonable work load document ($\bar{X}$=4.70) that necessitated major shifts in practice ($\bar{X}$=5.20). In addition, they have slightly agreed with the flexibility ($\bar{X}$=3.96) and the complexity of the NGSS structure ($\bar{X}$= 3.20) and the feasibility for its implementation ($\bar{X}$= 3.20). While they have disagreed about the view of less work ($\bar{X}$=2.85) is required than other standards for a successful implementation. Though of these disagreements, teachers have reported high agreement for their trust in practicing the curriculum. Regarding teachers views of the NGSS content, they have highly agreed that the content promotes students to work with others ($\bar{X}$= 5.35) and it assists students to use science in their daily lives ($\bar{X}$= 5.10). In addition, they have agreed that the content slightly promotes students to participate to society ($\bar{X}$= 3.30) and slightly takes into consideration individual difference among students ($\bar{X}$= 3.95) as well as some content is difficult to be taught ($\bar{X}$=3.50). Noticeably, they viewed the curriculum as not considering Emirati students society and culture ($\bar{X}$= 1.60).

Table 4: Teachers' Views of the NGSS Structure and Content

Element	Key Aspects	Item*	Mean	SD	Degree
Receptivity	Structure	Flexible	3.90	0.96	Moderate
		Complicated	3.20	1.05	Moderate
		Practical	2.15	1.69	V. High
		Reasonable workload	4.70	1.14	High
		Less work (than previous)	2.85	1.00	Low
		Better than previous	4.35	1.04	High
		Easy to implement	3.20	1.02	Moderate
		Substantially different	5.60	1.48	V. High
		Requires major shifts in practice	5.20	1.32	V. High
		Confident about implementation	4.10	0.97	High
	Content	Promote students to contribute to society.	3.30	0.94	Moderate
		Promote students to work with others.	5.35	1.39	V. High
		Take into account individual difference among students.	3.95	0.96	Moderate
		Encourage students use science in daily lives.	5.10	1.12	V. High
		Consider Emirati students society and culture.	1.60	1.41	V. Low
		Include content that is difficult to teach.	3.50	0.93	Moderate

** The items have been adopted from the survey of the evaluation of curriculum implementation in New Zealand. *A 6 point Likert scale has been used to assess the views around the NGSS content and structure with 1= Strongly Disagree, 2= Disagree, 3= Slightly Disagree, 4= Slightly Agree, 5= Agree, 6= Strongly Agree.*

4.2.4. "Understanding" the NGSS:

The findings for the evaluation of the teachers' views and understandings of the key components and vision of the NGSS and their descriptions for the necessary science instructional practices required for a successful implementation have been displayed in Tables 5 and 6. The findings have showed that under NGSS teachers' have considered but not altered the way to report parents ($\bar{X}$= 2.40) and the planning documentation ($\bar{X}$= 2.10) whereas they have considered and moderately altered the role of students take in the classroom ($\bar{X}$= 4.50), their teaching and learning activities ($\bar{X}$= 5.35) and the resources used for the teaching and learning activities ($\bar{X}$= 5.35). Regarding the teachers' self-reported descriptions for their practices, the findings have showed that the 'use of activity sheet to reinforce skills or content' ($\bar{X}$= 5.85), the 'use of open-ended questions to promote whole class-discussions' ($\bar{X}$ = 5.60) and 'encouraging students to work' ($\bar{X}$ = 5.60) and 'collaborate in groups' ($\bar{X}$ = 5.15) have been self reported as very strongly evident in their instructional practices. Whereas, encouraging students to 'apply science concepts for explaining real-world contexts' ($\bar{X}$= 4.75), 'promoting students to connect what they learned to their life' ($\bar{X}$=4.80) and 'assess the prior knowledge of the students about certain science topic' ($\bar{X}$= 4.80) have been self-reported as strongly evident. Lastly, the 'practices for providing direct instructions to explain science' ($\bar{X}$= 3.40) and 'demonstrating an experiment' ($\bar{X}$= 3.80) have been reported as frequently evident. No items have been reported to be not practiced or fit the low and very low categories.

