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TIMSS 2015 – Grade 8

National Report

Trends in International Mathematics and Science Study

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PREFACE

Educational tests are considered the means to signify the level of the learning achievement in the target subject matter. Thus, the analysis of its results requires taking corrective and perhaps structural decisions, which may include developing the subject matter curricula, amending its objectives, and updating its methods of teaching and evaluation. This continues until we are able to link these elements with the programs and curricula of preparing teachers of basic as well as secondary education so that development would be comprehensive and harmonious, and able to serve the purpose for which it was found.

This documented study, which dealt with the national and international tests in which Lebanon participated, places in our hands – as personnel who are involved in educational planning and educational management – scientific means and detailed research results. Such means and results could be added to the database reached by the Center for Educational Research and Development through studies, research statistics and analysis of the results of the official examinations. These in turn could be our reference in the workshop of developing, reforming, modernizing and restructuring the educational curricula in a way that is compatible with the interactive digital age, which uses technology and digital media in all aspects of life.

We are working very hard with all partners in the public, private and university educational sectors to improve the performance of the educational system and consequently to increase the learners' preparations in order to make their skills and competencies suitable for the requirements of international and national tests. In this way, we maintain Lebanon's regional and international rank and improve our techniques, curricula and methods to compete countries that have made successful educational leaps and formed educational systems that can be referred to as exemplary models in facilitating education and in preparing creative learners who are not bound by the burdens that impede their abilities or inhibit their aspirations to shine in studying and in the job market.

I congratulate those who participated in this study, and I call for continuing the research and testing approach so that we could achieve the desired educational progress, according to the scientific standards.

The Acting President of the Center for
Educational Research and Development
Dr. Nada OWEIJANE

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INTRODUCTION

In 2015, Lebanon participated in the Trends in International Mathematics and Science Study (TIMSS), an international study directed by the International Association for the Evaluation of Educational Achievement (IEA). Lebanon has participated in TIMSS since 2003 (2007, 2011, and 2015) gathering rich data about trends in mathematics and science achievement over years.

TIMSS is an assessment of mathematics and science that has been conducted at Year 4 and Year 8 on a four-year cycle since 1995. To inform educational policy in the participating countries, TIMSS also routinely collects extensive background information through a series of questionnaires for students, parents, teachers, principals and curriculum specialists.

Lebanon was one of 57 countries that participated in TIMSS 2015. In Lebanon, 3873 Year 8 students participated in TIMSS. These students completed tests in mathematics and science achievement, and answered questionnaires on their background and experiences in learning mathematics and science at school. School principals and the students' mathematics and science teachers also completed detailed questionnaires.

The purpose of this national report is to establish how well students in Lebanon have performed over time, both in relation to Lebanon's previous achievements and to the achievements of students in other participating countries. It also considers and compares factors identified as influential on achievement, such as students attitudes towards math and science and their perceptions of teaching in these subjects as well as principals' and teachers' views on school discipline and resources.

The report is structured to provide comprehensive and internationally comparable data about math and science achievement of Lebanese grade 8 students and includes the following. An introductory chapter (Chapter 1) that provides an overview of TIMSS and the Lebanese education system in addition to a snapshot of the 2015 results. Chapter 2 summarizes the findings from TIMSS 2015 in terms of a number of parameters particular to the Lebanese context like geographic location, gender, type of school, and language of instruction. Chapters

3 and 4 summarize the findings from TIMSS 2015 in terms of math and science performance, respectively. Chapter 5 draws on responses from the school principals to report on demographic characteristics of their schools, while chapters 6,7, and 8 draw on responses of principals, teachers and students to report on school climate, school safety, and student engagement and attitudes, respectively. Principals, teachers and students views on classroom instruction in Lebanese schools is reported in chapter 9, while chapter 10 focuses on teacher and principal preparation, qualification and experience and its effect on performance in math and science. The effect of home environment support like availability of educational resources at home as well as the effect of speaking the language of the test at home on the student's achievement in mathematics and science is reported in chapter 11. Chapter 12 summarizes the main findings from the study, provides a perspective on their implications, and draws out several themes that are important for improvement and better achievement. Recommendations are also provided.

Throughout the report comparisons are made with Lebanon's prior performance and with other countries that took part in the study and with Arab countries.

CHAPTER 1

Overview

1-1 Introduction

In this introductory chapter, an overview of the TIMSS test will be conveyed along with all the necessary information required for the reader to understand all the facets related to this assessment. Above all, this test is important for Lebanon because it provides an international source of evidence that can, along with other national studies, provide guidance when it comes to identifying gaps in math, science, and physics for the purpose of improving the curricula, the teaching practices, and students' achievement; hence, the overall learning outcomes can be enhanced by scrutinizing the performance of the concerned Lebanese students via different perspectives. Furthermore, the tracking of such studies over the years, will help the country monitor its performance and check whether progress is taking place with time, especially when compared to other developed and developing countries. The main aim is to deploy such studies in the service of the Lebanese education system and the school learner.

1-2 TIMSS: A brief history

Research in education became a need for some countries like the United States of America in order for them to analyze and understand the performance of their students, mainly in math and science. The culmination of these attempts that started in the 1960s led to the Third International Mathematics and Science Study (TIMSS) in the 1990s. Back then, it was the most comprehensive test meant to assess students' performance in various countries. The gathered information included how teachers affect students, how teachers are teaching, and the curricula that they are using. So, it was a way for the United States to compare its system of education to other countries' systems. The information that was collected focused more on math than science. Five ways were used to collect data: the achievement test, analyses of curricula, responses to questionnaires taken by students, teachers, school administrators, policy issue studies, and videos of teachers teaching inside classrooms. In the process, concerns surfaced: Can the results of this test in one country be compared to another where the context and the samples of students are different? Thus, the test designers tried to reduce such biases and the random selection of students became the norm. The timing of the test, the age of students, and the curricular differences were all voiced worries and the creators of the test tried to work on them (Global perspectives for local action: Using TIMSS to improve U.S. Mathematics and Science Education, 1999).

1-3 TIMSS today

The TIMSS test was developed to furnish refined data to differentiate between countries vis-à-vis the U.S., as far as the achievement of students in grades 4 and 8 is concerned. This collection of data started in 1995 and it continues to take place. The students of participating countries sit for the test every four years. Additionally,

another test-TIMSS Advanced- was designed to quantify the achievement of students in math and physics during the last year of secondary schooling in various countries. TIMSS advanced has been administered in 1995, 2008, and 2015 (www.nces.ed.gov/timss/).

The TIMSS test is supported by the International Association for the Evaluation of Educational Achievement (IEA) and it is supervised by the National Center for Education Statistics (NCES) which works under the supervision of the U.S. Department of Education (www.nces.ed.gov/timss/). The IEA has been established in 1959 in Holland, and it is one of the largest organizations that conduct comparative studies as far as student achievement is concerned (Lebanon in the international study: TIMSS 2011, 2012).

The last TIMSS round took place in 2015. Students, representing around 60 nations, from grades 4, 8, and 12 participated in it. TIMSS Advanced, in 2015, was administered in nine countries. Appendix A table shows the various countries that participated in TIMSS since 1995. A sample of Lebanon's grade 8 students has taken the test in 2003 along with 52 other countries; with 67 in 2007 and with 62 in 2011 (Lebanon in the international study: TIMSS 2011, 2012), and finally Lebanon took part in the 2015 test (Appendix A sheds light on the process since 1995, including Lebanon's participation as highlighted in the table); moreover, in 2008 and 2015 a sample of Lebanese students studying in their last year of secondary school took the TIMSS Advanced test as found in Appendix B (www.nces.ed.gov/timss/). Nine countries participated in TIMSS Advanced in 2015.

1-4 TIMSS 2015: Test content

As stated by the National Center for Education Statistics, "the TIMSS mathematics assessment is organized around two dimensions: (1) a content dimension specifying the subject matter to be assessed and (2) a cognitive dimension specifying the cognitive or thinking processes to be assessed. In grade 4, TIMSS assesses student knowledge in three content domains: *number*, *geometric shapes and measures*, and *data display*. In grade 8, TIMSS assesses student knowledge in four content domains: *number*, *algebra*, *geometry*, and *data and chance*. In both grades (and across all content domains), TIMSS assesses students' mathematical thinking in three cognitive domains: *knowing*, *applying*, and *reasoning*" (www.nces.ed.gov/timss/timss15_assessments.asp).

As for the TIMSS science assessment, "it is similarly organized around two dimensions: (1) a content dimension specifying the subject matter to be assessed and (2) a cognitive dimension specifying the cognitive or thinking processes to be assessed. In grade 4, TIMSS assesses student knowledge in three content domains: *life science*, *physical science*, and *Earth science*. In grade 8, TIMSS assesses student knowledge in four content domains: *biology*, *chemistry*, *physics*, and *Earth science*. In both grades (and across all content domains), TIMSS assesses students' scientific thinking in three cognitive domains: *knowing*, *applying*, and *reasoning*" (www.nces.ed.gov/timss/timss15_assessments.asp).

It is worth noting that a sample of Lebanon's grade 8 students (N=3873) participated in the 2015 round, and students were allowed to use calculators where applicable, Tables 1-1.A and 1-1.B clarify the weight of each content domain, whether in math or science, regarding the assessment percentage.

Tables 1-1.A and 1-1.B Percentage of TIMSS mathematics and science assessment score points devoted to content and cognitive domains, by grade: 2015

Table 1-1.A. Mathematics content and cognitive domains			
Grade 4		Grade 8	
Content domains	Percent of assessment	Content domains	Percent of assessment
Number	52	Number	31
Geometric shapes and measures	32	Algebra	28
Data display	15	Geometry	21
		Data and chance	21
Knowing	36	Knowing	31
Applying	44	Applying	45
Reasoning	20	Reasoning	24

Table 1-1.B. Science content and cognitive domains			
Grade 4		Grade 8	
Content domains	Percent of assessment	Content domains	Percent of assessment
Life science	46	Biology	36
Physical science	35	Chemistry	19
Earth science	19	Physics	24
		Earth science	21
Knowing	41	Knowing	36
Applying	38	Applying	41
Reasoning	21	Reasoning	23

NOTE: The percentages in this table are based on the number of score points, not the number of items. The number of score points and the number of items are not the same because some constructed-response items are worth more than one score point. (For the corresponding percentages based on the number of items, see the Technical Notes *[forthcoming]*.) The content domains define the specific mathematics and science subject matter covered by the assessment, and the cognitive domains define the sets of thinking processes students are likely to use as they engage with the respective subject's content. Each content domain has several topic areas. Each topic area is presented as a list of objectives covered in a majority of participating education systems, at either grade 4 or 8. However, the cognitive domains of mathematics and science are defined by the same three sets of expected processing behaviors—*knowing*, *applying*, and *reasoning*. Detail may not sum to totals because of rounding. SOURCE: Martin, M.O., Mullis, I.V.S., and Hooper, M. (Eds.). (2016). *Methods and Procedures in TIMSS 2015*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

1-5 TIMSS Advanced 2015: Test content

In terms of TIMSS Advanced, it is split into the math part and the physics part.

"The advanced mathematics assessment is organized around two dimensions: (1) a content dimension specifying the subject matter to be assessed and (2) a cognitive dimension specifying the cognitive or thinking processes to be assessed (see Table V). TIMSS Advanced assesses student knowledge in three content domains—*algebra*, *calculus*, and *geometry*—which vary in the percentage of score points they represent and, therefore, in their contribution to the overall advanced mathematics scale score. TIMSS Advanced assesses students' mathematical thinking in three cognitive domains: *knowing*, *applying*, and *reasoning*. The cognitive domains also vary in the percentage of score points they represent. Calculator use is permitted in TIMSS Advanced" (www. nces.ed.gov/timss/timss15advanced_assessments.asp)

"The physics assessment is similarly organized around two dimensions: (1) a content dimension specifying the subject matter to be assessed and (2) a cognitive dimension specifying the cognitive or thinking processes to be assessed (see Table 1-2). TIMSS Advanced assesses student knowledge in three content domains—*mechanics and thermodynamics*, *electricity and magnetism*, and *wave phenomena and atomic/nuclear physics*—which vary in the percentage of score points they represent and, therefore, in their contribution to the overall physics scale score. TIMSS Advanced assesses students' scientific thinking in three cognitive domains: *knowing*, *applying*, and *reasoning*. The cognitive domains also vary in the percentage of score points they represent" (www. nces.ed.gov/timss/timss15advanced_assessments.asp). Similar to TIMSS 2015, Table V clarifies the weight of each content domain, whether in advanced math or physics, regarding the assessment percentage.

Table 1-2. Percentage of TIMSS Advanced score points devoted to content and cognitive domains, by subject area: 2015

Advanced mathematics		Physics	
Content domains	**Percent of assessment**	**Content domains**	**Percent of assessment**
Algebra	35	Mechanics and thermodynamics	41
Calculus	36	Electricity and magnetism	26
Geometry	29	Wave phenomena and atomic/nuclear physics	33
Knowing	29	Knowing	27
Applying	41	Applying	44
Reasoning	30	Reasoning	29

NOTE: The percentages in this table are based on the number of score points, not the number of items. The number of score points and the number of items are not the same because some constructed-response items are worth more than one score point. (For the corresponding percentages based on the number of items, see the Methodology and Technical Notes. The content domains define the specific

advanced mathematics and physics subject matter covered by the assessment, and the cognitive domains define the sets of thinking processes that students are likely to use as they engage with the respective subject's content. Each of the content domains has several topic areas. Each topic area is presented as a list of objectives covered in a majority of the participating education systems. However, the cognitive domains of advanced mathematics and physics are defined by the same three sets of expected processing behaviors—*knowing, applying,* and *reasoning.* What defines each of the processing behaviors, however, differs slightly for each subject to reflect the specific thinking skills required for advanced mathematics and for physics. Detail may not sum to totals because of rounding. SOURCE: Martin, M.O., Mullis, I.V.S., and Hooper, M. (Eds.). (2016). *Methods and Procedures in TIMSS Advanced 2015*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

1-6 Test administration and sampling

After the assessment framework is prepared, the test and questionnaires are usually piloted in each country with the help of the national research coordinator representing each country. The tools are piloted after the translation of the instrument takes place to suit the language of instruction in each country such as a French version, other than the English one, for Lebanon. Based on the piloting phase, the tools are usually amended, and then copies of the various booklets are made available. Everything is supervised by the IEA. Answer keys, implementation guide, coordinators' guide, sampling guide, quality control and monitoring guide, as well as a data entry guide are all prepared to guarantee the implementation of a highly organized process.

Regarding the sample selection, the TIMSS team asks each participating country "to draw probability samples of students who were nearing the end of their fourth or eighth year of formal schooling" (www. nces.ed.gov/timss/faq.asp). Even more, they further utilize "a two-stage stratified cluster sampling design. The first stage made use of a systematic probability-proportionate-to-size (PPS) technique to select schools. The second stage of sampling consisted of selecting classrooms within sampled schools" (www. nces.ed.gov/timss/faq.asp).

Following that, the test is administered and the questionnaires are filled. This is usually followed by correcting the booklets. Afterwards, data entry and data processing take place at the IEA Data Processing Center. Finally, the international report is usually prepared and the final results are analysed by the IEA, in collaboration with the national entity in charge of the test (Lebanon in the international study: TIMSS 2011, 2012). The above mentioned steps were followed in 2015 when Lebanon participated in this international assessment.

1-7 An overview of the Lebanese educational system

In Lebanon, there are two types of schools: public and private; the private sector is more developed than the public one (Kobeissi, 1999). The public schools are operated by the government and they are free of charge. The private ones are either religious or secular, and they charge fees in varying degrees depending on the services that are

offered by the school. As well, there are some private schools that are buttressed by the government too; they charge minimal fees since they receive financial aid from the government, and they may be secular or religious (Lebanon-Education system, 2005). Lebanese students join school at the age of three. Education is considered to be compulsory for the first six years of schooling (Yaacoub, & Badre, 2012) and nowadays till the age of 15; however, the age bracket-15- is not officially stated by the Ministry of Education and Higher Education. Parents choose the schools that their kids go to. The language of instruction varies depending on the school. Some schools focus on French as the second language, others focus on English, and a few focus on both; nevertheless, in all cases, students study math and science either in French or in English and not in Arabic.

The number of students enrolled in Lebanese schools, for the academic year 2015-2016, was 1, 003,634. Those studying in the public sector constituted 31% whilst the private sector attendees reached 69% (CERD, 2016).

Lebanon used to be a leader in education when compared to the neighbouring countries, before the 1975 war. Once the war started, the education sector got affected, similar to all other sectors, and with time the system suffered the consequences especially that the country was not able to change its curriculum except in 1997 (Kobeissi, 1999), and no genuine reform attempts were initiated since then; however, the Lebanese curriculum change initiative is currently being undertaken by CERD.

The following sections present a quick glance on Lebanon's performance in TIMSS from the year 2003 and up until 2015.

1-8 A snapshot on Lebanon's achievement in TIMSS since 2003

The performance of the Lebanese students who participated in the TIMSS test, whether in math or science, across the years did not improve in a significant manner as reported in Table 1-3.A. The table shows that in 2015 8% of grade 8 students in Lebanon have reached the High international benchmark; that is scoring 550 and above; and 8% of grade 8 students in Lebanon have reached the Advanced International benchmark; that is scoring 600 and above. Most of the Lebanese students were at the Intermediate benchmark; scoring 475 and above; and Low benchmark scoring 400 and above.

Table 1-3.A Percentage of Students, from Lebanon, Reaching the International Benchmarks of Mathematics Achievement across Assessment Years

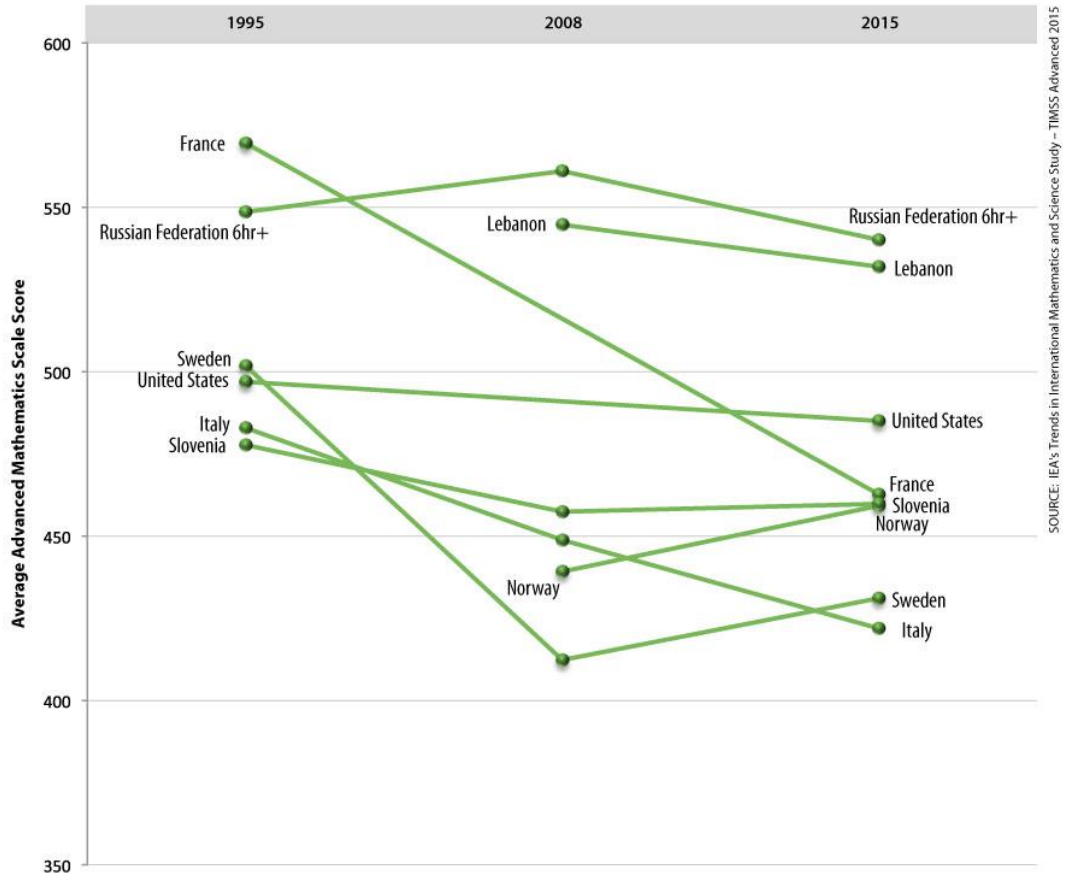
	Advanced International Benchmark (625)						High International Benchmark (550)					
	Percent of Students						Percent of Students					
	2015	2011	2007	2003	1999	1995	2015	2011	2007	2003	1999	1995
Lebanon	0	1	1	0			8	9	10	4		

The results were similar in Science where only !% of grade 8 students in Lebanon reached the Advanced international benchmark and 7% reached the High international benchmark with the majority reaching the Intermediate international benchmark and Low International benchmark.

TIMSS Advanced showed better results for students in Lebanon in mathematics but not in physics. It is worth noting that TIMSS Advanced is implemented in Lebanon by grade 12 general sciences students. Exhibit M1.4 shows the performance of grade 12 Lebanese students in mathematics across the rounds in which TIMSS Advanced was administered as compared to other countries. Note that Lebanon participated in the 2008 and 2015 rounds only.

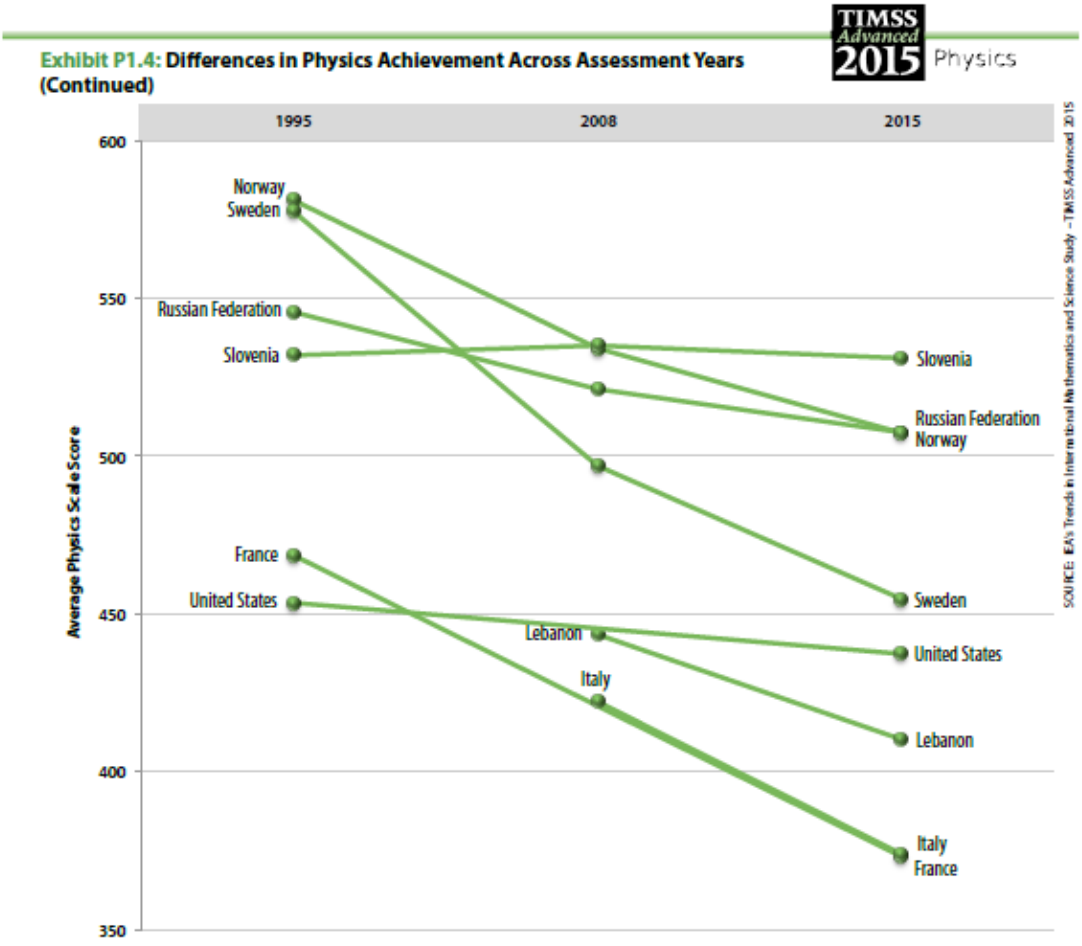
TIMSS Advanced 2015 Mathematics

Exhibit M1.4: Differences in Advanced Mathematics Achievement Across Assessment Years



The graph shows the mathematics results for TIMSS Advanced only. The results show that Lebanon ranked second in the world though the overall performance declined from 2008 to 2015.

Exhibit P1.4 shows the performance of Lebanese students in physics in TIMSS Advanced as compared to other countries and across TIMSS Advanced rounds. Lebanon ranked seventh among the nine participating countries in both 2008 and 2015 rounds. Results show a decline in performance of Lebanese students from 2008 to 2015.



The results for TIMSS Advanced show that Lebanon ranked second in mathematics and seventh in physics among nine countries who participated in TIMSS Advanced. These results are not encouraging taking into consideration that the performance of Lebanese grade 12 students decreased from 2008 till 2015.

The upcoming chapters will examine the achievement of Lebanese students using a different perspective through a deep analysis and will concentrate only on TIMSS 2015 and not TIMSS Advanced. It is worth noting that Lebanon never participated in TIMSS grade 4.

The following chapters will report in detail on Lebanon's results in TIMSS's math and science and their various domains and cognitive levels, presenting strengths and challenges, areas of progress and drop, in addition to correlates of achievement with various home, school, and contextual variables.

Appendix A

TIMSS Participating Countries

Education system	1995		1999	2003		2007		2011		2015		2019	
	4th grade	8th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade
Albania												●	
Algeria						●	●						
Argentina		○			○								
Armenia				●	●	●	●	●	●	○	○	●	●
Australia	●	●	●	●	●	●	●	●	●	●	●	●	●
Austria	●	●				●		●				●	
Azerbaijan								●				●	
Bahrain					●		●	●	●	●	●	●	●
Belgium (Flemish)-BEL		●	●	●	●			●		●		●	
Belgium (French)-BEL		●											
Bosnia and Herzegovina							●					●	
Botswana					●		●						
Bulgaria		●	●		●		●			●		●	
Canada	●	●	●							●	●	●	●
Chile			●		●			●	●	●	●	●	●
Chinese Taipei			●	●	●	●	●	●	●	●	●	●	●
Colombia		●				●	●						
Croatia								●		●		●	●
Cyprus	●	●	●	●	●		●			●		●	●
Czech Republic	●	●	●			●	●	●		●		●	
Denmark		●				●		●		●		●	
Egypt					●		●				●	●	
El Salvador						●	●						
England-GBR	●	●	●	●	○	●	●	●	●	●	●	●	●
Estonia					●								
Finland			●					●	●	●		●	●
France		●								●		●	●
Georgia						●	●	●	●	●	●	●	●
Germany		●				●		●		●		●	
Ghana					●		●		●				
Greece	●	●											
Hong Kong-CHN	●	●	●	●	●	●	●	●	●	●	●	●	●
Hungary	●	●	●	●	●	●	●	●	●	●	●	●	●
Iceland	●	●											
Indonesia	○	○	●		●		●		●	●			
Iran, Islamic Republic of	●	●	●	●	●	●	●	●	●	●	●	●	●
Ireland	●	●						●		●	●	●	●
Israel	●	●	●		●		●		●		●		●
Italy	○	○	●	●	●	●	●	●	●	●	●	●	●
Japan	●	●	●	●	●	●	●	●	●	●	●	●	●
Jordan			●		●		●		●	●	●		●
Kazakhstan						●		●	●	●	●	●	●
Korea, Republic of	●	●	●		●		●	●	●	●	●	●	●
Kosovo												●	

Education system	1995		1999	2003		2007		2011		2015		2019	
	4th grade	8th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade	4th grade	8th grade
Kuwait	●	●				●	●	●		●	●	●	●
Latvia	●	●	●	●	●	●							
Lebanon					●		●		●		●		●
Lithuania		●	●	●	●	●	●	●	●	●	●	●	●
Macedonia, Republic of			●		●				●			●	
Malaysia			●		●		●		●		●		●
Malta							●	●			●	●	
Mexico	○	○											
Moldova, Republic of			●	●	●								
Mongolia						○	○						
Montenegro, Republic of												●	
Morocco			●	●	●	●	○	●	●	●	●	●	●
Netherlands	●	●	●	●	●	●		●		●		●	
New Zealand	●	●	●	●	●	●		●	●	●	●	●	●
Northern Ireland-GBR								●		●			●
Norway[1]	●	●		●	●	●	●	●	●	●	●	●	●
Oman							●	●	●	●	●	●	●
Pakistan												●	
Palestinian Nat'l Auth.					●		●		●				
Philippines		○	●	●	●							●	
Poland								●		●		●	
Portugal	●	●						●		●		●	
Qatar						●	●	●	●	●	●	●	●
Romania		●	●		●		●	●	●			●	
Russian Federation		●	●	●	●	●	●	●	●	●	●	●	●
Saudi Arabia					●		●	●	●	●	●	●	●
Scotland-GBR	●	●		●	●	●	●						
Serbia					●		●	●		●		●	
Singapore	●	●	●	●	●	●	●	●	●	●	●	●	●
Slovak Republic		●	●		●	●		●		●		●	
Slovenia	●	●	●	●	●	●	●	●	●	●	●	●	
South Africa		●	●		●								
Spain		●						●		●		●	
Sweden		●			●	●	●	●	●	●	●	●	●
Switzerland		●											
Syrian Arab Republic							●		●				
Thailand	●	●	●				●	●	●		●		
Tunisia			●	●	●	●	●	●	●				
Turkey			●				●	●	●	●	●	●	●
Ukraine						●	●		●				
United Arab Emirates								●	●	●	●	●	●
United States	●	●	●	●	●	●	●	●	●	●	●	●	●
Yemen				○		●		●					
Total	**29**	**46**	**38**	**26**	**47**	**37**	**50**	**50**	**42**	**49**	**38**	**58**	**39**

Appendix B

TIMSS Advanced Participating Countries

Education system	1995 Last-year Secondary School	2008 Last-year Secondary School	2015 Last-year Secondary School
Armenia		●	
Australia	●		
Austria	●		
Canada	●		
Cyprus	●		
Czech Republic	●		
Denmark	●		
France	●		●
Germany	●		
Greece	●		
Iran, Islamic Republic of		●	
Israel	●		
Italy	●	●	●
Latvia[1]	●		
Lebanon		●	●
Lithuania[2]	●		
Netherlands		●	
Norway[1]	●	●	●
Philippines		●	
Portugal			●
Russian Federation	●	●	●
Slovenia	●	●	●
Sweden	●	●	●
Switzerland	●		
United States	●		●
Total	**19**	**10**	**9**

● = Indicates participation in particular assessment with results reported or forthcoming.
[1] Administered physics but not advanced mathematics in 1995.
[2] Administered advanced mathematics but not physics in 1995.
NOTE: OECD member countries are bolded.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS).

CHAPTER 2

Students' Achievement by Lebanese factors

This chapter summarizes the findings from TIMSS 2015 in terms of a number of parameters particular to the Lebanese context. The chapter describes the changes in mean performance according to:

- School geographic location or governorate: Beqaa, Beirut, South Lebanon, Nabatieh, North Lebanon, Mount Lebanon suburbs.
- School sector: Private or public
- School teaching language: English, French, Both English and French.
- Gender: boys, girls.

2.1 Participants in TIMSS 2015 in Lebanon

A total of 3873 students from 138 schools participated, the sample was selected randomly from both the private sector 65% and the public sector 35%, among the 6 Governorates, the selected schools implement either English or French as a foreign language for teaching mathematics and science subjects. Table 2.1 shows the percentage and number of grade 8 students and schools participating in TIMSS in each governorate.

Table 2.1 Percentage of Students and Schools Participating in TIMSS by Governorate

Governorate	Schools		Students	
	Percentage of Schools	Number of Schools	Percentage of Students	Number of Students
Beirut	7.97	11	***8.13***	***315***
Mount Lebanon suburbs	21.01	29	***19.9***	***771***
Mount Lebanon	11.59	16	***15.13***	***586***
North	23.91	33	***22.72***	***880***
Beqaa	15.94	22	***18.95***	***734***
South	11.59	16	***8.88***	***344***
Nabatieh	7.97	11	***6.27***	***243***
TOTAL	100%	138	***100%***	***3873***

Among the sample of participating students, 33.1% attended public schools and 66.9% attended private schools. Out of the attendees, 53.7% were females and 46.3% were males. 38.9% of students are English educated and 61.1% are French educated.

2.1.1 Mathematics achievement by geographic location of the school

In this section of the report we will study the average performance of students attending schools in the different governorates. Figure 2.1 shows the international mathematics center point 500, the Lebanese mathematics average 442, and the averages of algebra, geometry and mathematics of each governorate. The achievement in algebra in all governorates is higher than the achievement in geometry in each and higher than the overall mathematics achievement in Lebanon. It is crucial to mention that the weight of algebraic items and geometric items is not the same; this means that the mathematics average depends on the weight of each domain.

Figure 2.1. Students' Achievement in Mathematics by Governorate

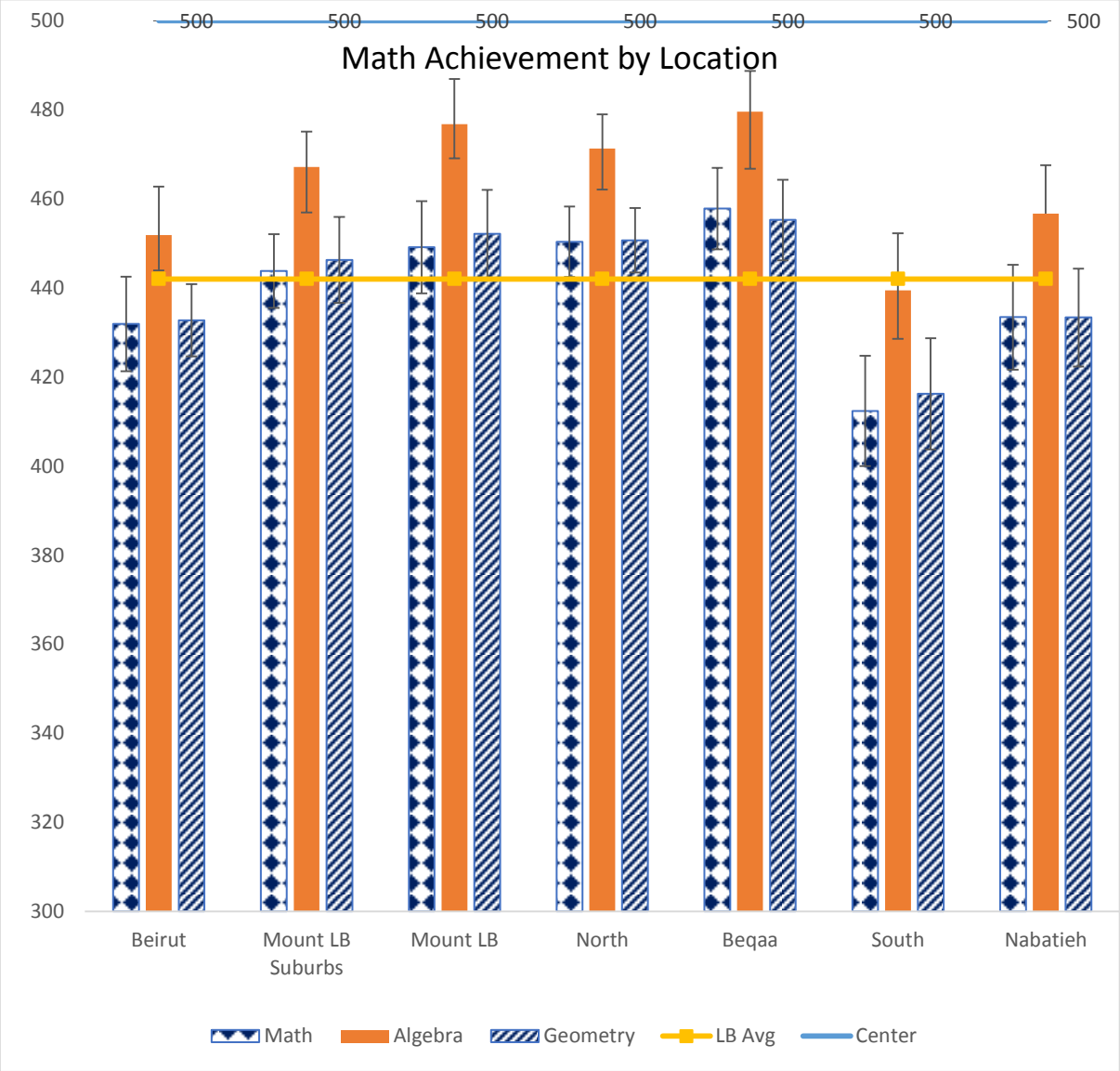


Table 2.2 shows the means and the percentage relative differences in achievement by each governorate. The percentage relative difference was calculated using the following formula $\%\ \text{R..D.} = 100 \times (\frac{\text{AVG}-\text{LB Avg}}{\text{LB Avg}})$ where AVG represents the governorate average.

Table 2.2 Percentage Relative Difference in Achievement by Each Governorate

	Beirut	Mount LB suburbs	Mount LB	North	Beqaa	South	Nabatieh
Math score	431.9	**443.82**	**449.15**	**450.35**	**457.82**	412.38	433.43
% R.D Math	-2.28	0.41	1.62	1.89	3.58	-6.70	-1.94
Algebra scores	**451.86**	**467.14**	**476.75**	**471.28**	**479.57**	439.47	**456.65**
% R.D Algebra	2.23	5.69	7.86	6.62	8.50	-0.57	3.31
Geometry	432.74	**446.29**	**452.13**	450.7	**455.27**	416.25	433.35
% R.D Geometry	-2.10	0.97	2.29	1.97	3.00	-5.83	-1.96

Governorates can be classified in decreasing order according to their achievement in mathematics is as follows:
Above 442 Lb. average: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs.
Below 442 Lb. average: Nabatieh, Beirut, South Lebanon.
The performance of Beqaa students is higher than other governorates and the percentage relative difference of Beqaa students is 3.58 while that of south is -6.7. Three governorates have scores less than Lebanese mathematics average 442.

The decreasing order of governorates according to their achievement in algebra is as follows:
Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South.
Five governorate scores are higher than the mathematics average "except for south" and this means that the students' performance in algebra is higher than that in geometry.

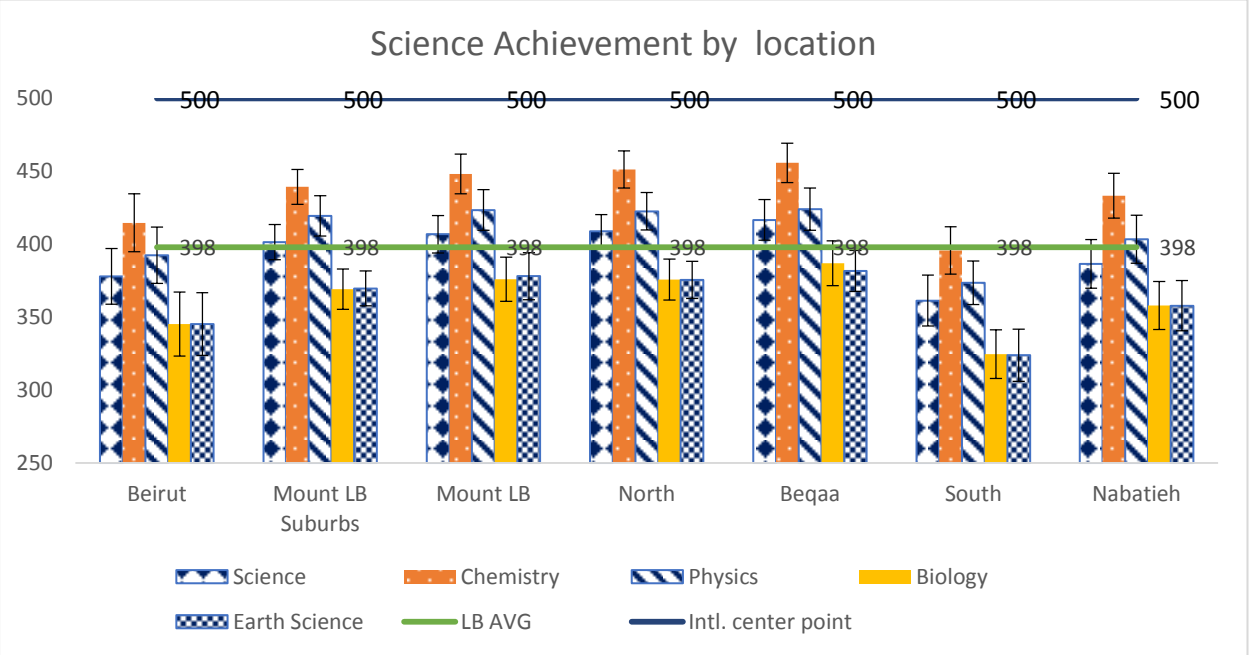
The decreasing order of governorates according to achievements in Geometry is as follows:
Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South.

All governorate students performed lower in geometry in comparison to their performance in algebra, but the decreasing order of governorates is still the same except one switch between North and Mount Lebanon in the second and third places.

2.1.2 Science achievement by geographic location of the school

In the above section we studied the difference between students' mathematics scores among Lebanese governorates, in this section we will study the average science performance of students attending schools in different governorates. Figure 2.2 shows the international Science center point 500, the Lebanese Science average 398, and the average of Chemistry, Physics, Biology, Earth Science to each governorate. The weight of the items is not the same so the overall average of science depends on the weight of the items in each domain.

Figure 2.2 Students' Achievement in Science by Governorate



Governorates can be classified in decreasing order according to their achievement in science as shown in table 2.3 is as follows:

Above 398=Lb. average: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs.

Below 398=Lb. average: Nabatieh, Beirut, South Lebanon. Which is the same order as that in mathematics

The highest percentage relative difference is that for Beqaa students 4.7 while the lowest is for the South -9.7. Also, three governorates have scores less than Lebanese science average 398 which is the same as the mathematics result.

Table 2.3 Percentage Relative Difference in Science Achievement by Each Governorate

	Beirut	Mount LB Suburbs	Mount LB	North	Beqaa	South	Nabatieh
Science	377.95	**401.44**	**406.92**	**408.97**	**416.71**	361.36	386.54
%R.D Science	-5.03	**0.86**	**2.24**	**2.76**	**4.70**	-9.20	-2.88

Table 2.4 shows that the students' performance in chemistry for all governorates is higher than the Science average except for South which is slightly lower than the average, while in physics the students' performance in 5 governorates is higher than the Science average but Beirut and South scores are below Lebanese Science average.

The decreasing order of governorates according to achievements in Chemistry is as follows: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs, Beirut, Nabatieh, South.

The decreasing order of governorates according to achievements in Physics is as follows: Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South.

Table 2.4 Percentage Relative Difference in Physics and Chemistry Achievements by Each Governorate

	Beirut	Mount LB Suburbs	Mount LB	North	Beqaa	South	Nabatieh
Chemistry	**414.72**	**439.33**	**448.21**	**451.29**	**455.84**	395.71	**433.31**
%R.D Chemistry	**4.20**	**10.38**	**12.62**	**13.39**	**14.53**	-0.58	**8.87**
Physics	392.53	**419.44**	**423.50**	**422.64**	**424.02**	373.58	**403.51**
%R.D Physics	-1.37	**5.39**	**6.41**	**6.19**	**6.54**	-6.14	**1.38**

Table 2.5 shows that the students' performance in biology and earth science for all governorates is lower than the science average.

The decreasing order of governorates according to achievements in biology is as follows: Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South.