Table 5: Teachers' Self-Reported Descriptions for the Educational Change according to the "Perceived" NGSS

Element	**Item***	**Mean**	**SD**	**Degree**
Understanding	Planning documentation.	2.10	1.26	Low
	Teaching and Learning activities.	5.35	1.37	V. High
	Resources used for teaching and learning activities.	5.35	1.37	V. High
	Themes/ Content/ of teaching and learning.	5.35	1.37	V. High
	Role of students take in the classroom.	4.45	1.07	High
	The way in which you report to parents.	2.40	1.11	Low

** The items have been adopted from the survey of the evaluation of curriculum implementation in New Zealand.*
** A 6 point Likert scale has been used to assess the teachers' descriptions of their educational change according to the "perceived" NGSS with 1=Not considered , 2= Considered, not to alter, 3= Intend to alter, 4= Small alteration, 5=Modest alteration, 6= Considerable alteration.*

Table 6: Teachers' Self-Reported Descriptions for the Science Instructional Practices in their Classrooms.				
Element	**Item***	**Mean**	**SD**	**Degree**
Practice	Provide direct instruction to explain science concepts.	3.40	0.93	Moderate
	Demonstrate an experiment and have students watch.	3.80	0.95	Moderate
	Use activity sheets to reinforce skills or content.	5.85	1.59	V. High
	Go over science vocabulary.	3.35	0.93	Moderate
	Apply science concepts to explain natural or real-world contexts.	4.75	1.11	High
	Talk with your students about things they do at home that are similar to what is done in science class.	4.80	1.12	High
	Discuss students' prior knowledge or experience related to the science topic or concept.	4.80	1.12	High
	Use open ended questions to stimulate whole class-discussions.	5.60	1.48	V. High
	Have students work with each other in small groups.	5.60	1.48	V. High
	Encourage students to explain concepts to each other.	5.15	1.96	V. High

** The items have been adopted from science instructional practices survey developed by Kathryn (2016).*
** A 6 point Likert scale has been used to assess the teachers' descriptions of their science instructional practices according to the "perceived" NGSS with 1=Not Evident, 2=Rarely Evident, 3= Sometimes Evident, 4= Frequently Evident, 5=Strongly Evident, 6=Very Strongly Evident.*

4.3. Qualitative Data Results:

The qualitative data have been gathered through semi-structured interviews and classroom observations. While the interviews questions were in-depth and open-ended focusing on the perceived curriculum by the teachers, the excerpts from the observations were focused on the operated curriculum in the classroom. Thus, the extent to which the teachers' observed classroom instructions confront with their described instructions has been assessed. The participants were nine science teachers; specifically the most experienced three teachers from each cycle. The qualitative data has been analyzed by thematic content analysis according to three themes: Teachers' Understanding of the NGSS, Teachers' Instructional Strategies, and Challenging for practicing NGSS in the classrooms.

4.3.1. Teachers' Understanding of the NGSS:

The interviewed science teachers have showed a strong knowledge and high awareness of their grade level science curriculum regarding the three dimension model of learning. Most of them have showed ability to cite content specific lessons into which SEPs, DCIs and CCCs could be incorporated. They have described NGSS as more rigorous but better than the past science standards. For example, Grade 5 science teacher has described her enforcement of the three dimension model of learning for the lesson "Matter and its Properties" that lies under the performance expectation *5-PS1-3, Make observations and measurements to identify materials based on their properties*. The teacher has planned to provide the students materials for classifying them into solid, liquid and gas as well as to describe their properties such as color, hardness, reflectivity, magnetic and heat conductor by using inquiry and group work. Thus, the students need to use the SEP "plan and carry out an investigation" to achieve the DCI "measurements of a variety of properties can be used to identify materials". In addition, the students will use the standard units to measure and describe physical quantity which is equivalent to the CCC "Scale, proportion and quantity". Similarly, Grade 8 science teacher has described her imposing of the three dimension model of learning in the lesson "Structure of an Animal Cell" that lies under the performance expectation *MS-LS1-2, Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.* The teacher has planned to use the SEP "building a model" for an animal cell along with the CCC "Models can be used to simulate systems" to achieve the DCI "Structure and Function". These descriptions have showed that SEPs and CCCs are not taught as isolated skills rather they are established in a conceptual contexts. On the other side, few teachers have not connected their lessons to the crosscutting concepts despite their knowledge of this dimension. For example, they have described their lessons using SEPs and DCIs only. This suggested the need for professional development sessions around the enforcement of CCCs in the science lesson along with DCIs and SEPs. In addition to that, the teachers ' answers have demonstrated their possession of a strong knowledge of their students' capabilities for using the SEPs. For example, high school science teachers have stated that high school students did not get the opportunity to use and apply the SEPs while they were in the elementary and middle schools because the NGSS were not released yet. Those students are more familiar with the steps of the scientific method rather than doing the science and engineering practices. Thereby, high school science teachers have built up their lessons on the three dimensions of the NGSS but they have revealed fears from not implementing it as expected.