The decreasing order of governorates according to achievements in Earth Science is as follows: Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South.

The scores of biology and earth science in all governorates are lower than the Lebanese Science average 398 which is the average of the subjects biology, Earth Science, physics and chemistry. The comparison of the Lebanese Science average and the international science average is done in another chapter.

Table 2.5 Students Performance in Biology and Earth Science by Governorate

	Beirut	Mount LB Suburbs	Mount LB	North	Beqaa	South	Nabatieh
Biology	345.24	369.25	375.99	375.74	386.97	324.70	358.01
%R.D Biology	-13.26	-7.22	-5.53	-5.59	-2.77	-18.42	-10.05
Earth Science	345.28	369.74	378.12	375.58	381.66	323.94	357.79
%R.D Earth Science	-13.25	-7.10	-4.99	-5.63	-4.11	-18.61	-10.10

Table 2.6 shows the general ranking of the seven governorates in comparison to each other, the ordering from the highest grades to the lowest, the ordering of the governorates is the same in both math and science. In the table below the underlined name of the governorate shows a governorate with a score lower than the Lebanese score, and the bold lines in the table splits the names according to higher or lower than Lebanese score.

Table 2.6 Ranking of Governorates by Students Performance in TIMSS 2015

Rank / Subject	1st	2nd	3rd	4th	5th	6th	7th
Mathematics	Beqaa	North	Mount Lebanon	Mount Lebanon suburbs	Nabatieh	Beirut	South Lebanon
Algebra	Beqaa	Mount Lebanon	North	Mount Lebanon suburbs	Nabatieh	Beirut	South
Geometry	Beqaa	Mount Lebanon	North	Mount Lebanon suburbs	Nabatieh	Beirut	South.
Science	Beqaa	North	Mount Lebanon	Mount Lebanon suburbs	Nabatieh	Beirut	South Lebanon
Chemistry	Beqaa	North	Mount Lebanon	Mount Lebanon suburbs	Beirut	Nabatieh	South
Physics	Beqaa	Mount Lebanon	North	Mount Lebanon suburbs	Nabatieh	Beirut	South
Biology	Beqaa	Mount Lebanon	North	Mount Lebanon suburbs	Nabatieh	Beirut	South
Earth Science	Beqaa	Mount Lebanon	North	Mount Lebanon suburbs	Nabatieh	Beirut	South.

2.2 Mathematics and Science Achievement by School sector

Schools in Lebanon can be classified into two sectors: governmental public sector and non-governmental private sector. The ministry of education manages the public sector and orients the private sector where both governmental and non-governmental follow the same curriculum in the broad sense. The sample of schools which participated in TIMSS 2015 is represented in table 2.7. Results show that the participant schools were 35% public and 65% private, the public-school students constitute 33.1% while the private school students constitute 66.9% of the whole sample.

Table 2.7 Percentage of Schools Participating in TIMSS 2015 by Sector

	Private	Public
Schools	65%	35%
Students	66.9%	33.1%

In this section of the report, we will study the average performance of students attending either private or public sector. Figure 2.3 shows the international mathematics and science center point 500, the Lebanese mathematics average 442, the Lebanese science average 398 and the averages of all subjects for both private and public-school students. The public students' achievement in all subjects seems to be higher than the private school students' achievement, but it is not statistically significant as revealed by the overlapping standard errors in figure 2.3.

Figure 2.3 Student Achievement by Sector for Each Subject

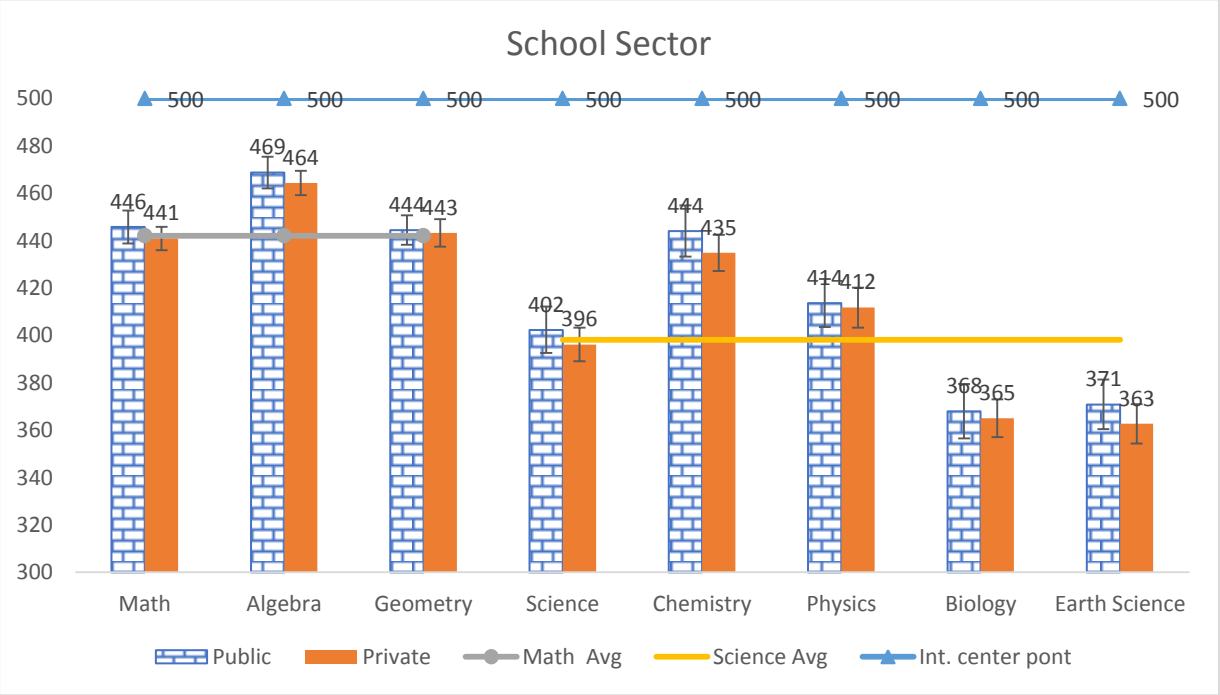


Table 2.8 shows the scores and the % relative differences = $100 \times (\frac{\text{AVG}-\text{LB Avg}}{\text{LB Avg}})$ for each subject the students' scores at public schools are higher than that of private schools, for example the mathematics score at public schools is above Lebanese average with a percentage relative difference +0.83 while at private schools it is below with a percentage relative difference -0.27, and the science score at public schools is above the Lebanese average with a percentage relative difference 1.08 while at private schools it is below the

Lebanese average with a percentage relative difference -0.48. The difference in geometry, physics and biology is also not significant as figure 2.3 shows overlapping standard errors and table 2.8 below shows the percentage relative differences.

Table 2.8 Percentage Relative Difference by Subject for Each Sector

		Math	Algebra	Geometry	Science	Chemistry	Physics	Biology	Earth Science
Public	scores	**445.67**	**468.63**	**444.38**	**402.31**	**443.98**	**413.61**	367.94	370.85
	%RD	**0.83**	**6.02**	**0.54**	**1.08**	**11.55**	**3.92**	-7.55	-6.82
Private	Scores	440.81	**464.25**	**443.15**	396.09	**434.74**	**411.66**	364.98	362.64
	%RD	-0.27	**5.03**	**0.26**	-0.48	**9.23**	**3.43**	-8.30	-8.88

2.3. Mathematics and Science achievement by language

Lebanese Schools use either English or French language to teach mathematics and science. Among the sample who participated in TIMSS 2015, there are 38.9% of students use the English language and 61.1% use French. In this section we will study the influence of the language on the mathematics and science scores.

Figure 2.4 shows the scores of the subjects in each language, the French students' scores in algebra were better than the English students' scores, While the English students' scores biology were better than French students' scores. In other subjects, French students' scores and English students' scores seem to be the same with a slight difference and an overlapping standard error.

Figure 2.4 Student Achievement by Language

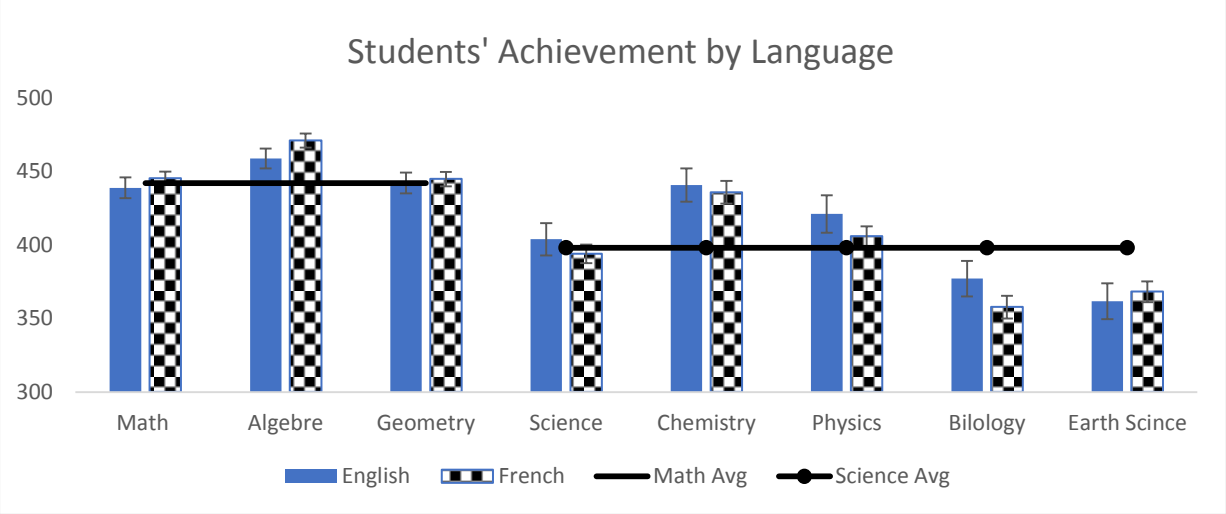


Table 2.9 shows the results and differences between English and French educated students within public and private sectors. In public schools, English educated students performed better than French educated in both Math and science, while in private schools French educated students scored better in Math but not in science.

Table 2.9 Student Performance by Language and Subject

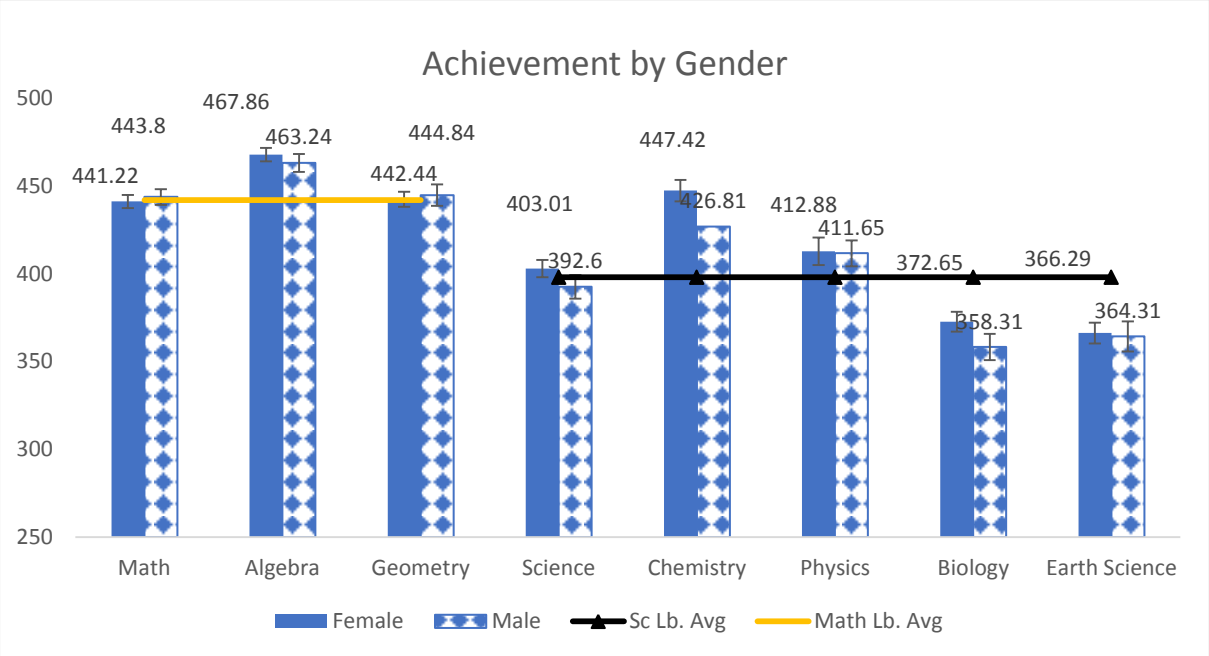
Sect	Language	Number of students	Math Score	Science Score
Public	English	311	448.04	425.47
	French	972	444.79	393.71
Private	English	1196	436.19	398.1
	French	1394	445.56	394.03

2.4 Mathematics and Science achievement by Gender

This section presents students' achievement according to gender in both Mathematics and science and in their separate domains, among the sample participated there were 53.7% female and 46.3% male.

Results in figure 2.5 showed that in Lebanon, there were no significant differences in performance by gender in math, however, girls outperformed boys in the overall achievement in science also girls outperformed boys in chemistry achievement and biology. However, the difference in other subjects is not statistically significant and fig 2.5 shows an overlapping standard error in math, algebra, geometry, physics and earth science.

Figure 2.5 Students Achievement by Gender



Conclusion:

The random sample "3873 students from 138 schools" was the representative sample for the Lebanese schools and students. The parameters studied in this chapter were: geographic location, school sector, students' language and gender. However, the sample is not a stratified sample to provide comparative findings between parameters. This report does not take into consideration the comparison between the following parameters: school sector and governorate, gender and governorate, gender and school sector. All the previous criteria cannot be studied due to the nature of the sample. The findings in this chapter showed that the geographic location and the students' achievement are related, the decreasing order is the same in both Math and Science and also in the domains of each subject. The data about the school sector also shows that the performance of students in public schools in mathematics, algebra, science and earth-science was higher than students' performance in private schools. Mainly in schools taught in English, the data about students' language does not show a difference in students' achievement in math, physics and earth science. It is also worth noting that girls did significantly better than boys in science, biology and chemistry subjects.

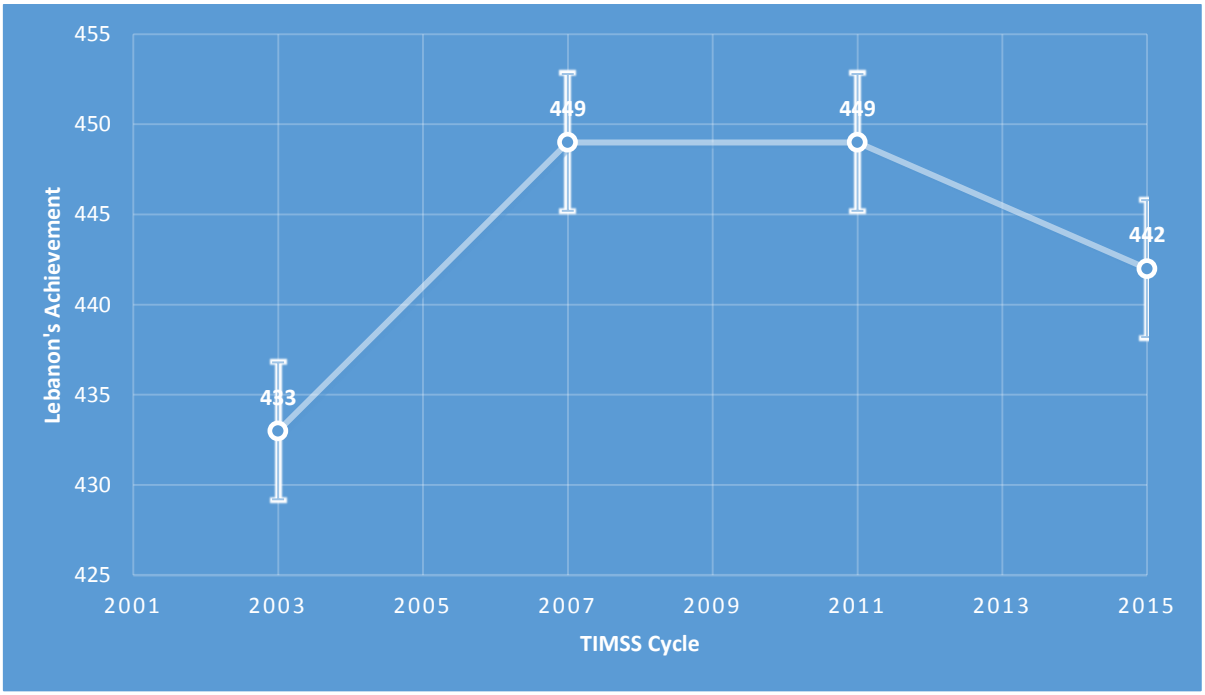
CHAPTER 3

Overall Performance in Mathematics

This chapter summarizes the findings from TIMSS 2015 in terms of math performance for grade 8 students in Lebanon. The chapter describes the changes in mean performance over time and changes in the percentage of students achieving each of the international benchmarks in mathematics. This chapter also explores the curriculum matching and alignment of TIMSS 2015 items with the Lebanese curriculum.

Figure 1 shows the graphical depiction of change in average mathematics over the four cycles in which Lebanon participated in TIMSS.

Figure 3.1 Growth of Mathematics Achievement average over years



It is clear from figure 1 that Lebanese grade 8 students showed an increase of 16 points on its average from 2003 to 2007. In 2011 the average achievement remained the same as that in 2007 but a decrease of 7 points which was not significant was detected in 2015 from 2011. However, considering the position of Lebanon compared to other countries over the years, Lebanon performed better than 14 out of the 50 (28th ile) participating counties in TIMSS 2003. In 2007, Lebanese students performed better than 20 counties out of the 48 (42%ile) participating countries. In 2011, Lebanon performed better than 20 of the 45 (44%ile) participating countries. While in 2015, Lebanon performed better than 12 of the 39 (31%ile) participating countries. It is also clearly noted that Lebanon performed less than the TIMSS scale average (500) over all the cycles.

3.1 Overall Performance in Mathematics

On average, Lebanon scored 442 (3.6) in 2015 which is lower than the TIMSS scale average (500) and less than the international mean score (505) (Table 1). Singapore, Korea and Chinese Taipei were the top-performing countries. The next highest performing country was Hong Kong, followed by Japan. These top 5 countries scored more than 50 points from the TIMSS scale average (500) while the other 13 top countries who scored more than the average TIMSS scale had a difference less than 50 points from that average.

Table 3.1 Distribution of Mathematics Achievement

Country	Average Scale Score			5th Percentile	25th Percentile	95% Confidence Interval (±2SE)		75th Percentile	95th Percentile
Singapore	621	(3.2)	▲	462	572	615	627	680	735
Rep. of Korea,	606	(2.6)	▲	455	551	601	611	665	738
Chinese Taipei	599	(2.4)	▲	419	539	594	604	669	739
Hong Kong SAR	594	(4.6)	▲	448	550	585	603	647	710
Japan	586	(2.3)	▲	434	529	582	591	647	729
Russian Federation	538	(4.7)	▲	399	483	529	547	594	669
Kazakhstan	528	(5.3)	▲	373	463	517	538	593	677
Canada	527	(2.2)	▲	406	482	523	532	576	635
Ireland	523	(2.7)	▲	392	478	518	529	574	634
United States	518	(3.1)	▲	378	461	512	524	577	651
England	518	(4.2)	▲	389	460	510	526	577	649
Slovenia	516	(2.1)	▲	400	470	512	520	564	629
Hungary	514	(3.8)	▲	355	452	507	522	582	660
Norway (9)	512	(2.3)	▲	392	465	507	516	560	622
Lithuania	511	(2.8)	▲	379	458	506	517	568	632
Israel	511	(4.1)	▲	332	441	503	519	586	664
Australia	505	(3.1)		365	449	499	511	563	637
Sweden	501	(2.8)		378	452	495	506	553	613
TIMSS Scale Centerpoint	500	(0.0)							
Italy	494	(2.5)	▼	365	445	489	499	547	612
Malta	494	(1.0)	▼	330	436	492	495	558	623
New Zealand	493	(3.4)	▼	345	433	486	499	555	633
Malaysia	465	(3.6)	▼	326	402	458	472	528	609
United Arab Emirates	465	(2.0)	▼	303	395	461	469	535	623
Turkey	458	(4.7)	▼	289	385	448	467	531	634
Bahrain	454	(1.4)	▼	324	399	451	457	507	588
Georgia	453	(3.4)	▼	297	390	446	460	520	596
Lebanon	442	(3.6)	▼	319	390	435	450	497	565
Qatar	437	(3.0)	▼	272	363	431	443	509	607

Country	Average Scale Score			5th Percentile	25th Percentile	95% Confidence Interval (±2SE)		75th Percentile	95th Percentile
Iran, Islamic Rep. of	436	(4.6)	▼	286	369	427	445	501	594
Thailand	431	(4.8)	▼	296	369	422	441	486	590
Chile	427	(3.2)	▼	297	372	421	434	482	560
Oman	403	(2.4)	▼	241	339	398	408	470	557
Kuwait	392	(4.6)	▼	247	330	383	402	452	550
Egypt	392	(4.1)	▼	229	322	384	400	463	553
Botswana (9)	391	(2.0)	▼	245	337	387	395	449	523
Jordan	386	(3.2)	▼	228	321	379	392	452	535
Morocco	384	(2.3)	▼	257	329	380	389	438	522
South Africa (9)	372	(4.5)	▼	242	311	363	381	426	529
Saudi Arabia	368	(4.6)	▼	230	309	359	377	425	514

▲ *Country average significantly higher than the centerpoint of the TIMSS 8th grade scale*

▼ *Country average significantly lower than the centerpoint of the TIMSS 8th grade scale*

3.2. Achievement at TIMSS International Benchmarks

TIMSS identified four points on the mathematics achievement scale for use as international benchmarks or reference points to describe students' performance at these benchmarks (Table2).

The table describes in details the abilities of students reaching each benchmark and specifies their scores. Students at the advanced benchmark should get a minimum score of 625 and are able to apply and reason in a variety of problem situations. Students at the high benchmark should get a minimum score of 550 and are able to apply their knowledge and understanding in relatively complex situations. At the medium benchmark, students need a minimum score of 475 and are able to apply basic mathematical knowledge in variety of situations while those at the low benchmark get a minimum of 400 and have some knowledge of numbers and basic graphs.

Table 3.2 Benchmark Cut off Scores and Description

Benchmark	Score	Description
Advanced Benchmark	625	*Students can apply and reason in a variety of problem situations, solve linear equations, and make generalizations.* They can solve a variety of fraction, proportion, and percent problems and justify their conclusions. Students can use their knowledge of geometric figures to solve a wide range of problems about area. They demonstrate understanding of the meaning of averages and can solve problems involving expected values.
High Benchmark	550	*Students can apply their understanding and knowledge in a variety of relatively complex situations.* They can use information to solve problems involving different types of numbers and operations. They can relate fractions, decimals, and percentages to each other. Students at this level show basic procedural knowledge related to algebraic expressions. They can solve a variety of problems with angles including those involving triangles, parallel lines, rectangles, and similar figures. Students can interpret data in a

Benchmark	Score	Description
		variety of graphs and solve simple problems involving outcomes and probabilities.
Medium Benchmark	475	*Students can apply basic mathematical knowledge in a variety of situations.* They can solve problems involving negative numbers, decimals, percentages, and proportions. Students have some knowledge of linear expressions and two- and three-dimensional shapes. They can read and interpret data in graphs and tables. They have some basic knowledge of chance.
Low Benchmark	400	*Students have some knowledge of whole numbers and basic graphs.*

The international medians of students reaching each benchmark are shown in table 3. TIMSS findings reveal that the percentage of Lebanese students at the four levels of performance is lower than the international medians at TIMSS international benchmarks. It demonstrates that 71% of the students reached the Low benchmark, and no one reached the Advanced benchmark (Table 3), with only 35% of the students at the Intermediate benchmark and 8% who were able to reach the High benchmark. On the other hand, 54% of Singaporean students reached the Advanced benchmark and 81% reached the High benchmark with 94% in the medium benchmark and 99% who were able to pass the low benchmark. On the international level, 5% were able to reach the Advanced benchmark, 26% the High with 62% and 84% reaching the medium and low benchmarks respectively.

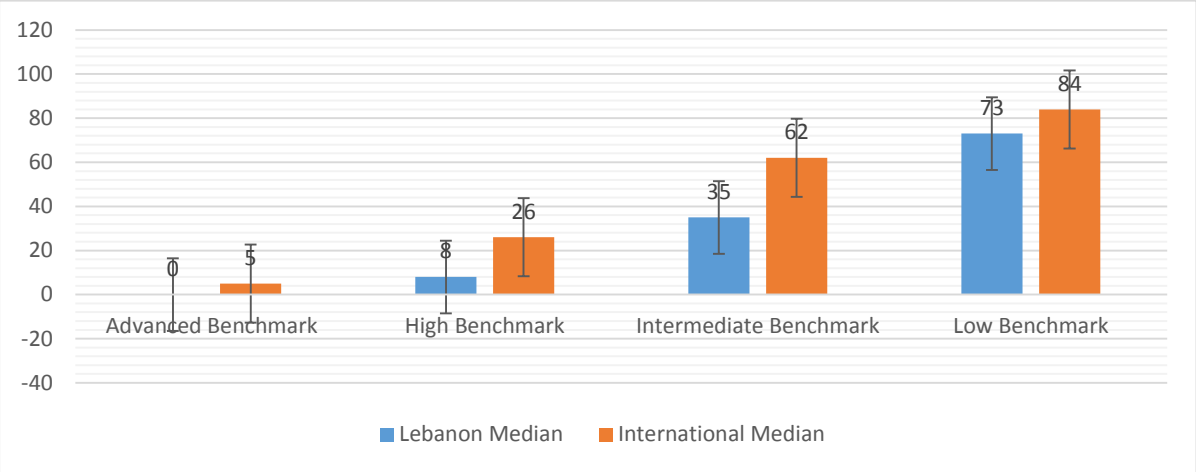
Table 3. 3 Percentages of Students Reaching International Benchmarks

	Advanced Benchmark (625)		*High Benchmark (550)*		*Intermediate Benchmark (475)*		*Low Benchmark (400)*	
Singapore	*54*	*(1.8)*	*81*	*(1.5)*	*94*	*(0.9)*	*99*	*(0.2)*
Chinese Taipei	*44*	*(1.2)*	*72*	*(0.9)*	*88*	*(0.6)*	*97*	*(0.4)*
Korea, Rep. of	*43*	*(1.4)*	*75*	*(1.0)*	*93*	*(0.5)*	*99*	*(0.2)*
Hong Kong SAR	*37*	*(2.3)*	*75*	*(1.9)*	*92*	*(1.3)*	*98*	*(0.6)*
Japan	*34*	*(1.2)*	*67*	*(1.0)*	*89*	*(0.7)*	*98*	*(0.3)*
Kazakhstan	*15*	*(1.7)*	*41*	*(2.6)*	*71*	*(2.1)*	*91*	*(1.1)*
Russian Federation	*14*	*(1.4)*	*46*	*(2.5)*	*78*	*(1.9)*	*95*	*(0.8)*
Israel	*13*	*(1.0)*	*38*	*(1.8)*	*65*	*(1.7)*	*84*	*(1.2)*
Hungary	*12*	*(1.2)*	*37*	*(1.7)*	*67*	*(1.7)*	*88*	*(1.1)*
United States	*10*	*(0.9)*	*37*	*(1.5)*	*70*	*(1.4)*	*91*	*(0.7)*
England	*10*	*(1.1)*	*36*	*(2.4)*	*69*	*(2.4)*	*93*	*(1.2)*
Canada	*7*	*(0.6)*	*39*	*(1.4)*	*78*	*(1.1)*	*96*	*(0.5)*
Australia	*7*	*(0.8)*	*30*	*(1.4)*	*64*	*(1.6)*	*89*	*(1.0)*
Ireland	*7*	*(0.8)*	*38*	*(1.7)*	*76*	*(1.3)*	*94*	*(0.8)*
New Zealand	*6*	*(0.8)*	*27*	*(1.2)*	*58*	*(1.5)*	*85*	*(1.2)*
Turkey	*6*	*(0.9)*	*20*	*(1.6)*	*42*	*(1.9)*	*70*	*(1.6)*
Lithuania	*6*	*(0.8)*	*33*	*(1.4)*	*68*	*(1.4)*	*92*	*(0.8)*
Slovenia	*6*	*(0.6)*	*32*	*(1.3)*	*73*	*(1.2)*	*95*	*(0.6)*
UAE	*5*	*(0.4)*	*20*	*(0.8)*	*46*	*(1.0)*	*73*	*(0.7)*

	Advanced Benchmark (625)		High Benchmark (550)		Intermediate Benchmark (475)		Low Benchmark (400)	
Malta	*5*	*(0.4)*	*29*	*(0.7)*	*62*	*(0.7)*	*84*	*(0.5)*
Norway (9)	*5*	*(0.5)*	*30*	*(1.2)*	*70*	*(1.3)*	*94*	*(0.5)*
Sweden	*3*	*(0.6)*	*26*	*(1.5)*	*65*	*(1.6)*	*91*	*(1.1)*
Qatar	*3*	*(0.5)*	*14*	*(0.9)*	*36*	*(1.2)*	*63*	*(1.4)*
Malaysia	*3*	*(0.4)*	*18*	*(1.0)*	*45*	*(1.9)*	*76*	*(1.9)*
Italy	*3*	*(0.5)*	*24*	*(1.3)*	*62*	*(1.7)*	*89*	*(1.0)*
Thailand	*3*	*(0.7)*	*10*	*(1.5)*	*29*	*(2.2)*	*62*	*(2.2)*
Iran	*2*	*(0.7)*	*12*	*(1.4)*	*34*	*(1.9)*	*63*	*(1.9)*
Georgia	*2*	*(0.4)*	*15*	*(1.2)*	*42*	*(1.7)*	*72*	*(1.6)*
Bahrain	*2*	*(0.3)*	*12*	*(0.6)*	*39*	*(0.8)*	*75*	*(0.9)*
Oman	*1*	*(0.1)*	*6*	*(0.5)*	*23*	*(0.9)*	*52*	*(1.2)*
Kuwait	*1*	*(0.3)*	*5*	*(1.2)*	*18*	*(1.9)*	*45*	*(1.9)*
Chile	*1*	*(0.2)*	*7*	*(0.8)*	*28*	*(1.3)*	*63*	*(2.0)*
South Africa (9)	*1*	*(0.2)*	*3*	*(0.8)*	*13*	*(1.7)*	*34*	*(2.3)*
Egypt	*0*	*(0.1)*	*5*	*(0.6)*	*21*	*(1.4)*	*47*	*(1.8)*
Lebanon	*0*	*(0.2)*	*8*	*(0.8)*	*35*	*(1.9)*	*71*	*(2.0)*
Saudi Arabia	*0*	*(0.2)*	*2*	*(0.7)*	*11*	*(1.3)*	*34*	*(1.8)*
Jordan	*0*	*(0.1)*	*3*	*(0.4)*	*18*	*(1.0)*	*45*	*(1.5)*
Botswana (9)	*0*	*(0.0)*	*2*	*(0.2)*	*16*	*(0.8)*	*47*	*(1.1)*
Morocco	*0*	*(0.0)*	*2*	*(0.3)*	*14*	*(0.7)*	*41*	*(1.1)*
International Median	*5*		*26*		*62*		*84*	

A comparison between the median percentages of Lebanon and the international medians is shown in figure 3. The bar diagram shows that percentages of Lebanese students were lower than that of the international in each benchmark.

Figure 3.3 A comparison of percentages of students reaching international benchmarks in Lebanon and internationally



Additionally, slight significant variations in students' performance across the highest three benchmarks were evident across the last four TIMSS assessment years as shown in the figure below (Fig. 4).It is clear that the percentage of students in 2015 in the intermediate and high international benchmarks was significantly higher than that in 2003, but was same or slightly lower than in 2007 and 2011.

Figure 3.4 Percentage of Students Reaching the International Benchmarks across Assessment Years

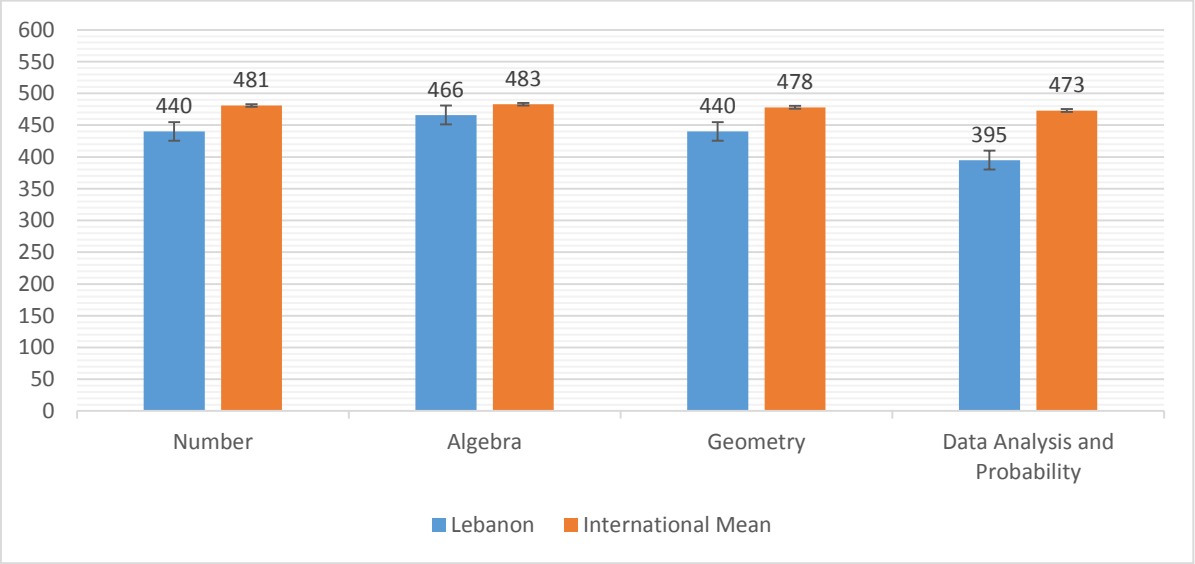
Country	Advanced International Benchmark (625)						High International Benchmark (550)						Intermediate International Benchmark (475)					
	Percent of Students						Percent of Students						Percent of Students					
	2015	2011	2007	2003	1999	1995	2015	2011	2007	2003	1999	1995	2015	2011	2007	2003	1999	1995
Singapore	54	48 ▲	40 ▲	44 ▲	42 ▲	40 ▲	81	78	70 ▲	77	77	84	94	92	88 ▲	93	94	98 ▼
Chinese Taipei	44	49 ▼	45	38 ▲	37 ▲		72	73	71	66 ▲	67 ▲		88	88	86	85 ▲	85 ▲	
Korea, Rep. of	43	47	40	35 ▲	32 ▲	31 ▲	75	77	71 ▲	70 ▲	70 ▲	67 ▲	93	93	90 ▲	90 ▲	91	89 ▲
Hong Kong SAR	37	34	31 ▲	31 ▲	28 ▲	23 ▲	75	71	64 ▲	73	70	65 ▲	92	89	85 ▲	93	92	88
Japan	34	27 ▲	26 ▲	24 ▲	29 ▲	29 ▲	67	61 ▲	61 ▲	62 ▲	66	67	89	87 ▲	87 ▲	88	90	91
Kazakhstan	15	3 ▲					41	23 ▲					71	57 ▲				
Russian Federation	14	14	8 ▲	6 ▲	12	9 ▲	46	47	33 ▲	30 ▲	39 ▲	38 ▲	78	78	68 ▲	66 ▲	73	73
Israel	13	12					38	40					65	68				
Hungary	12	8 ▲	10	11	13	10	37	32 ▲	36	41	43 ▼	40	67	65	69	75 ▼	75 ▼	74 ▼
United States	10	7 ▲	6 ▲	7 ▲	7	4 ▲	37	30 ▲	31 ▲	29 ▲	30 ▲	26 ▲	70	68	67	64 ▲	62 ▲	61 ▲
England	10	8	8	5 ▲	6 ▲	6 ▲	36	32	35	26 ▲	25 ▲	27 ▲	69	65	69	61 ▲	60 ▲	61 ▲
Australia	7	9	6	7		7	30	29	24 ▲	29		33	64	63	61	65		68
Ireland	7					8	38					37	76					73
Lithuania	6	5	6	5	3 ▲	2 ▲	34	29 ▲	30 ▲	28 ▲	18 ▲	17 ▲	69	64 ▲	65	63 ▲	53 ▲	50 ▲
New Zealand	6	5		5	6	6	27	24		24	26	28	58	57		59	57	64 ▼
Turkey	6	7					20	20					42	40				
Slovenia	6	4 ▲	4	3 ▲		4 ▲	32	27 ▲	25 ▲	21 ▲		22 ▲	73	67 ▲	65 ▲	60 ▲		60 ▲
United Arab Emirates	5	2 ▲					20	14 ▲					46	42 ▲				
Malta	5		5				29		26 ▲				62		60			
Sweden	3	1 ▲	2	3		12 ▼	26	16 ▲	20 ▲	24		46 ▼	65	57 ▲	60 ▲	64		81 ▼
Qatar	3	2					14	10 ▲					36	29 ▲				
Malaysia	3	2 ▲	2	6 ▼	10 ▼		18	12 ▲	18	30 ▼	36 ▼		45	36 ▲	50	66 ▼	70 ▼	
Italy	3	3	3	3	4		24	24	17 ▲	19 ▲	21		62	64	54 ▲	56 ▲	53 ▲	
Thailand	3	2	3		3		10	8	12		17 ▼		29	28	34		45 ▼	
Iran, Islamic Rep. of	2	2	1 ▲	0 ▲	1 ▲	0 ▲	12	8 ▲	5 ▲	3 ▲	6 ▲	4 ▲	34	26 ▲	20 ▲	20 ▲	26 ▲	24 ▲
Georgia	2	3	1 ▲				15	13	7 ▲				42	36 ▲	26 ▲			
Bahrain	2	1	0 ▲	0 ▲			12	8 ▲	3 ▲	2 ▲			39	26 ▲	19 ▲	17 ▲		
Norway (8)	1	1	0 ▲	0		4 ▼	17	12 ▲	11 ▲	10 ▲		26 ▼	59	51 ▲	48 ▲	44 ▲		64 ▼
Oman	1	0	0 ▲				6	4 ▲	2 ▲				23	16 ▲	14 ▲			
Chile	1	1		0	1		7	5		3 ▲	4 ▲		28	23 ▲		15 ▲	16 ▲	
South Africa (9)	1	1					3	3					13	9 ▲				
Egypt	0		1	1			5		5	6			21		21	24		
Lebanon	0	1	1	0			8	9	10	4 ▲			35	38	36	27 ▲		
Saudi Arabia	0	1					2	5 ▼					11	20 ▼				
Jordan	0	0	1 ▼	1 ▼	3 ▼		3	6 ▼	11 ▼	8 ▼	12 ▼		18	26 ▼	35 ▼	30 ▼	33 ▼	
Kuwait	0		0				1		0 ▲				11		6 ▲			
Botswana (9)	0	0					2	2					16	15				
Morocco	0	0					2	2					14	12 ▲				

3.3. Mathematics Performance in Content Domains

TIMSS enables a detailed comparison of students' math performance in specific content domains. Each of the TIMSS assessment questions is categorized according to four **content domains** (Numbers, Algebra, Geometry, and Data analysis and Probability).

1n 2015, in comparison with Lebanon's overall mean score in math, grade 8 students performed best in algebra, then in geometry and were weakest in data analysis and probability. The comparison of Lebanon's performance with the international average for each content domain is shown in figure 5.

Figure 3.5 Mean scores for 2015 in different content mathematics domains compared to the international means



Compared to the international mathematics mean for each content domain, Grade 8 Lebanese students performed lower in the four subject areas with a difference of 41 points for numbers (significant), 17 points for algebra, 38 points for geometry and 78 points for data analysis and probability. So in comparison with international results, Lebanon performance is better in algebra and weakest in data analysis and probability.

Considering the development of Lebanese students across the four assessment years, Table 4 shows the performance of Lebanese students in the four content domains across the four assessment years.

Table 3.4 Differences in Achievement for Mathematics content Domains across Assessment Years

Exhibit 3.6: Differences in Achievement for Mathematics Content Domains Across Assessment Years

Eighth Grade

Instructions: Read across the row to determine if the performance in the row year is significantly higher (▲) or significantly lower (▼) than the performance in the column year.

Country	Number Average Scale Score	Number Differences Between Years		Algebra Average Scale Score	Algebra Differences Between Years		Geometry Average Scale Score	Geometry Differences Between Years		Data and Chance Average Scale Score	Data and Chance Differences Between Years	
		2011	2007		2011	2007		2011	2007		2011	2007
Lebanon												
2015	440 (4.1)	-11 ▼	-13 ▼	466 (4.0)	-5	-2	444 (4.0)	-4	-12 ▼	395 (4.6)	2	7
2011	451 (3.8)		-1	471 (3.8)		3	447 (3.8)		-8	393 (5.2)		5
2007	453 (3.9)			468 (3.6)			455 (4.2)			388 (5.3)		

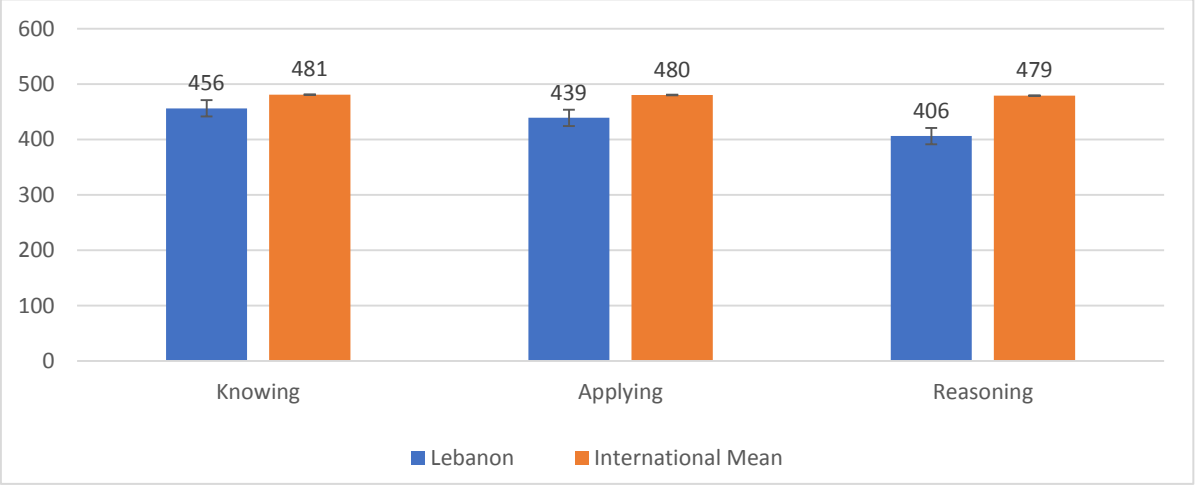
It is clear from the table that Lebanese students performed significantly lower in Number in 2015 than in 2011 (-11) and 2007 (-13) and significantly lower in Geometry which showed a decrease of 12 points from that in 2007. However, the decrease in Algebra content domain was not significant and the slight increase in Data analysis and Probability (+2 from 2011 and +7 from 2007) was not significant.

3.4. Mathematics Performance in Cognitive Domains

TIMSS enables a detailed comparison of students' math performance in specific cognitive domains. Each of the TIMSS assessment questions is categorized according to three **cognitive domains** (Knowing, Applying and Reasoning).