4.3.2. Teachers' Instructional Strategies:

Teachers have described a wide variety of instructional strategies could be used to integrate NGSS in the classroom such as group/pair work, experiment, investigation, guided inquiry, etc. The most common instructional strategies were the collaborative activities in which students will be asked to plan and conduct an investigation to collect data that serves as an evidence to answer a question. However, the teachers have agreed that students have difficulties in SEP7 "Engaging in argument from evidence" and SEP8"Obtaining, evaluating and communicating information" as those have been related to the English language arts instructions. This situation has necessitated more scaffolds in terms of distinguishing between fact and opinion and using facts as evidence to support analysis.

4.3.3. Challenges of Practicing NGSS in the Classroom:

The nine science teachers have agreed on four difficulties. Firstly, the teachers' answers have focused on the curriculum content as one of the challenges for complete and successful implementation. They have reported that the content of the NGSS was not linked to the Emirati culture, religion, society and environment of the country which has necessitated increasing the focus on curriculum adaptation. In addition, they have stated that the amount of the content for each grade level was large and no enough time to be covered as well as some content was hard for the age group. Secondly, the teachers have considered the high demands of three dimension model of learning of NGSS in terms of resources, appropriate teaching tools and laboratory supplies as a challenge. Thirdly, some classes have large number of students which negatively affects the teaching instructions and hinders the learning process especially for the NGSS curriculum that requires doing and practicing science. Lastly, the teachers have asked for high quality training sessions around the implementation of the three dimension model of learning model fostered in NGSS. Some teachers have reported that they have participated in professional development sessions related to certain aspects of NGSS and they have helped their colleagues around implementation. Other teachers have read about NGSS demands by themselves.

Chapter 5: Discussion, Conclusion, Limitations and Recommendation

5.0. Introduction:

This chapter displays the discussion of the study findings in which the results from multiple instruments have been triangulated and compared to other findings in the literature. These discussions have been arranged as answers of the research sub-questions to achieve the objectives of the study. Then, these discussions have been used to answer the main research question and thereby achieving the aim of the study which is to evaluate the implementation of the NGSS in order to determine its effectiveness in one private US curriculum school in Dubai, UAE. Then, tt sews the conclusion, highlights the limitations and suggests recommendations. In addition, it provides a roadway for future studies in the same field.

5.1. Discussion:

The results of the questionnaire and the semi-structured interviews have reflected the answer of the first research sub-question about the extent of feeling convinced or challenged by the implementation of the NGSS. It has been shown that the science teachers were convinced about the NGSS curriculum despite the encountered challenges during its implementation. The science teachers have viewed the NGSS positively and considered it to be better than previous standards as it is somehow flexible, practical and less work loaded. However, they have been challenged by the content of the NGSS as it is not related to the students' culture, society, religion and environment. Thus, the teachers have sometimes faced difficulties in grasping the attention and promoting the interest of their students. These results are similar to those of Dagher and BouJaoude (2011), who claimed that the culture and society of the students and teachers must be taken into consideration during the adoption of a new science curriculum. Similarly, these results have agreed with those of Kawagley et al. (1998), who debated that, the transfer of science curriculum from a western context to a non-western context would not promote the interest of students as they think about science content as not related to their lives. Though of this challenge, the science teachers have demonstrated high trust in practicing the curriculum.