1n 2015, in comparison with Lebanon's overall mean score in math, grade 8 students performed best in Knowing, then in Applying and were weakest in Reasoning. The comparison of Lebanon's performance with the international average for each content domain is shown in figure 3.6.

Figure3.6 Mean scores for 2015 in different cognitive mathematics domains compared to the international means.



Compared to the international mathematics mean for each cognitive domain, Grade 8 Lebanese students performed significantly lower in the three cognitive domains areas with a difference of 25 points for knowing, 41 points for applying and 73 points for reasoning.

Considering the development of Lebanese students across the four assessment years, Table3.5 shows the performance of Lebanese students in the three cognitive across the last three assessment years.

Table 3.5 Differences in Achievement for Mathematics Cognitive Domains across Assessment Years

Exhibit 3.8: Differences in Achievement for Mathematics Cognitive Domains Across Assessment Years

Eighth Grade

Instructions: Read across the row to determine if the performance in the row year is significantly higher (▲) or significantly lower (▼) than the performance in the column year.

Country	Knowing Average Scale Score	Knowing Differences Between Years		Applying Average Scale Score	Applying Differences Between Years		Reasoning Average Scale Score	Reasoning Differences Between Years	
		2011	2007		2011	2007		2011	2007
Lebanon									
2015	456 (3.8)	-8	-1	439 (3.9)	3	-8	406 (4.5)	-20 ▼	-17 ▼
2011	464 (3.9)		7	436 (4.1)		-11	426 (4.6)		3
2007	457 (4.2)			447 (4.5)			423 (4.7)		

It is clear from the table that Lebanese students performed lower in knowing in 2015 than in 2011 (-8) and 2007 (-1), better in applying with an increase of 3 points from 2011 but a decrease of 8 points from 2007, though the above differences are not statistically significant. However, the significant drop prevails in the reasoning domain with a decrease of 20 points from 2011 and 17 points from 2007.

3.5 Curriculum matching and alignment of TIMSS Test Items with Lebanese Mathematics Curriculum

3.5.1.A. Alignment with content domain

TIMSS findings reveal that around 31% of grade 8 students in Lebanon provide correct answers on the overall test items compared to a percent correct of 42% in the other participating countries

(Table 6). Results also show that the percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the four content domains was always lower than their international counterparts across domains. Percent change ranged from -20 to -42 with an average percent change on -29, with the highest % R.D. (- 42%) in Data analysis and Probability. This reason is mainly referred to the fact that probability is not tackled in the Lebanese curriculum before grade 11.

Table 3.6. Performance in the Different Mathematics Content Domains

TIMSS Mathematics Topics	Number of TIMSS Test items	Percent correct Lebanon	SE Lebanon	Percent correct Int.	SE Int	Absolute Difference	% R.D.
Numbers	64	35.39	2.6	46.52	1.9	- 11.13	**- 29**
Algebra	61	30.67	2.4	36.70	1.8	- 6.03	**-20.1**
Geometry	44	29.09	2.8	38.20	2.4	- 9.11	**-28.4**
Data Analysis & Probability	41	29.05	2.6	46.66	2.3	- 17.61	**- 42.0**
Average	**210**	**31.52**	**1.3**	**42.02**	**1.1**	**-10.5**	**-29.1**

Checking the TIMSS items that exceed the absolute % R.D. in each content domain, it was noticed that 35 items in Number (55%) exceeded the absolute % R.D. A close look at these items is shown in appendix 1 where the item code is given together with the description about this item, its cognitive level and the grade level it is taught in in Lebanon. Appendix 1 shows that 21 items (60%) out of the 35 items were at the TIMSS Applying cognitive level. The situations are mainly real life situations in spite of the fact that all the 21 items are taught at a grade below than grade 8. The problem, then, may lie in the type of problems Lebanese students tackle which are not related to application of knowledge on real life situations. The table also shows that 20% of the items are at the reasoning level. The situation reveals a type of situations Lebanese students are not familiar with like "Which plan is less expensive?" in which students need to take decisions and defend them. The items that were classified as knowing were mainly items with terms not familiar to Lebanese grade 8 students like "octagon" or "ratio" or "percentage" knowing that the terms percentage and ratio are given in grade 6 but not given much attention and were not taken into consideration in other grades. As for the term octagon, it is neither mentioned in the Lebanese curriculum nor in the national textbook.

Checking the TIMSS items that exceed the absolute % R.D. in Algebra (Appendix 2), it was noticed that 38 items exceeded the absolute % R.D. (62%) . A close look at these items is shown in table 7 where the item code is given together with the description about this item, its cognitive level and the grade level it is taught in in Lebanon. Appendix 2 shows that 10 items (26%) out of the 38 items were at the TIMSS Knowing cognitive level of which 6 which are taught in grades above grade 8. 13 items (34%) are at the reasoning level of which 6 are not in the program and the rest mainly taught in levels above grade 8. The remaining 15 items are in the applying domain but mainly taught at a level higher than grade 8.

It is noted that Algebraic reasoning is not included in the Lebanese program though it was recommended by NCTM (2000) and it is now a big part of the math curricula in most of the world's countries starting from grade 1 to grade 12.

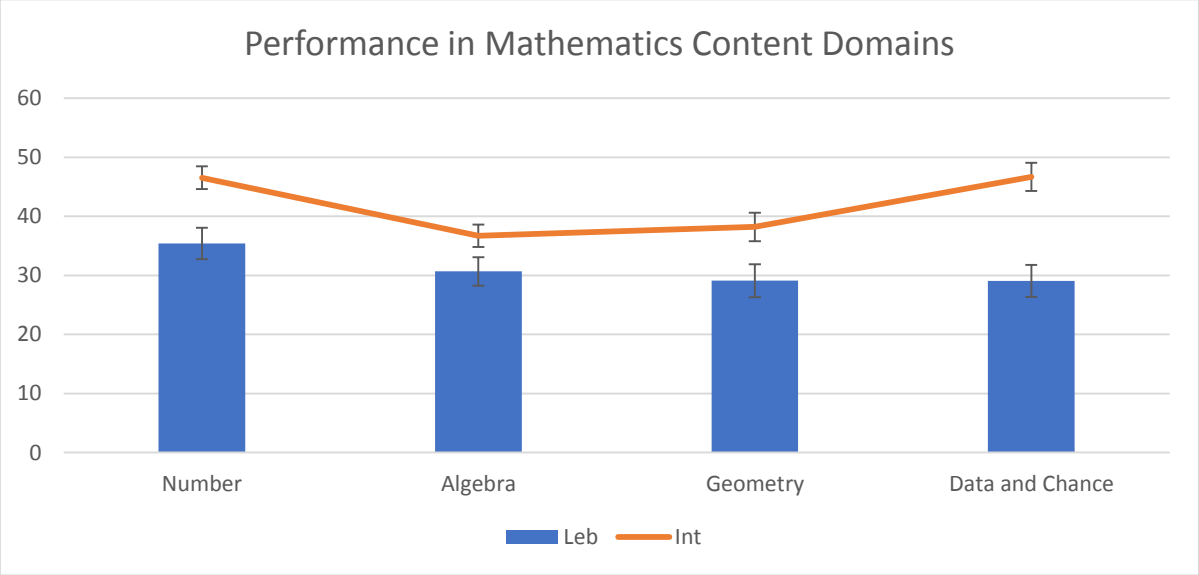
Considering the Geometry items in which the % R.D. exceeds the absolute % R.D. The same procedure was followed as in the previous content domains. Appendix 3 shows that there are 28 items (63.6%) with absolute relative % R.D. more than the average absolute relative percentage. Out of these items, there are 15 items (53.5%) in the TIMSS reasoning cognitive domain. It is worth noting that most of these items classified as reasoning are taught at a level higher than grade 8 like similar triangles and 3 dimensional geometry.

Appendix 2 also shows that 5 of the items only are taught in grade 8, 8 taught below grade 8 and the remaining (53.5%) are taught above grade 8.

The fourth content domain under study is Data and Probability. Appendix 4 shows the % R.D. exceeds the absolute % R.D. There are 22 items out of 41 (68.3%) of the items in this content domain in which the relative absolute % R.D. exceeds that of the average absolute relative % R.D. From these items, only two are taught in grade 8 while the rest are either taught above grade 8 or are not in the program. The situations listed show that most of these items are probability items which is not introduced before grade 11 in Lebanon. Other situations show questions about the median, mode and range of a statistical data which is introduced in grade 9 according to the Lebanese curriculum.

Figure3.7 shows the bar diagram comparing the Lebanese students achievement as compared to that of the international associated with the error bars. The graph describes the difference between Lebanese students' percentage means and that of the international in the four content domains.

Figure 3.7 Lebanese and International Performance in Mathematics Content Domains



On the other hand, another analysis was made concerning the alignment of the TIMSS items with the Lebanese curriculum.

3.5.1B. Alignment with grade level

Further analysis was done to explore the grade level(s) where TIMSS mathematics test item are taught in the Lebanese curriculum. Table 3.6 shows that 34 items out of 213 that is a percentage of 16% of the concepts related to the TIMSS items are taught in grade 8 only. It is clear that 110 items (52%) of the concepts are taught before grade 8, the remaining are either taught above grade 8 (26.7%) or are not present in the curriculum which constitutes around 6% of the items.

Table3.6 Performance of Lebanese Students and Internationally by Grade Level and Mathematics Topics Taught

Grade levels where TIMSS items are taught in Lebanon	Number of TIMSS test items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	%R.D.
Below grade 8	110	37.70	(1.9)	46.23	(1.5)	-8.5	- 18.40
Grade 8	34	30.29	(3.0)	38.06	(2.6)	-7.76	-20.47
Above grade 8 or not in the curriculum	69	22.26	(1.7)	37.26	(1.7)	-15	-40.54
Average	213	31.52	(1.3)	42.02	(1.1)	-10.5	- 28.63

Table 6 also reveals the fact that when students are tested in topics taught to grade 8 students, they tend to answer correctly compared to their peers from the other countries (difference account -7.8%). Reasonably, a low percentage of students provide correct answers if they are tested in topics taught at higher level or in topics not in the curriculum (22.26%) in comparison to topics taught at a lower level (37.7%) or in grade 8 (30.3%). Results are clearly due to the fact that students have not learnt the required concepts on the date of the test. The fact that more than 20% of students have answered topics learned at a higher level may be due to the students answering multiple choice questions by guessing or due to the general information students may have. Table 6 shows that the difference was highest for topics taught above grade 8 and it shows that there is a decline from international sample for all categories. The difference between Lebanese and international percentage correct was also considerable for topics taught in grade 8. The reason may be due to the fact that these topics were not taught before the date of the test in April.

All aforementioned findings would recommend a better and closer alignment between the Lebanese curriculum and international curricula and TIMSS specifications. Therefore, an evaluation of the existing curriculum should be considered and measures for development of a new curriculum that meets the international global curriculum and TIMSS requirements should be taken.

3.5.1.C. Alignment with Objectives

In this section, the focus will be on the objectives listed by TIMSS 2015. The percentage correct in Lebanon and internationally for each specific objective was calculated in Table 3.7. Results show that the international percent correct was higher than that of the Lebanese for all objectives except for "expressions and operations" in algebra. The reason for that is the focus of the Lebanese curriculum on the notion of algebraic expressions in grades 7, 8 and 9.

Table 3.7: Correct Percent and Internationally by TIMSS Objectives

Numbers					
	Number of TIMSS Items	Average Percent Correct in Lebanon	Average Percent Correct Internationally	Absolute Difference	%R.D.
Whole Numbers	23	42.13	50.30	-8.17	16.2
Fractions, decimals and integers	19	35.90	47.74	-11.84	24.8
Ratio, proportion and percent	19	28.69	43.37	-14.68	33.8
Algebra					
Expressions and Operations	23	46.00	43.87	2.13	4.8
Equations and Inequalities	19	29.05	37.05	-8	-21.5
Relationships and Functions	23	19.26	32.08	-12.82	-39.9
Geometry					
Geometric shapes	27	31.44	39.60	-8.16	-20.6
Geometric Measurement	11	16.55	28.45	-11.9	-4.2
Location and Movement	8	30.25	39.50	-9.25	-23.4
Data and Chance					
Characteristics of a data set	8	16.13	34.00	-17.87	- 52.5
Data interpretation	21	35.00	50.09	-15.09	-30.1
Chance	11	27.45	48.27	-20.82	-43.1

Table 7 also shows that the largest difference is in Data and Chance that is not given vast attention in the Lebanese curriculum and specifically Chance that is not introduced before grade 11 in Lebanon. Another aspect that is not considered in the Lebanese curriculum in lower grades is "relationships and functions" in which the difference (-12.82) is remarkable.

3.5.2. Grade 8 Student Performance in the different Cognitive Domains in Mathematics

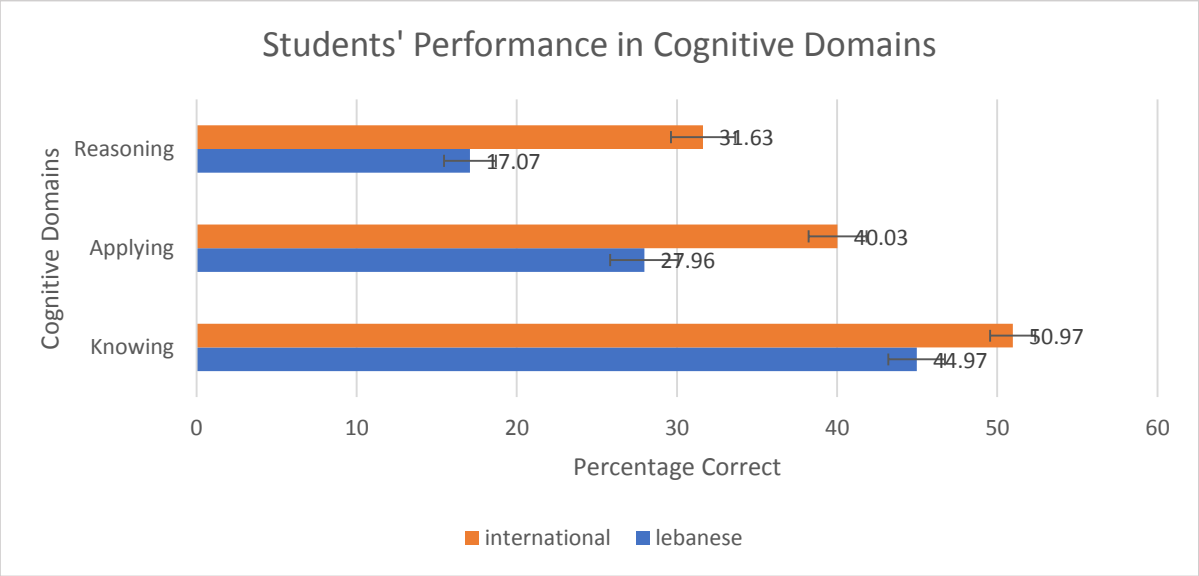
Table 3.8 shows that in Lebanon, as the case internationally, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question, the percentage being the lowest in reasoning (17%) and highest in knowing (45%). Moreover, results show that Lebanese grade 8 students performed lower in the three cognitive domains: Knowing, Applying and Reasoning compared to students internationally. The huge difference between the Lebanese and international students' achievement in applying and reasoning might be due to the level of teaching which tends to use direct application of formulas with little access to real life situations.

Table 3.8. Performance in different Cognitive Domains- Mathematics

Cognitive Domain	Number of Items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
Knowing	74	45	(2.1)	51	(1.8)	-6	- 11.76
Applying	93	28	(1.7)	40	(1.4)	-12	- 30.00
Reasoning	46	17	(1.6)	31.6	(2.0)	-14.6	- 46.20

To identify TIMSS test items where there is a big difference between grade 8 students' performance in Lebanon and internationally, we have calculated the average of percent change for each cognitive domain which is considered to be our reference point. Figure 8 illuminates this difference. The noticeable difference in reasoning items may be due to the types of assessment in schools which does not involve problems at the reasoning level. The major reason lies in the math grade 9 (Lebanese Brevet national exam) which is a conventional predicted exam in which students use their memory rather than their reasoning.

Figure 3.8. Lebanese and International Students' Achievement in Cognitive Domains



3.5.3 Other Parameters that Could influence Student Performance in Mathematics

There are other parameters that may influence students' performance in mathematics.

3.5.3.A. Type of Questions

The type of questions asked in TIMSS 2015 vary from diagram complete question (DCQ), fill in the blanks questions, multiple choice questions which were the majority, open questions, short answered questions and True-False questions which were the minority in mathematics. The classification made in this report is different from that made in TIMSS 2015 which splits the questions into two types: either constructed response or multiple choice items. Table 9 shows the performance of students according to the type of questions. Lebanese students tend to perform lower than their international counterparts

for most of the types of questions except for True-False items which were few. The absolute difference is highest for open questions and this may be due to unfamiliarity of Lebanese students with these type of questions in which students need to determine the method to use in solving a problem. The large remarkable difference appears also for short answer questions. Reasons for this discrepancy need to be further analyzed. The lowest difference is for "fill in the blanks" questions

Table 3.9. Performance in Mathematics and Types of Questions in TIMSS Test

Type of Questions	Number of TIMSS test Items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
DCQ	10	35.71	(7.8)	45.86	(5.2)	10.14	-22.22
Fill in the blanks	8	24.13	(5.8)	30.75	(4.2)	-6.63	-21,75
Multiple Choice	112	38.44	(1.6)	48.96	(1.1)	-10.53	- 21.75
Open	14	13.00	(2.6)	26.14	(2.7)	-13.14	-52.87
Short Answer	64	22.28	(1.9)	33.69	(1.6)	-11.42	- 33.90
True-False	4	76.75	(1.3)	75.75	(1.0)	1.0	1.31

3.5.3.B. Type of Document

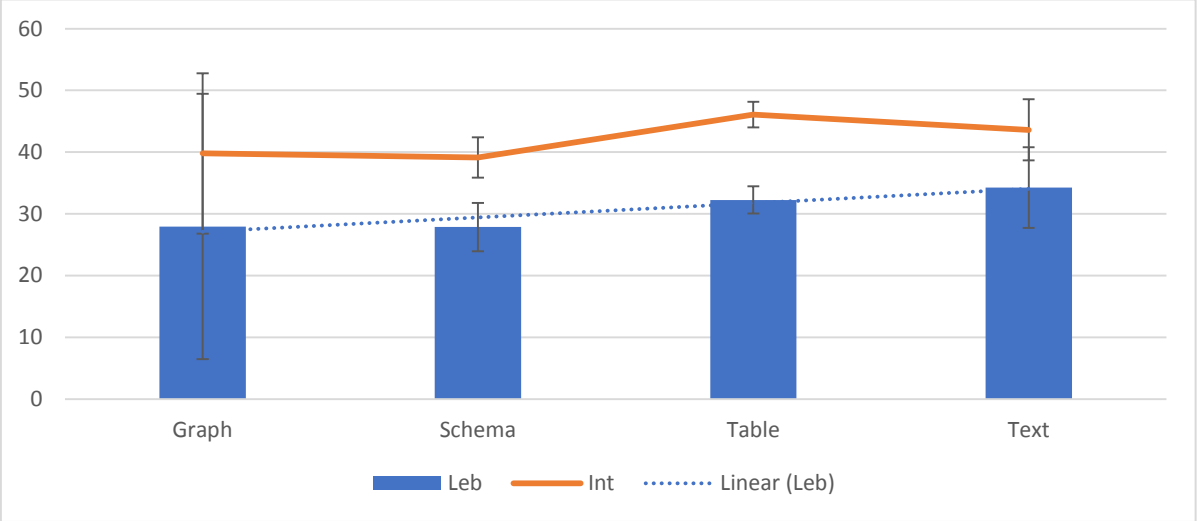
Another parameter to be taken into consideration is the type of document used to analyze a certain question. The types of documents used in TIMSS 2015 items were: Graph, schema, table and text. In spite of the difference in performance between the Lebanese students and Internationally (table 10), Lebanese students tend to perform even lower when the document used refers to a graph or to schema and this result may be due to the fact that students in Lebanon are used to problems in which information is extracted from a text or a table more than a graph and schema.

Table 3.10. Performance in Mathematics and Types of Document in TIMSS Test

Type of Questions	Number of TIMSS test Items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
Graph	**19**	27.95	(3.9)	39.79	(3.2)	-11.84	-29.65
Schema	**66**	27.86	(2.2)	39.12	(2.0)	-11.26	-28.64
Table	**12**	32.25	(6.5)	46.08	(4.9)	-13.83	- 30.15
Text	**114**	34.24	(1.9)	43.61	(1.4)	-9.37	-21.56

A closer look is shown in figure 9. Lebanese students tend to perform lower when they extracting information from graphs and schema and perform best when the document used in the item is the text. The international percent score was highest for items using tables as documents and lowest for schema.

Figure 3.9 Lebanese and International Students' Achievement by Document used



3.5.3.C. Types of Action Verbs

The action verb used in asking the question in a given item can also be considered a parameter. The types of questions were classified into "action verbs" or "Wh" questions.

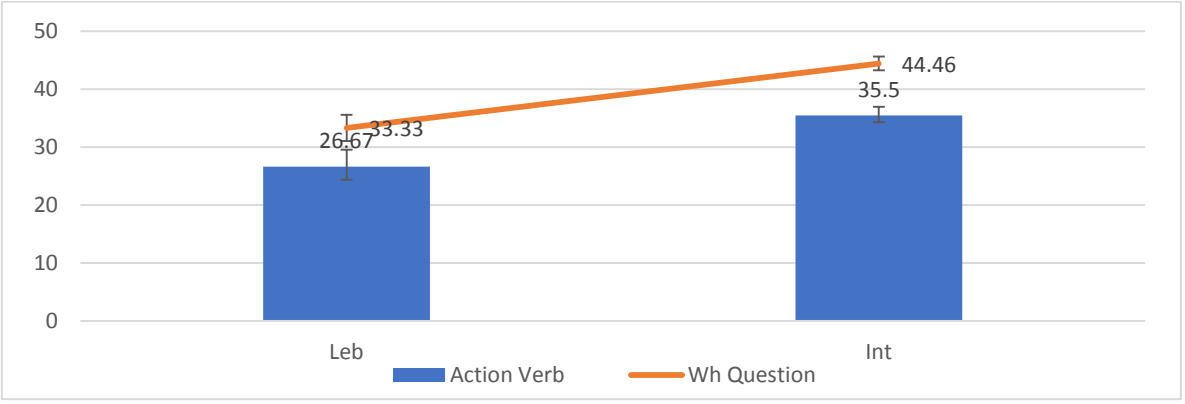
An action verbs usually shows the student the method to be used like "determine, solve, find, calculate…).On the other hand, a "wh" question is either "what, who, when," which doesn't show clearly the method or the action the student need to take. The Results show that like International results, Lebanese students tend to perform higher in "Wh" questions but lower than their international counterparts on both categories of items. The absolute difference between The Lebanese students' percent correct and that of the international is higher for "wh" questions.(Table 3.11).

Table 3.11. Performance in Mathematics and Verb Used in TIMSS Test

Action Verb	Number of TIMSS test items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
Action Verb	**59**	26.67	(2.9)	35.50	(2.2)	-8.83	- 24.79
Wh Question	**157**	33.33	(1.4)	44.46	(1.2)	-11.13	-25.00

The difference between Lebanese and international mean scores in both types of questions is clearly revealed in figure 10.

Figure 3.10. Lebanese and International Students' Achievement by Verb Used



5.5.3.D. Suspended topics from the Lebanese curriculum

The center of education for research and development decided to suspend some topics found in the curriculum due to time restrictions. These topics can be considered a parameter that could have an effect on Lebanese students' performance in TIMSS 2015. Table 12 displays the number of items that tackled suspended items in TIMSS with the mean percent correct in Lebanon and internationally. Results show a difference more than 10 points between Lebanese and International means whether the items were suspended or not. But the difference was larger for suspended items (-15.73) which shows that suspended items had a direct effect on the performance of Lebanese students. This recommends restoration of the suspended items into the curriculum. The percentage correct was lower for Lebanese students on suspended items than on "Not suspended" and also lower than international sample.

Table 3.12. Performance in Mathematics and Items Suspended in the Lebanese Curriculum

Action Verb	Number of TIMSS test items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
Suspended	**11**	21.82	(6.1)	37.55	(5.4)	-15.73	- 41.89
Not Suspended	**203**	32.04	(1.3)	42.18	(1.1)	10.14	-25.00

5.5.3. E. Misconceptions

TIMSS 2015 contained items that involved targeted misconceptions. This report studies the effect of these items on the performance of Lebanese students versus their international counterparts. Table 13 shows that the difference between Lebanese average percent correct and that of the international was lower with items targeting misconceptions. Results show that students' misconceptions need to be taken into considerations in development of new curricula so that they can be avoided. Lebanese students performed lower on items targeting misconceptions than on items with no misconceptions, and their performance on these items was lower than international sample.

Table 3.13. Performance in Mathematics and Targeted Misconceptions in TIMSS Test

Misconceptions	Number of TIMSS test items	Average percent correct in Lebanon	SE	Average percent correct internationally	SE	Absolute Difference	% R.D.
Items with targeted misconceptions	**24**	24.25	(3.2)	30.58	(2.5)	-6.33	- 20.70
Items with no targeted misconceptions	**190**	32.44	(1.4)	43.47	(1.1)	-11.03	-25.37

Conclusion:

Lebanese students performed lower than their international counterparts in all content and cognitive domains and when several other parameters were taken into account. But, there remains to claim that all the aforementioned parameters play an important role and should be taken into consideration in planning for the new curricula. In this process, the following recommendations can be taken into consideration:

- The mathematics content domains need to be organized. Important topics need to be included in lower grades like algebraic reasoning and functions. Another important topic to be added is "probability" which can be introduced as early as grade 1. Other topics need to be stressed like "analysis of data" and "ratio, proportion and percent".
- The mathematics cognitive domains should be taken into consideration when developing new curricula. More emphasis should be made on higher levels like applying and reasoning.
- Real life situations should be emphasized in exams to enable students to model situations mathematically and solve them.
- Suspended topics need to be returned back into action since they represent an important part of TIMSS curriculum.
- Misconceptions need to researched and studied so that they can be avoided in development of new curricula.
- Varied types of questions should be used in assessments especially open questions which make students responsible of their decisions. Also, other types involving diagrams and tables need to be used too.

Appendix 1

TIMSS Items that Exceed the Absolute % R.D. in Number Content Domain

ITEM Code	TIMSS Cognitive Level	Situation	Grade taught	Lebanon's Percent Correct	International Percent Correct	% R.D.
M042114B	**Applying**	Number of papers in a 28mm stack	**Before grade 8**	**32**	**44**	-27.27
M042194	**Knowing**	**Percent of games the team lose**	**Before grade 8**	**43**	**65**	-33.85
M042302A	**Applying**	**Cost of phone for 1 year**	**Before grade 8**	**5**	**31**	-83.87
M042302B	**Applying**	**Pay after first year**	**Before grade 8**	**4**	**31**	-87.10
M042302C	**Reasoning**	**Which plan is less expensive**	**Before grade 8**	**3**	**9**	-66.67
M052006	**Reasoning**	**Which statement about x is true**	**Before grade 8**	**31**	**44**	-29.55
M052021	**Reasoning**	**Complete TV game show table**	**After grade 8**	**10**	**25**	-60.00
M052024	**Knowing**	**Octagon with equivalent shading**	**Before grade 8**	**29**	**50**	-42.00
M052034	**Knowing**	**Fraction of class wanted to go on a trip**	**Before grade 8**	**27**	**52**	-48.08
M052058A	**Applying**	**Time when first lap finished**	**Before grade 8**	**40**	**59**	-32.20
M052058B	**Applying**	**percentage of laps finished**	**Before grade 8**	**7**	**22**	-68.18
M052078	**Applying**	**Percentage of money saved**	**Before grade 8**	**14**	**39**	-64.10
M052079	**Applying**	**Length of shorter string pieces**	**Before grade 8**	**36**	**54**	-33.33
M052094	**Reasoning**	**Who spent more for shoes**	**Before grade 8**	**10**	**20**	-50.00
M052134	**Knowing**	**How much hotter is city A than B?**	**Before grade 8**	**28**	**63**	-55.56
M052142	**Applying**	**Height of a stack of stools**	**Not in the Lebanese Program**	**18**	**40**	-55.00
M052147	**Applying**	**True statement about percentages of numbers**	**Before grade 8**	**31**	**46**	-32.61

ITEM Code	TIMSS Cognitive Level	Situation	Grade taught	Lebanon's Percent Correct	International Percent Correct	% R.D.
M052174A	**Applying**	**Number of kilocalories used**	**Before grade 8**	**25**	**43**	-41.86
M052174B	**Applying**	**True statement about percentages of numbers**	**Before grade 8**	**6**	**22**	-72.73
M052215	**Knowing**	**Fraction of diagram shaded**	**Before grade 8**	**33**	**56**	-41.07
M052217	**Reasoning**	**Who paid less for a hockey stick**	**Before grade 8**	**14**	**29**	-51.72
M052364	**Applying**	**Analysis of a solution**	**Before grade 8**	**28**	**51**	-45.10
M062111B	**Applying**	**Flowers Mariam sold - total number**	**Before grade 8**	**11**	**30**	-63.33
M062139	**Applying**	**Number of biscuits Marina keeps for herself**	**Before grade 8**	**14**	**33**	-57.58
M062143	**Reasoning**	**Number of girls given ratio**	**Before grade 8**	**4**	**24**	-83.33
M062146	**Applying**	**Percent of fir trees in a park given ratio**	**Before grade 8**	**15**	**37**	-59.46
M062150	**Knowing**	**Difference between two temperatures**	**Before grade 8**	**37**	**58**	-36.21
M062151	**Reasoning**	**Number of cups of water to fill 3 pitchers**	**Before grade 8**	**12**	**28**	-57.14
M062152	**Applying**	**Least number of crates for apples**	**Before grade 8**	**15**	**39**	-61.53
M062153	**Applying**	**Jihad, Rabih, and Sarah share zeds**	**Before grade 8**	**33**	**50**	-34.00
M062212	**Applying**	**Four containers partially filled with water**	**Before grade 8**	**13**	**28**	-53.57
M062214	**Applying**	**Cost of ice cream and a book**	**Before grade 8**	**16**	**38**	-57.89
M062215	**Applying**	**Fill in new price after discount**	**Before grade 8**	**9**	**22**	-59.09
M062346	**Applying**	**Explain which brand has cheaper price per battery**	**Before grade 8**	**13**	**30**	-56.67

Appendix 2

TIMSS Items that Exceed the Absolute % R.D. in Algebra Content Domain

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M042050	Knowing	Value of the expression	Above grade 8	43	32	34.38
M042066	Reasoning	Missing term in the sequence	Not in the Lebanese Program	26	45	-42.22
M042074A	Reasoning	Circles for patterns 4 & 30	Not in the Lebanese program	20	36	-44.44
M042074B	Reasoning	Procedure for finding the number	Not in the Lebanese program	11	32	-65.63
M042074C	Reasoning	Procedure for finding the number	Not in the Lebanese program	7	21	-66.67
M042093	Applying	Temperature at mountain top	Above grade 8	7	17	-58.82
M042100	Knowing	Pair of numbers that satisfy equation	Above grade 8	46	61	-24.59
M042109	Applying	Formula for distance traveled	Below grade 8	30	37	-18.92
M042197	Reasoning	Rule to get terms in the pattern	Not in the program	20	26	-23.07
M042202	Applying	Formula for K the cost of trip	Above grade 8	36	53	-32.08
M042229B	Knowing	Length of longest side of triangle	Below grade 8	17	28	-39.29
M042234	Knowing	What is the value of x?	Below grade 8	34	52	-34.62
M042243	Knowing	Which equation is satisfied	Above grade 8	30	45	-33.33
M052087	Applying	Solve for simultaneous equations	Above grade 8	5	16	-68.75
M052090	Applying	Set up system of equations	Above grade 8	33	43	-23.26
M052092	Applying	Graph of a linear function	Above grade 8	15	25	-40.00

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M052105	Applying	Which slope is greater	Above grade 8	3	13	-76.92
M052110	Knowing	Convert Celsius into Fahrenheit	Grade 8	24	30	-20.00
M052121A	Reasoning	Area of the 5th square	Not in the Lebanese program	39	48	-18.75
M052121B	Reasoning	Area of the nth square	Not in the Lebanese program	3	10	-70.00
M052126	Applying	Expression for the shaded area	Grade 8	5	17	-70.59
M052131	Applying	Step in solving the equation	Below grade 8	65	44	47.73
M052146A	Reasoning	Number of matches	Grade 8	22	46	-52.17
M052146B	Reasoning	Rule for number of matches	Grade 8	3	16	-81.25
M062027	Reasoning	y-value in table of points on straight line	Above grade 8	11	37	-70.27
M062030	Applying	Find cost of taxi ride	Grade 8	30	50	-40.00
M062078	Reasoning	Given perimeter of triangle ABC find length of AB	Below grade 8	16	29	-44.83
M062084	Knowing	Solve the inequality with y	Grade 8	32	23	39.13
M062095	Applying	Equation for cellphone cost	Grade 8	26	47	-44.68
M062105	Reasoning	Area of rectangle in terms of x	Grade 8	5	22	-77.27
M062149	Applying	Find expression to calculate earning	Grade 8	23	42	-45.24
M062237	Applying	Solve system of equations for x and y	Above grade 8	7	19	-63.16
M062241	Applying	Phone business	Below grade 8	13	30	-56.67
M062242	Reasoning	Relationship of a graph of a line in words	Above grade 8	32	54	-40.74

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M062317	**Knowing**	**Points on a parabola graph - fill in table**	**Above grade 8**	**19**	**24**	-20.83
M062341	**Knowing**	**Find slope of a line given equation**	**Above grade 8**	**24**	**31**	-22.58
M062350	**Applying**	**Given point and slope, select collinear point**	**Above grade 8**	**12**	**21**	-42.86
M062351	**Knowing**	**Identify line with positive slope**	**Above grade 8**	**14**	**33**	-57.58

Appendix 3

TIMSS Items that Exceed the Absolute % R.D. in Geometry Content Domain

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M042151	Applying	Shape with AB as line of symmetry	Below grade 8	30	-51	-41.18
M042257	Reasoning	Which 2 shapes fit together	Not in the program	26	39	-33.33
M042264	Reasoning	Conditions for similar triangles	Not in the program	16	22	-27.27
M042268	Reasoning	Area of the triangle ABC	Grade 8	23	31	-25.81
M042271	Applying	How many cubes were left	Grade 8	30	51	-41.18
M052039	Applying	Length of a segment in two similar triangles	Above grade 8	27	41	-34.14
M052041	Reasoning	Height of the building	Above grade 8	6	16	-62.50
M052044	Reasoning	Point equidistant from P and Q	Grade 8	34	49	-30.61
M052046	Reasoning	Rotation and reflection of a figure	Above grade 8	18	31	-41.94
M052048	Applying	Lines of symmetry for polygon	Below grade 8	10	21	-52.38
M052057	Reasoning	Figure that can be folded as box	Below grade 8	29	57	-49.12
M052083	Applying	Surface area of a prism	Above grade 8	16	35	-54.29
M052208	Reasoning	Number of cubes that fit in a box	Above grade 8	12	22	-45.45
M052407	Applying	What is the value of angle a	Below grade 8	47	62	-24.19
M062040	Applying	Estimate area of irregular shape	Grade 8	28	44	-36.36
M062170	Reasoning	Number of cubes corresponding to number of faces coated with paint	Above grade 8	7	14	-50.00
M062171	Knowing	Square reflected over a line	Below grade 8	42	60	-30.00
M062173	Reasoning	Find angle on a	Grade 8	22	27	-18.52

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
		folded piece of paper				
M062183	Applying	Draw the reflection of shaded object over the line	Below grade 8	18	43	-58.14
M062192	Applying	Distance from base of ladder to base of building	Grade 8	6	19	-68.42
M062194	Reasoning	Number of cubes in a solid figure	Above grade 8	51	69	-26.09
M062202	Reasoning	Liza's net of cube - face opposite face Q	Below grade 8	32	60	-46.67
M062250 A	Applying	Length of a strip around a hexagon box	Above grade 8	17	45	-62.22
M062250B	Applying	Area of blue paper for sides	Above grade 8	8	25	-68.00
M062261	Reasoning	Find side x with 2 similar triangles	Above grade 8	11	20	-45.00
M062286	Applying	Show Afaf how to find area of an irregular shape	Below grade 8	1	8	-87.50
M062300	Reasoning	Draw a rectangle given area and perimeter	Above grade 8	10	30	-66.67
M062301	Reasoning	Sculpture from solid cube	Above grade 8	3	23	-86.96

Appendix 4

TIMSS Items that Exceed the Absolute % R.D. in Data Analysis and Probability Content Domain

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M042164	Reasoning	Agree/disagree with the salesman	Grade 8	9	35	-74.29
M042167	Reasoning	Overall average of 9 for Ahmed	Above grade 8	9	25	-64.00
M042252	Applying	Speed time graph	Not in the program	22	41	-46.34
M042261	Knowing	How likely it will rain	Not in the program	25	58	-56.90
M052115	Applying	Favorite flavor	Above grade 8	13	43	-69.77
M052161	Applying	Number of balls in a bag	Above grade 8	38	64	-40.63
M052170	Applying	List with specified mean and range	Above grade 8	20	40	-50.00
M052418B	Applying	Compare time of smartphone use	Below grade 8	24	47	-48.94
M052421	Reasoning	Explain why a graph is correct	Above grade 8	14	35	-60.00
M052422B	Applying	Red color on the spinners	Above grade 8	27	51	-47.06
M052501	Reasoning	Sports survey bar graph mistake	Grade 8	14	27	-48.15
M062120	Knowing	Chance of second marble without replacement	Above grade 8	18	45	-60.00
M062123B	Applying	Mean time when two runners improve	Above grade 8	16	37	-56.76
M062124	Knowing	Chance Clara picks a blue marble	Above grade 8	11	39	-71.79
M062132B	Applying	Mobile phone factory - expected vs. actual faulty	Above grade 8	16	45	-64.44
M062133	Reasoning	Black and white marbles with replacement	Above grade 8	25	45	-44.44
M062254	Reasoning	Characteristics of test scores from dot plots	Above grade 8	6	17	-64.71

TIMSS Item Code	TIMSS Cognitive Level	Situation	Grade Taught	Lebanon's Percent Correct	International Percent Correct	Relative % R.D.
M062296	**Reasoning**	**Draw a spinner given chance of outcomes**	**Above grade 8**	**25**	**45**	-44.44
M062320	**Applying**	**Proportion of fish released**	**Above grade 8**	**17**	**39**	-56.41
M062325	**Knowing**	**Statements about electronic device usage survey**	**Above grade 8**	**35**	**51**	-31.37
M062344	**Applying**	**Number of bowls to raise the average**	**Above grade 8**	**6**	**23**	-73.91
M062345A	**Applying**	**Fishing spots - calculate mean and median**	**Above grade 8**	**1**	**23**	-95.65

CHAPTER 4

Overall Performance in Science

This chapter summarizes the findings from TIMSS 2015 in terms of science performance for Grade 8 students in Lebanon. The chapter describes the changes in mean performance over time and the percentage of students achieving each of the international benchmarks in science. Additionally, the chapter highlights major findings from an extensive descriptive analysis of the science TIMSS items in terms of the content coverage areas and associated objectives, cognitive domains, types of questions, types of documents, and misconceptions. In some instances, where necessary, a comparison with the Arab countries is done.

4.1 Achievement in Science

On average, Lebanon scored 398±5.3 which was lower than the international mean score of 486 (Figure 4.1). Compared to Arab countries, Lebanon scored lower than UAE, Bahrain, Qatar, Oman, Jordan, and Kuwait, but higher than Saudi Arabia, Morocco, and Egypt. Still however, Grade 8 students' performance of all the Arab countries was below the international average mean (Figure 4.2).

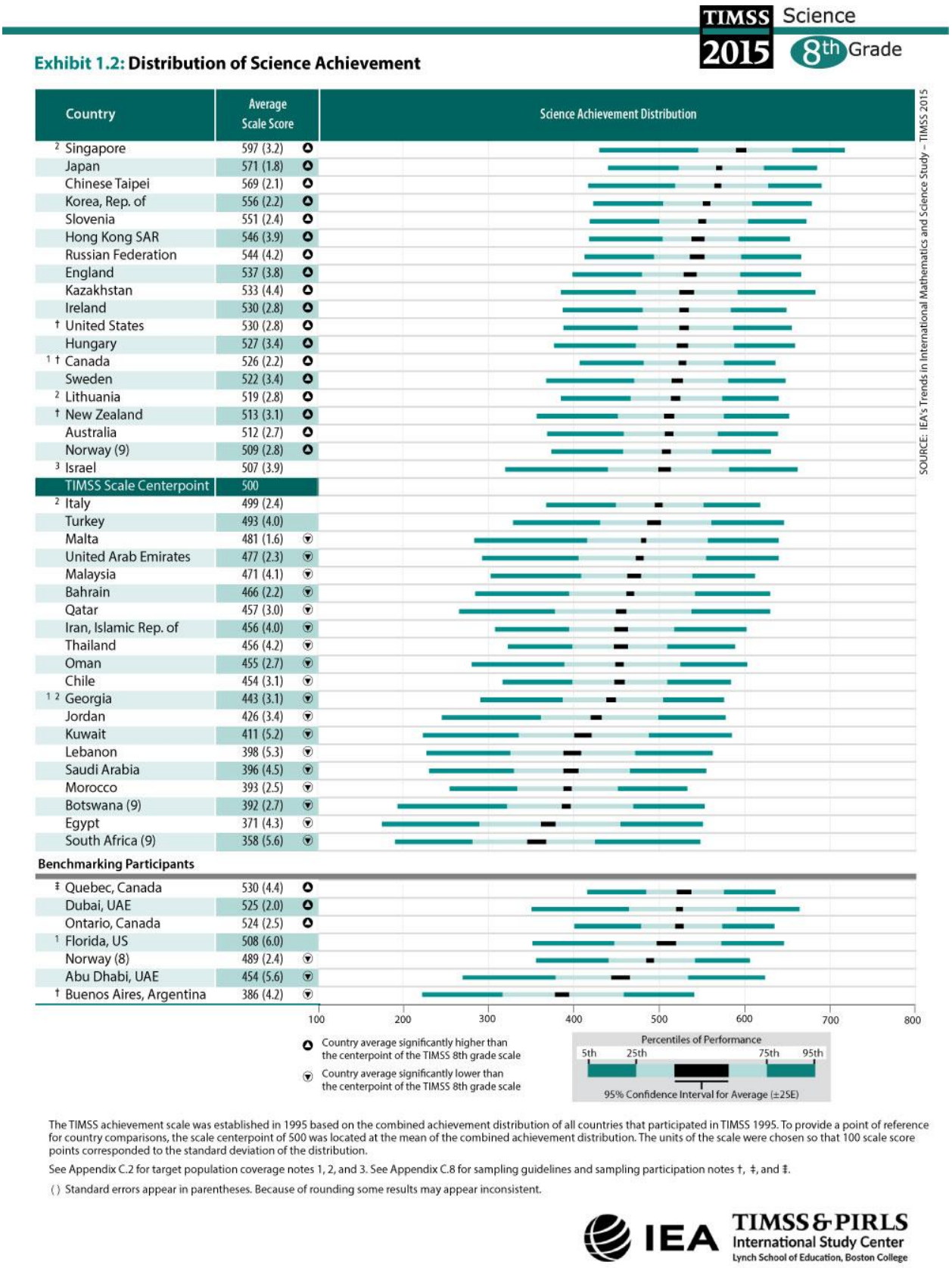
4.1.1. Achievement at TIMSS International Benchmarks

TIMSS identified four points on the science achievement scale for use as international benchmarks or reference points to describe students' performance at these benchmarks (Table 4.1).