Similarly, both the self-reported responses and the open-ended responses from the questionnaire and interviews have provided answers to the second research sub-question about science teachers' understandings of the NGSS. The science teachers have demonstrated high awareness of the key components of the NGSS: the three dimensions model of learning, DCIs, CCCs, and SEPs as this was clear from their descriptions of the classroom instructional practices during the semi-structured interviews. Interestingly, their descriptions of the instructional practices were compatible with the components and demands of the NGSS though few teachers have ignored the implementation of the crosscutting concepts to their lessons. In addition to that, the teachers have elaborated that the students have skills gap in critical thinking skills and prior knowledge such as the basic science knowledge and knowledge of the scientific method which might hinder the implementation of some SEPs due to the switch from a multiple choice culture of assessments to a style of assessment that needs critical and reasoning skills. Furthermore, all interviewed teachers have elaborated that full implementation of NGSS takes more time than the past standards along with the necessity for different types of resources for a successful transition. They have stated that highly targeted professional development sessions and collaboration with other staff members must be associated with a lot of required resources such as pre-packaged units, lessons, lab space and supplies.

Lastly, the classroom observations for the same interviewed science teachers have been used to answer the third research sub-question about the extent of accommodations between the observed and the described instructional practices. The findings have revealed the existence of gaps between what described and what practiced during implementation of the NGSS. All the teachers have approximately showed the same extent of the gaps between the "perceived" and the "operated" NGSS. The interview responses have claimed both the ease of teaching science under NGSS in primary and elementary cycles and the complexity of teaching it in the high cycles. In addition, the data have suggested that most teachers were skilled at designing instructions for implementing the three dimension model of learning. However, during observations, it was clear that difficulty in implementing their documented planning as intended and planned in the three cycles. Similar results were found in literature for Kawasaki (2015) who has explored the presence of gaps between the teachers' depicted and operated classroom practices and the goals of the NGSS. Most of the observed teachers have identified students' misconceptions and fixed them. Indeed, this works with the past standards not NGSS as suggested by Krajcik et al (2014). According to Krajcik et al. (2014), the adoption of instructions based on the prior knowledge and experiences of students is highly favored to assist learners from all cultural backgrounds grasp scientific knowledge, practice it to solve problems and relate it to the real life context. The failure of the science teachers in transcribing their descriptions into operations can be traced back to the prospect that the teachers have encountered with the almost same challenges and obstacles during implementation as well as they have probably received the same quantity and quality of support encounters for NGSS implementation support. The findings of the "Support Encounters" from the questionnaire have supported this probability as it was clear the presence of different types of support from both inside and outside the school. However, the majority of the teachers have agreed on the quality of the support has to be improved and becomes more generous, productive, relevant and simulating. This similar to what was shown by Banilower (2013) about the lack of high quality support for teachers' development which adds obstacles on effective implementation. In addition, Wilson (2013) proved that the most professional development concentrated mainly on growing isolated skills and techniques. Lederman (2013) and Duschi and Bybee (2014) have demonstrated that the application of SEPs, CCCs and DCIs in the classrooms would be better after attending specific workshops to educate teachers how to integrate these three dimensions of learning the science classroom. The importance of running high quality and specified professional development sessions has been studied by Qablan (2016) in Jordan. He has showed that a subject-specific professional development program around planning and implementing inquiry-based science lessons in the classrooms has highly benefited the participant teachers and were able to design and implement what they have learnt.

5.2. Conclusion:

NGSS promote quality science instructions distinguished by sponsoring the science and engineering practices in tandem with learning contemporary science concepts for satisfying the demands of the current highly technological society demands and improving the students' scores in the international assessments. This study has been carried out to evaluate the implementation of the NGSS in order to determine its effectiveness in one private US curriculum school in Dubai, UAE. The findings have showed that despite well- informed understanding of the NGSS content and structure, the teachers were not able to completely shift their classroom instructions as what they have described. This has suggested the presence of gaps between the perceived and implemented NGSS in the classrooms. These gaps in curriculum implementation could be traced back to a variety of challenges including scarcity of targeted professional development sessions, shortage of resources, and the high number of students per class. The efforts to incorporate the three dimension model of learning within the instructional practices would happen in tandem with appropriate training for in-service teachers to support NGSS implementation. Therefore, the NGSS vision has not completely translated into the classroom practices which have resulted in incomplete implementation and ineffectiveness in preparing the students as intended.