Table 4.1. Benchmark Cut off Scores and Description

Benchmark	Score	Description
Advanced Benchmark	625	*Students communicate understanding of complex concepts related to biology, chemistry, physics and Earth science in practical, abstract, and experimental contexts.*
High Benchmark	550	*Students apply and communicate understanding of concepts from biology, chemistry, physics, and Earth science in everyday and abstract situations.*
Medium Benchmark	475	*Students demonstrate and apply their knowledge of biology, chemistry, physics, and Earth science in various contexts.*
Low Benchmark	400	*Students show some basic knowledge of biology, chemistry, physics, and Earth science.*

Figure 4.1. Distribution of student achievement in Grade 8 Science



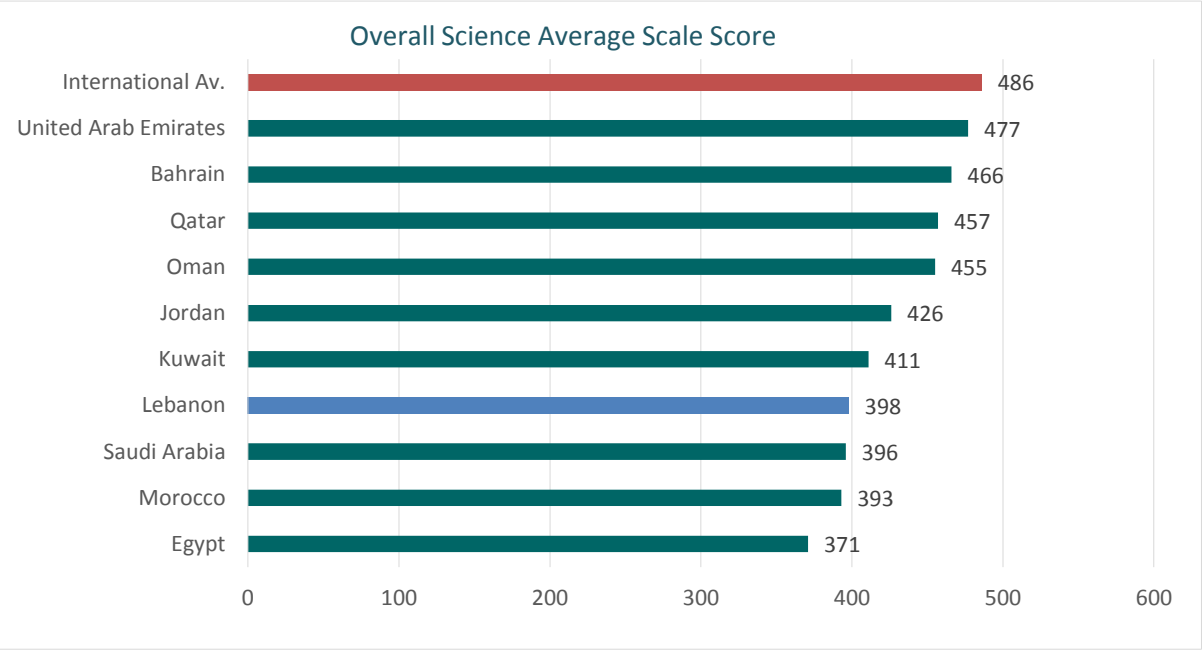
The TIMSS achievement scale was established in 1995 based on the combined achievement distribution of all countries that participated in TIMSS 1995. To provide a point of reference for country comparisons, the scale centerpoint of 500 was located at the mean of the combined achievement distribution. The units of the scale were chosen so that 100 scale score points corresponded to the standard deviation of the distribution.

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

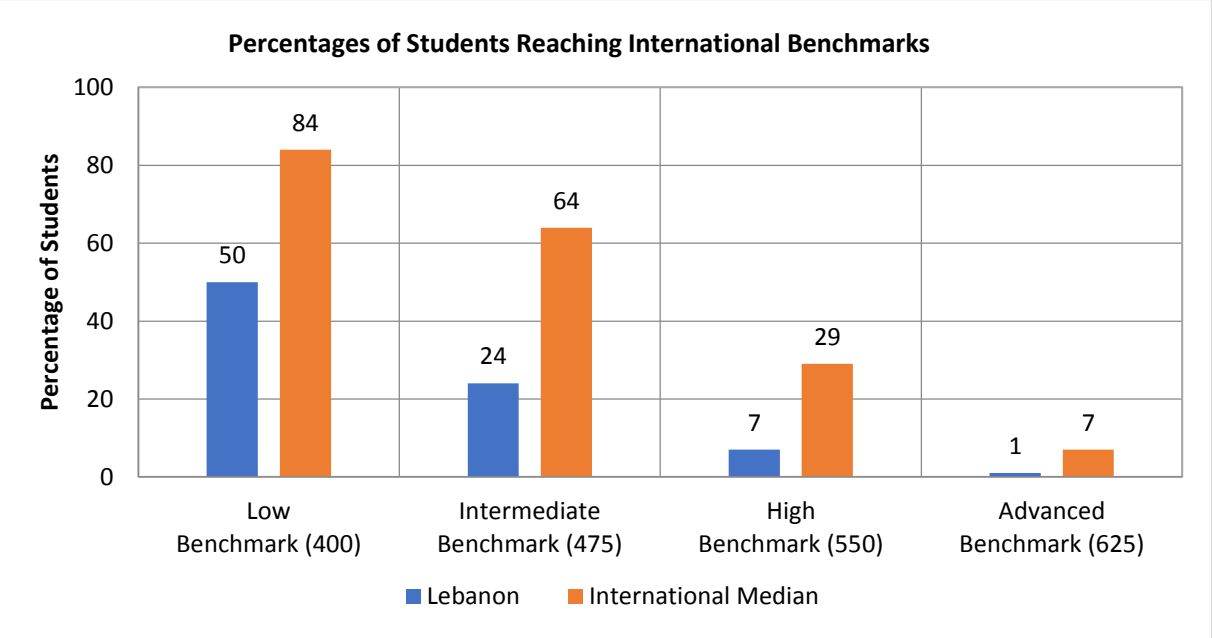
IEA TIMSS & PIRLS International Study Center Lynch School of Education, Boston College

Figure 4.2. A Comparison of the overall science score across Arab countries



TIMSS findings revealed that the percentage of Lebanese students achieving at the four levels of performance decreased with the increase in performance expectation (Low to Advanced), similar to their international counterparts; this percentage, however, was at least 1.5 times lower in Lebanon compared to the international median of grade 8 student achievement at TIMSS international benchmarks. Also, while 50% of Lebanese students managed to reach the lowest benchmark, only 1% reached the advanced benchmark (Figure 4.3).

Figure 4.3. A comparison of percentages of students reaching international benchmarks in Lebanon and internationally, TIMSS 2015



4.1.2 Trends in Achievement

The overall science achievement in TIMSS 2015 was lower than the achievement in both 2011 and 2007, but slightly higher than the mean of students' achievement in TIMSS 2003 (Figure 4.4). After the significant increase in TIMSS performances between 2003 and 2007 (20-point increase), the steady drop observed in the mean achievement over the past years since then raises red flags, especially since at its best, Lebanon was 86 points behind the TIMSS scale center point (500). Thus, serious measures should be taken to inquire about such a decrease despite teacher training and curriculum improvement efforts undertaken by the Lebanese Ministry of Education and Higher Education (MEHE).

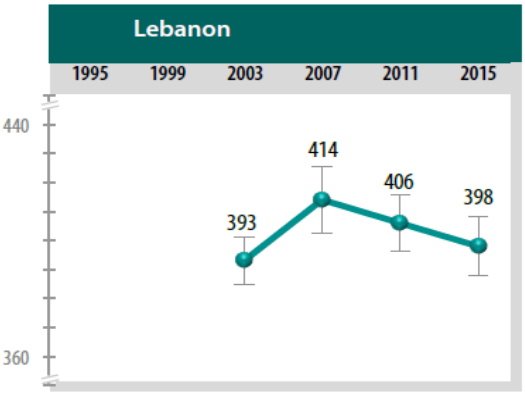
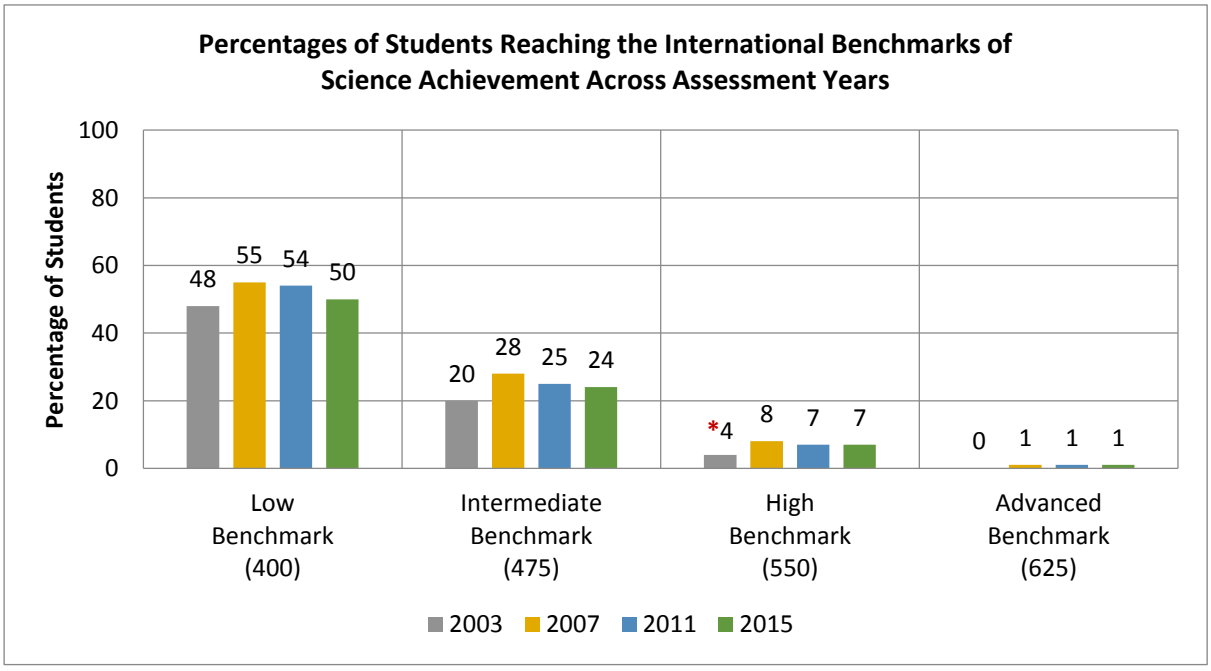


Figure 4.4. Changes in achievement for Lebanon with data comparisons with previous TIMSS assessments

Additionally, no significant variations in Lebanese students' performance across the four benchmarks were evident across the last four TIMSS assessment years as shown in the figure below (Figure 4.5).

Figure 4.5. Performance of Lebanese students at the international benchmarks of science achievement across the years



** 2015 percent significantly higher*

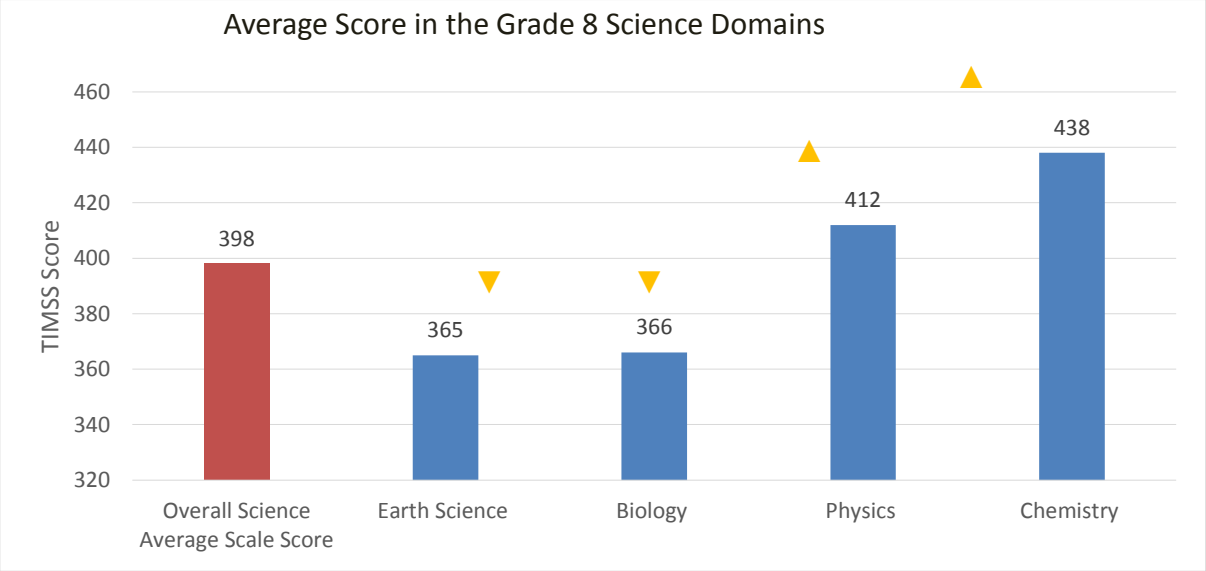
This lack of pattern variation highlights that changes at the level of school practices and school policy needs to be thoughtfully considered.

4.1.3. Science Performance in Different Content Domains

TIMSS enables a detailed comparison of students' science performance in specific subjects and cognitive domains. Each of the TIMSS assessment test item is categorized according to four **content domains** (Biology, Earth Science, Physics, or Chemistry).

In 2015, when comparing Lebanon's mean scores in science to the overall mean, grade 8 students performed best in chemistry, and weakest in Earth Science and Biology (Figure 4.6). This difference in performance could be due to misalignment of the Lebanese curriculum with what was assessed in TIMSS in Life and Earth Sciences.

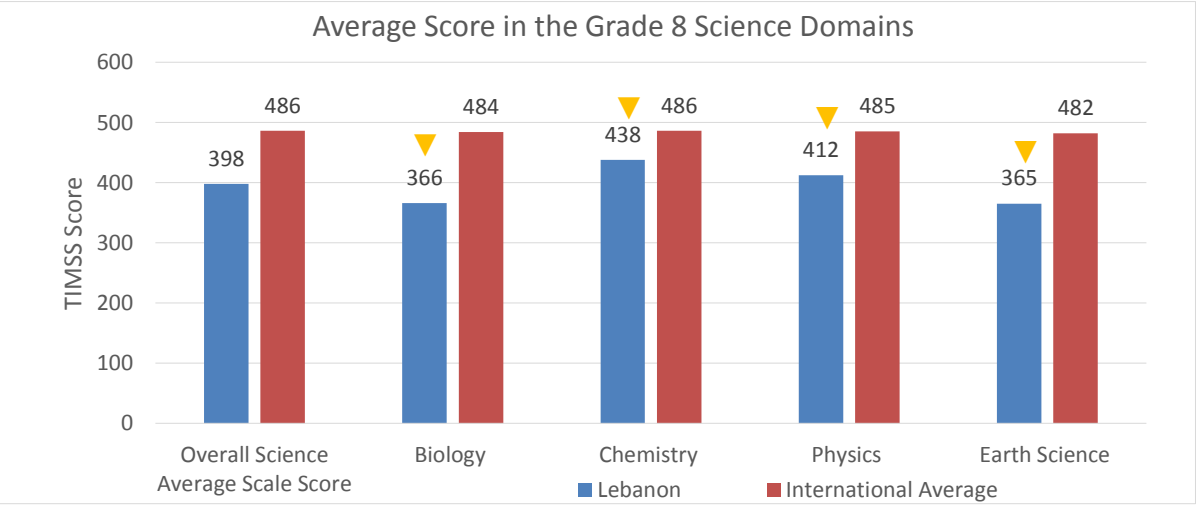
Figure 4.6. Mean scores for 2015 in different content domains of Grade 8 science in Lebanon



▲: *Subscale score significantly higher than overall science score*
▼: *Subscale score significantly lower than overall science score*

Compared to the international science mean for each content domain, Grade 8 Lebanese students performed lower in the four subject areas (Figure 4.7).

Figure 4.7. Mean scores for 2015 in different content domains of science compared to the overall mean score in Lebanon and international means



▼: *Subscale score significantly lower than overall science score*

4.1.4 Science Performance in the different cognitive domains

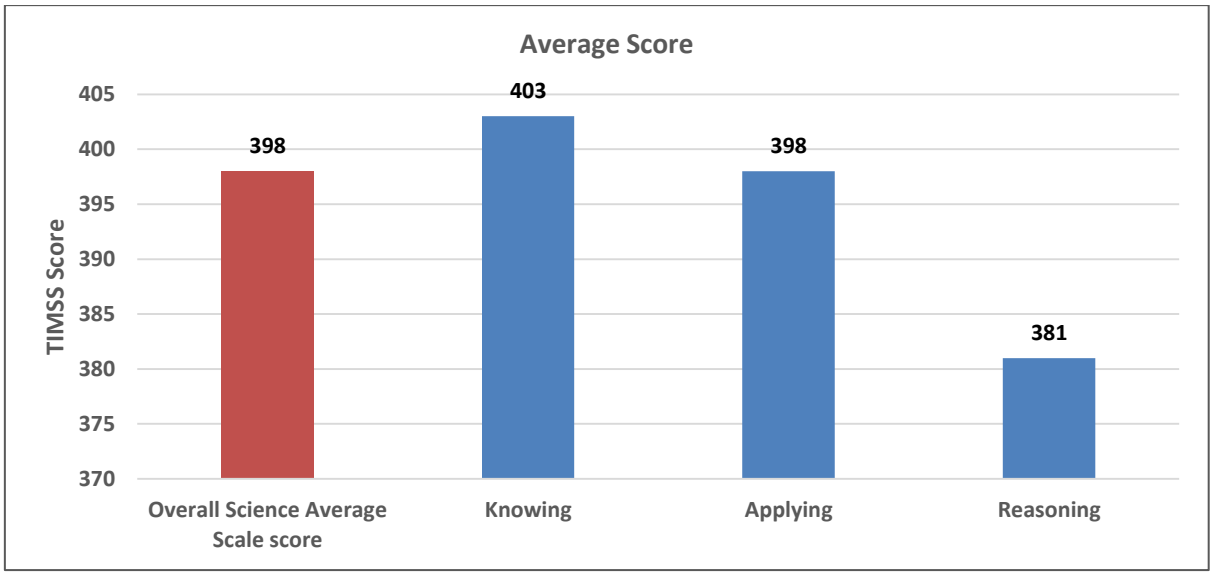
In science, TIMSS assesses students' performance in three cognitive domains: Knowing, Applying, and Reasoning. The domains describe the kind of thinking that students do when engaged with science tests (Table 4.2). Student performance in the three cognitive domains was highly correlated with performance in the TIMSS subject domains and performance overall, meaning that no one domain is more – or less – important for overall performance.

Table 4.2. The three domains and their descriptions

Domain	Description
Knowing	Includes the facts, concepts, and procedures students need to know
Applying	focuses on pupils using knowledge and understanding to, for example, solve problems and answer questions
Reasoning	includes using evidence and science understanding to analyze, synthesize, and generalize, with emphasis upon doing these within 'unfamiliar situations and complex contexts

In Lebanon, students performed highest in the Knowing domain and lowest in the Reasoning domain, as shown in Figure 4.8 below, which is in line with the increasing difficulty of the levels.

Figure 4.8. Student Performance in the different Cognitive Domains



The following sections 4.2, 4.3, 4.4, and 4.5 provide a detailed description of Grade 8 students' performance in TIMSS 2015 in each of the four science disciplines (Biology, Earth Science, Physics, and Chemistry respectively) in context of the analysis of the Lebanese science curriculum.

Conclusion:

- Grade 8 students' performance of all the Arab countries was below the international mean.
- Compared to Arab countries, Lebanon scored lower than UAE, Bahrain, Qatar, Oman, Jordan, and Kuwait, but higher than Saudi Arabia, Morocco, and Egypt.
- The percentage of students at the four levels of performance was lower than grade 8 student achievement at TIMSS international benchmarks.
- 50% of Lebanese students managed to perform at the low level of performance, and only 1% reached the advanced benchmark.
- The overall science achievement in TIMSS 2015 was lower than the achievement in both 2011 and 2007, but slightly higher than the mean of students' achievement in TIMSS 2003.
- No significant variations in Lebanese students' performance across the four benchmarks were evident across the last four TIMSS assessment years.
- In 2015, Lebanese Grade 8 students performed best in Chemistry, and weakest in Earth Science and Biology.
- Compared to the international science mean for each content domain, Grade 8 Lebanese students performed lower in the four subject areas.
- In Lebanon, students performed highest in the Knowing domain and lowest in the Reasoning domain, which is in line with the increasing difficulty of the levels.

4.2 Achievement of Grade 8 Students in Biology

This session summarizes findings that link Grade 8 students' performance in biology with several parameters that could help in analyzing TIMSS biology test items in a more comprehensive manner.