5.3. Limitations and Recommendations:

This is a very limited study as it has been carried out in one private US curriculum school in Dubai. It has been focused on the exploration of the gaps between the "intended", "Perceived" and "Operated" NGSS based on teachers' questionnaire, interviews and classroom observations. The findings cannot be generalized. However, it serves as a roadway for future studies in the same area of research in the context of UAE. The findings might assist educational leaders and policymakers befit more purposed when they plan, design and prepare for pre and in-service professional development, courses and programs to guide and train the science teachers for the purpose of ensuring that the intended curriculum becomes the taught one. This study has focused on the three dimensions of learning; a suggestion for following research studies would be to examine the frequency of incorporating SEPs into the lessons. Moreover, this study has kept it general for the three cycles in one school; another study would be to focus on examining the implementation of the NGSS per each grade level or cycle across in more than one school. In addition to that, comparative studies could be done which means to conduct the same study in large number of schools across UAE.

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Appendix

Teacher Questionnaire Survey

I have read and understood the information describing the purpose and content of the following questionnaire. I am aged 20 years or older. I agree to take part in this research under the terms indicated in the informed consent. *Please indicate your agreement to participate here:* ☐	*Please mark boxes with X* **to indicate your responses**

PART I: Demographic Information					
Your age group	**Your gender**	**Grade Level Taught**	**Your highest level of education**	**Your education background**	**Your years of teaching experience**
☐ 21 - 29 ☐ 30 - 39 ☐ 40 - 49 ☐ 50 - 59 ☐ 60 or Older	☐ Male ☐ Female **Your Nationality** Specify _____	☐ High School ☐ Middle School ☐ Elementary School ☐ KG	☐ High school ☐ Bachelor ☐ Masters ☐ PhD/ Doctorate ☐ Other, specify ________	☐ General Science ☐ Biological Science ☐ Physical Science ☐ Engineering and Computer science ☐ Other, specify ________	☐ New teacher ☐ 1 - 3 years ☐ 4 – 6 years ☐ 7 – 10 years ☐ Over 10 years

PART II: Support for NGSS Implementation

The frequency of getting an opportunity to talk with/ read/ use the supports listed below during the implementation of NGSS curriculum in the academic year 2017-2018:

	Items	1 (Not at all)	2 (Few times per year)	3 (Few times / semester)	4 (Few times per month)	5 (Few times per week)	6 (Almost daily)
1	Advisors						
2	Private Consultants						
3	School Leadership Team						
4	Colleagues from own school						
5	Colleagues from other schools						
6	Ministry of Education Publication						
7	NGSS online website						

Your view about the provided support for implementing NGSS curriculum during the academic year 2017-2018:

	Items	1 (Strongly Disagree)	2 (Disagree)	3 (Slightly Disagree)	4 (Slightly Agree)	5 (Agree)	6 (Strongly Agree)
1	Generous						
2	Productive						
3	Relevant						
4	Stimulating						
5	Sound						
6	Challenging						

PART III: Receptivity

Your views about the structure of the NGSS curriculum for the following items:

	Items	1 (Strongly Disagree)	2 (Disagree)	3 (Slightly Disagree)	4 (Slightly Agree)	5 (Agree)	6 (Strongly Agree)
1	Flexible						
2	Complicated						
3	Practical						
4	Reasonable workload						
5	Less work (than previous)						
6	Better (than previous)						
7	Easy to implement						
8	Substantially different						
9	Requires major shifts in practice						
10	Confident about implementation						

Your views about the content of the NGSS for the following items:

	Items	1 (Strongly Disagree)	2 (Disagree)	3 (Slightly Disagree)	4 (Slightly Agree)	5 (Agree)	6 (Strongly Agree)
1	Encourage students to contribute to society.						
2	Encourage students to work with others.						
3	Take into account individual difference among students.						
4	Help students use science in daily lives.						
5	Consider Emirati students society and culture.						
6	Include content that is difficult to teach.						

PART IV: Understanding

Describe your educational change of the following items according to the "Perceived" NGSS:

	Items	1 (Not considered)	2 (Considered, not to alter)	3 (Intend to alter)	4 (Small alteration)	5 (Modest alteration)	6 (Considerable alteration)
1	Planning documentation.						
2	Teaching and Learning activities used in the classroom.						
3	Resources used for teaching and learning activities.						
4	Themes/ Content/ Topics of teaching and learning.						
5	Role of students take in the classroom.						
6	The way in which you report to parents.						