4.2.1. Curriculum matching and alignment of TIMSS Test Items with Lebanese Biology Curriculum

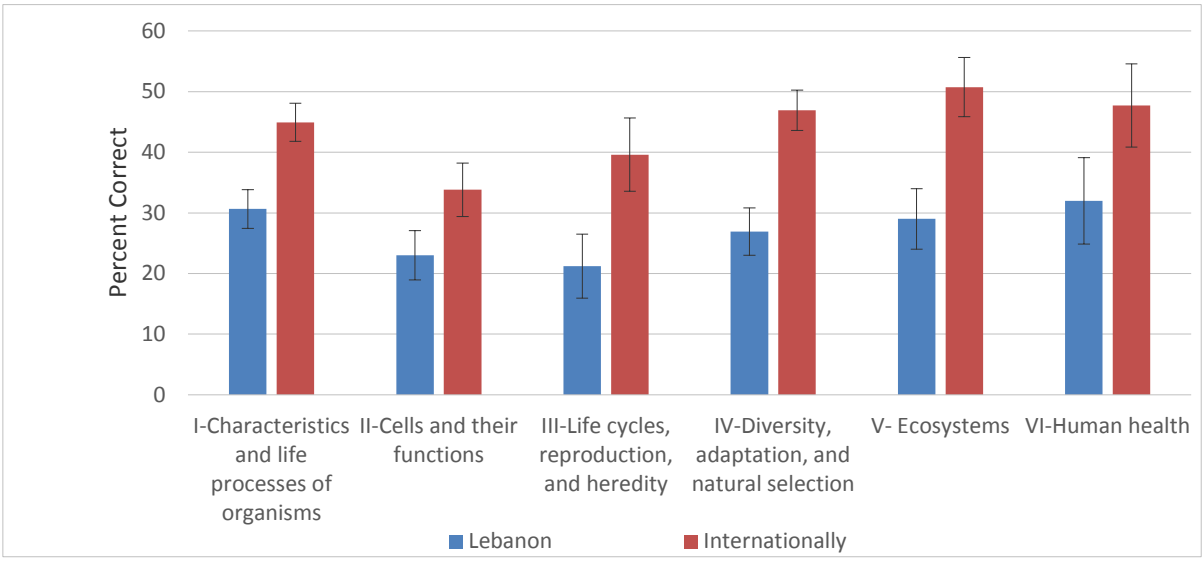
4.2.1.A. Alignment with topic area and grade level

TIMSS findings revealed that 27% of grade 8 students in Lebanon provided correct answers on the overall test items compared to a percent correct of 44% in the other participating countries (Table 4.3). Results also showed that the percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the six topic areas was always lower than their international counterparts (Table 4.3 and Figure 4.9), with a difference ranging from -30% to -52%. Results also showed that the highest relative change (-52%) was in topic III addressing concepts related to life cycles, reproduction, and heredity. Also, 8th graders in Lebanon performed poorly on test items related to topic V about ecosystem (- 49%) and topic IV on diversity and natural selection (-45%).

Table 4.3. The comparison of Lebanon's and the international performance across the different Biology Topic Areas

Topic area	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
I-Characteristics and life processes of organisms	14	Mean	30.64	44.93	-14.3	-.30
		Std. Error	3.20	3.13	3.18	.076
II-Cells and their functions	16	Mean	23.00	33.81	-10.81	-.38
		Std. Error	4.06	4.41	1.71	.057
III-Life cycles, reproduction, and heredity	10	Mean	21.20	39.60	-18.40	-.52
		Std. Error	5.29	6.05	1.54	.05
IV-Diversity, adaptation, and natural selection	14	Mean	26.93	46.93	-20.00	-.45
		Std. Error	3.90	3.33	2.73	.06
V-Ecosystems	19	Mean	29.00	50.74	-21.74	-.49
		Std. Error	4.99	4.90	2.36	.05
VI-Human health	7	Mean	32.00	47.71	-15.71	-.38
		Std. Error	7.12	6.84	2.62	.07
Total	**80**	**Mean**	**27.01**	**44.01**	**-17.00**	**-.42**
		Std. Error	**1.90**	**1.99**	**1.1**	**.03**

Figure 4.9. A Comparison of Grade 8 student performance in the different Life Science topic areas in Lebanon and Internationally



Such a result could be explained by the following reasons. First, Heredity is taught in a higher-grade level, Grade 9. Second, the theme "life cycles of animals" is taught in Grade 6 and students might not have recalled the learned concepts. Third, the topic on Ecosystem, although present in the biology curriculum for Grade 7, had been suspended.

This explanation was reinforced with evidence presented in Table 4.4 which reveals an enormous difference between international and Lebanon samples when comparing the percentage of 8th graders who correctly answered TIMSS test items not within the Lebanese biology curriculum (64%, N=4/80) or test items related to suspended themes (48%, N=19/80). Such a difference was less prominent when Lebanese grade 8 students were tested on items present within their biology curriculum (38.86%).

Table 4.4. Relative Difference in student performance on TIMSS Biology test items in Lebanon (Grades 1-12) and Internationally

Suspension Status	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
TIMSS test items taught in the Lebanese Biology curriculum (G1-12)	57	Mean	27.72	42.54	-14.82	-.38
		Std. Error	2.27	2.305	1.25	.032
TIMSS test items present in the Lebanese Biology curriculum but suspended	19	Mean	26.63	48.58	-21.95	-.48
		Std. Error	4.03	4.310	2.11	.04
TIMSS test items not within the Lebanese biology curriculum	4	Mean	18.75	43.25	-24.50	-.64
		Std. Error	6.65	9.490	3.79	.12
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.90	1.98	1.09	.02

Nevertheless, further analysis was done to explore the grade level(s) where TIMSS Biology test item are taught in the Lebanese curriculum and the extent to which teaching affects student performance.

Table 4.5. Grade level and Biology topics taught

Grade levels where TIMSS items are taught in Lebanon	Number of TIMSS test items	Average percent correct in Lebanon	Average percent correct internationally	Absolute Difference	R.D.
Grades 4-5-6-7	57	25.98	42.15	-16.17	**-41.93%**
Grade 8	5	40.6	52	-11.4	**-28.41%**
Grades 9-10-11-12	14	28.71	48.93	-17	**-43.13%**
Not within Biology curriculum	4	18.75	43.25	-24.5	**-63.73%**
Average	80	27.01	44.01	-17	**-38.63%**

Table 4.5 reveals that when students were tested on topics taught to G8 students, they tended to answer more correctly compared to their peers from the other countries (difference of -11.4%). On the other hand, a high percentage of students did not provide correct answers when they were tested on topics taught at either a higher level (28.71%) or at lower level (25.98%), although they make up 70% and 18% of items respectively. Results might draw on several facts:

(a) Difference in percentages of students taught material at an earlier grade is approximately the same as those not taught the material yet; this observation indicates the low level of students' retention of learned concepts taught before grade 8. Reason could be attributed to classroom instruction which favors memorization. Such a result necessitates a change in teaching practices and strategies that foster long retention of studied concepts.

(b) 18.75% of grade 8 Lebanese students were able to correctly answer TIMSS questions that were not within the Lebanese Biology curriculum. This percentage could have two explanations:

(1) learning could be acquired from informal sources outside the classroom, mainly from TV, internet, parents, etc.

(2) students answered the questions, particularly MCQs, by guessing.

These findings call for the adjustment of TIMSS test items, if possible, to assess concepts taught within the context of the Lebanese biology curriculum in order to better compare performances with the international counterparts, since one could question the trustworthiness and, in particular, the fairness and reliability of TIMSS results otherwise. An alternative would be to work on revising the Lebanese curriculum so that it becomes more in line with the international standards and global curriculum. It is also important to ensure that content taught in earlier grades is retained and not forgotten as is the case and this can be done by focusing on understanding and application and relating content to real life experiences.

4.2.1.B Alignment with Objectives

An extensive analysis of TIMSS items in relation to the objectives of the six topic areas was done (Appendix 4.2.I). Additionally, some possible explanations, derived from comparison with the Lebanese curriculum, were provided for test items with a big difference in achievement between 8th graders in Lebanon and their international counterparts.

Findings revealed that Grade 8 students in Lebanon outperformed students in the other countries only in two objectives related to Biology (I.2.A and I.2.B) which assess student knowledge in identifying organs and organ systems in the human body and comparing them with those in other vertebrates. However, a great deviation in performance from the international mean ranging from (-44.06% to -70.59%) was identified on 12/36 objectives (33%) and was highly associated with objectives related to suspended themes (6/12 objectives) or to themes taught in lower grades (5/12). A similar result was evident for objectives related to concepts taught at a lower grade levels (grades 6 and 7). Surprisingly, Grade 8 student performed well on test items related to some biology notions not taught in grade 8 with a relatively small deviation from the international mean (e.g. IV.2.B, percentage difference of -33.54%).

4.2.2. Grade 8 Student Performance in the different Cognitive Domains- Biology

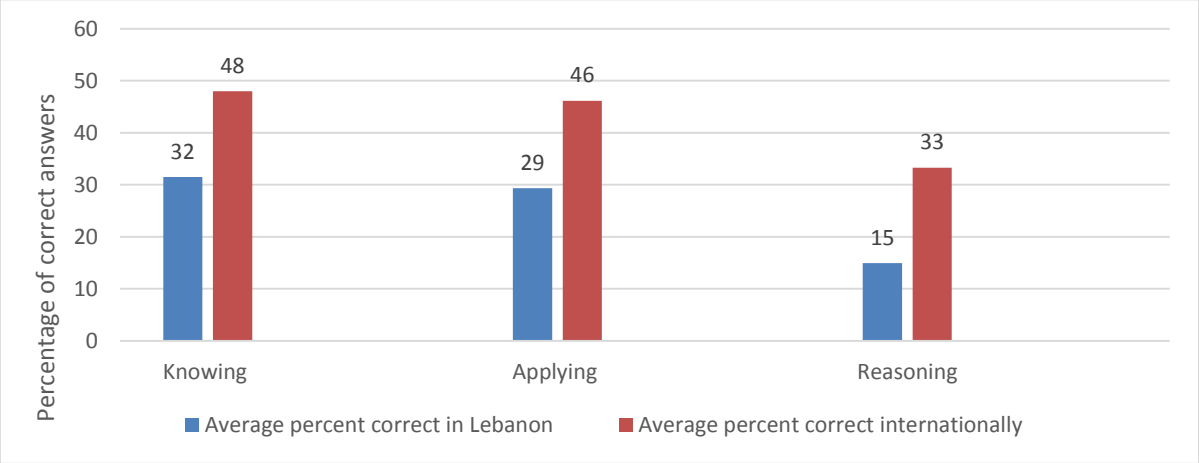
Table 4.6 and Figure 4.10 show that in Lebanon, as is the case internationally, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question, the percentage being the lowest in Reasoning and highest in Knowing.

Moreover, results show that grade 8 students performed lower in the three cognitive domains: Knowing, Applying, and Reasoning, compared to students internationally. Although, the difference in percent correct was nearly the same in the three domains, grade 8 students in Lebanon were way behind the international average in reasoning (-58%) compared to the other two domains: knowing and applying (-36% and -39%, respectively) as shown in Table 4.6.

Table 4.6. Performance in different Cognitive Level in Lebanon and Internationally

Cognitive Level	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
Knowing	28	Mean	31.48	47.96	-16.48	-.36
		Std. Error	3.16	3.16	1.75	.04
Applying	36	Mean	29.36	46.11	-16.75	-.39
		Std. Error	2.92	3.04	1.82	.04
Reasoning	16	Mean	14.94	33.29	-18.35	-.58
		Std. Error	2.64	3.71	2.15	.05
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.90	1.96	1.09	.026

Figure 4.10. Percent correct by TIMSS Cognitive Domains in Lebanon and Internationally



Analysis of TIMSS test items was done in the context of the competencies-based evaluation domains adopted in Lebanon. This system described three domains of competencies as shown in table below (Table 4.7).

Table 4.7. Domains of Competencies of the Lebanese Evaluation System-Biology

Domain	Domain	Competencies
D1	Mastering Acquired Knowledge	▪ Apply acquired knowledge to a similar context ▪ Relate acquired knowledge to new givens
D2	Practicing Scientific Reasoning	▪ Pick up information by analyzing texts or scientific representation ▪ Relate information in order to explain ▪ Pose a problem ▪ Formulate a hypothesis ▪ Test a hypothesis by designing an experimental protocol ▪ Deduce by interpreting results ▪ Elaborate a synthesis ▪ Perform critical thinking by discussing an experimental result or a behavior
D3	Mastering Communication Techniques	▪ Use an adapted scientific language ▪ Use the means of scientific representation

It is worth noting that D1 corresponds to knowing domain in TIMSS and D2 corresponds to Applying and Reasoning domains in TIMSS. Classification of TIMSS items according to Lebanese domains D1 and D2 revealed that 60 TIMSS test item is in domain D1 and only 20 items is in D2.

Table 4.8 and Figure 4.11 show the comparison of Lebanon's and the international performance according to the Lebanese Cognitive domains. Comparison in D3 was not calculated since this domain is not present as a separate category in the identification of the cognitive domains of the TIMSS test items.

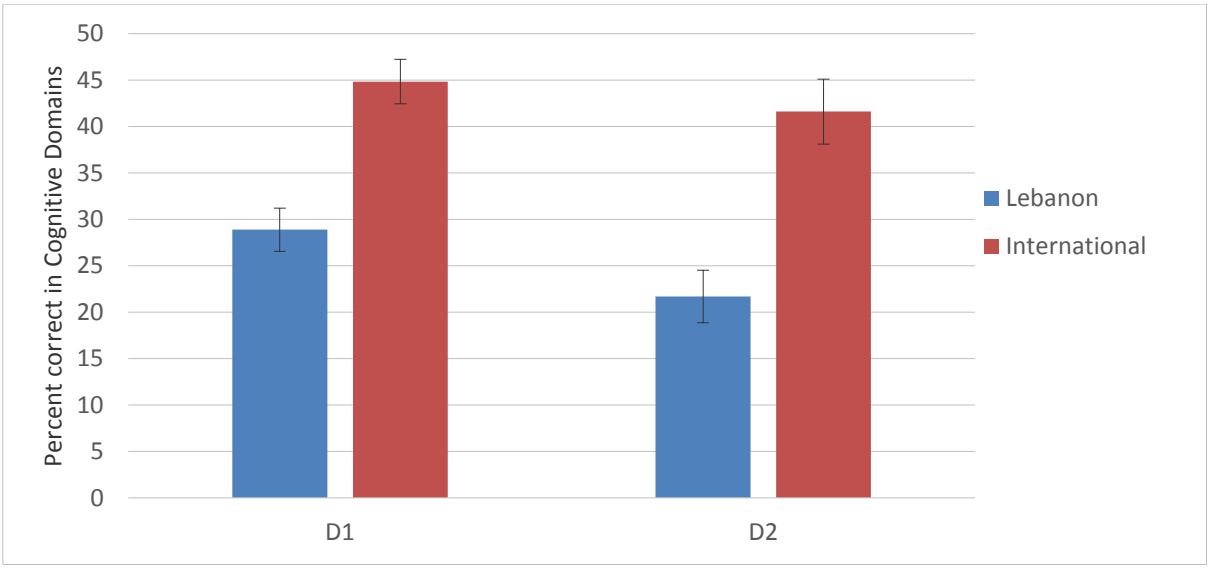
Results show that students' performance in D1 was higher than their performance in D2 for both Lebanon and internationally. Moreover, internationally, the percentage of

students (44.86%) who answered correctly test items in D1 was 1.5 times higher than the percentage of Lebanese students who correctly answered the same test items (28.9%). This difference was higher, about two times as much, for D2.

Table 4.8. Performance of Students according to Lebanese Cognitive Domains and Internationally

Cognitive Domain	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
D1	60	Mean	28.90	44.86	-15.97	-.39
		Std. Error	2.336	2.39	1.25	.032
D2	20	Mean	21.71	41.62	-19.90	-.50
		Std. Error	2.82	3.515	2.21	.041
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.90	1.985	1.09	.026

Figure 4.11. Performance of Students in TIMSS according to different Cognitive Domains in Lebanon and Internationally



To further identify TIMSS test items where there was a big difference between grade 8 students' performance in Lebanon and internationally, we have calculated the average of percent change for each cognitive domain to be our reference point.

A- Item Analysis: Knowing

The average of percentage change in the knowing domain was equal to 36.58%. Table 4.10 below shows the test items with percent change greater than this average with a detailed description of each item (for more details, see appendix 4.2.II).

Table 4.10. Items in Knowing Domain with descriptions

TIMSS Test Item	Description of the test item	Absolute Difference	Type of question	Type of document	Action verb	Other features	Targeted Misconceptions
S062093	mammals in cold weather	-73.53	Short-Answer	Text	Action Verb	Grades 4-5	No
S062089	symbiosis between two organisms	-70.59	Multiple-Choice	Text	Wh question	7 (suspended)	No
S062101	stomach tissue and function	-66.67	Matching	Schema	Action Verb	Not within curriculum	No
S052090B	how influenza spread	-63.16	Short-Answer	Text	Action Verb	Grade 8	No
S062094	classifying an animal based on given data	-58.00	Multiple-Choice	Text	Wh question	Grades 4-5-6	Yes
S052069	organisms with cell wall	-52.73	Multiple-Choice	Schema	Wh question	Grade 6	No
S042016	organelle producing energy	-50.00	Multiple-Choice	Text	Wh question	Grade 6 and grade 11	No
S062274	raw materials for photosynthesis	-50.00	Short-Answer	Text	Action Verb	Grade 7	No
S062064	structure of bones in flying animal (hollow bones)	-49.18	Short-Answer	Text	Wh question	Not within curriculum	No
S052267	inherited and acquired characteristic	-48.89	Multiple-Choice	Text	Wh question	9 and 12	No
S062279	constituents of balanced food	-45.61	Multiple-Choice	Text	Wh question	4 -5 - 11	No
S062106	transmission of hereditary characteristics from parents to offspring	-36.99	Multiple-Choice	Text	Wh question	Grades 9 and 12	No

Results showed that 91.6% (11 questions/12) of the Knowing items above tested student knowledge on concepts which were not in their Biology curriculum, taught at a different grade level, or suspended, with only 1 item that targeted misconceptions. Most of these items were presented in a text format.

B- Item Analysis: Applying

The reference point for this analysis is the average of percentage change in the applying domain (39.48%). Table 4.11 below shows the test items with percent change greater than this average with a detailed description of each item (for more details, see appendix 4.2.III).

Table 4.11. Items in Applying Domain with descriptions

TIMSS Test Item	Description of the test item	Absolute Difference	Type of question	Type of document	Action verb	Other features	Targeted Misconceptions
S062118	mice living on beach and natural selection	-84.31%	Open	Text	Wh question	Grade 12 (suspended)	No
S052265	monohybrid cross between cats with the same trait	-76.67%	Short answer	Text	Action Verb	Grade 9	Yes
S052006	penguin behavior and survival	-71.88%	open	Text	Action Verb	Grade 5	No
S042030	Asexual reproduction in potato	-70.83%	Short-Answer	Schema	Action Verb	Grade 7 (suspended)	Yes
S062098B	Differences between animal and plant cells	-70.00%	Short-Answer	Text	Action Verb	Grade 6	Yes
S052071	adaptation to cold weather, birds puff up their feather	-65.96%	Multiple-Choice	Text	Wh question	Grades 4- 5	No
S042222B	Life cycle stage monarch develops	-64.29%	Short-Answer	Text	Action Verb	Grade 6	No
S042049A	variation in the size of rabbits and lynx populations across years	-61.76%	open	Table	Action Verb	Grade 7 (suspended)	No
S062111	Food group in balanced diet	-61.54%	Fill-in-the-blank	Table	Action Verb	Grade 9 (suspended)	No
S042408	interdependence of organisms in an ecosystem birds can't survive without plants	-60.00%	open	Text	Action Verb	Grade 7	Yes

TIMSS Test Item	Description of the test item	Absolute Difference	Type of question	Type of document	Action verb	Other features	Targeted Misconceptions
S042005	Classification of animals by a criterion specified by students	-57.58%	Short-Answer	Table	Action Verb	Grades 4 and 5	No
S042222A	life cycle stage monarch grows	-52.63%	Short-Answer	Text	Action Verb	Grade 6	Yes
S052095Z	competition and predation birds-cats	-51.85%	Multiple-Choice	Schema	Action Verb	Grade 7 (suspended)	No
S042222C	advantage for viceroy butterfly	-45.31%	Multiple-Choice	Text	Wh Question	Grade 12	No
S052094	Similarity in the life cycle of bird and frog	-44.83%	Short-Answer	Text	Action Verb	Grade 6	No
S062100	Cell structure of fossil	-44.19%	Short-Answer	Text	Action Verb	Not within curriculum	No
S052095D	competition and predation birds-cats	-43.48%	Multiple-Choice	Schema	Action Verb	Grade 7 (suspended)	No
S052095C	competition and predation birds -cats	-43.04%	Multiple-Choice	Schema	Action Verb	Grade 7 (suspended)	No

Results showed that 100% (18 questions/18) of the applying items above tested students' knowledge on concepts which were not in their Biology curriculum, suspended, or taught at a different grade level, where 27.78% (5 questions) addressed misconceptions. Students did not perform well on all types of documents (Text, Table, or Schema). Also, analysis reflects that the lowest performance (-84.31% percent change) when using "Wh" questions, students' achievement still remained low when action verbs were used irrespective of the type of question (short answer, open, or multiple choice).

C- Reasoning: Item analysis

The reference point for this analysis is the average of percentage change in the reasoning domain which is 57.75%. Table 4.12 below shows the test items with percent change greater than this average with a detailed description of each item (for more details, see appendix 4.2.IV).

Table 4.12. Items in the Reasoning Domain with descriptions

TIMSS Item Number	Item description	Absolute Difference	Type of Question	Type of document	Action verb	Other features	Targeted Misconceptions
S052273	Flooding and shortage of water	-100.00%	Open	Text	Action Verb	Not within curriculum	No
S042049B	possible explanation for variation in population size	-86.36%	Open	Table	Action verb	Grade 7 (suspended)	No
S062103B	Effect of intensity of light on rate of photosynthesis	-84.62%	Short-Answer	Text	Action Verb	Grade 7	No
S052085A	Facts about crocodile an adaptation to its environment	-68.42%	Open	Schema	Action Verb	Grade 5	No
S052021	organisms that compete with human	-67.65%	Short answer	Schema	Action verb	Grade 7 (suspended) question unclear, how animals compete with organisms!!	No
S042319	Designing plant growth experiment	-66.67%	Open	Schema	Action Verb	Grade 7	No
S052085B	crocodile: advantage vision	-61.54%	Open	Schema	Action verb	Not within curriculum	No
S052303B	pond: adding more fish	-58.33%	Short answer	Text	Action verb	Grade 7 (suspended)	No

Results showed that 100% (8 questions/8) of the above reasoning items tested students' knowledge on concepts which were not within the Biology curriculum, taught at a lower grade level, or suspended. There was no definite pattern that reflects whether students performed better in the different document types. Also, analysis reflected that when action verbs were used in any type of question (short answer or open ended), students' achievement tended to be the lowest.

The following section describes possible impact of types of questions, types of documents, types of action verbs, and misconceptions on performance.

4.2.3. Other Parameters that Could influence Student Performance in Biology

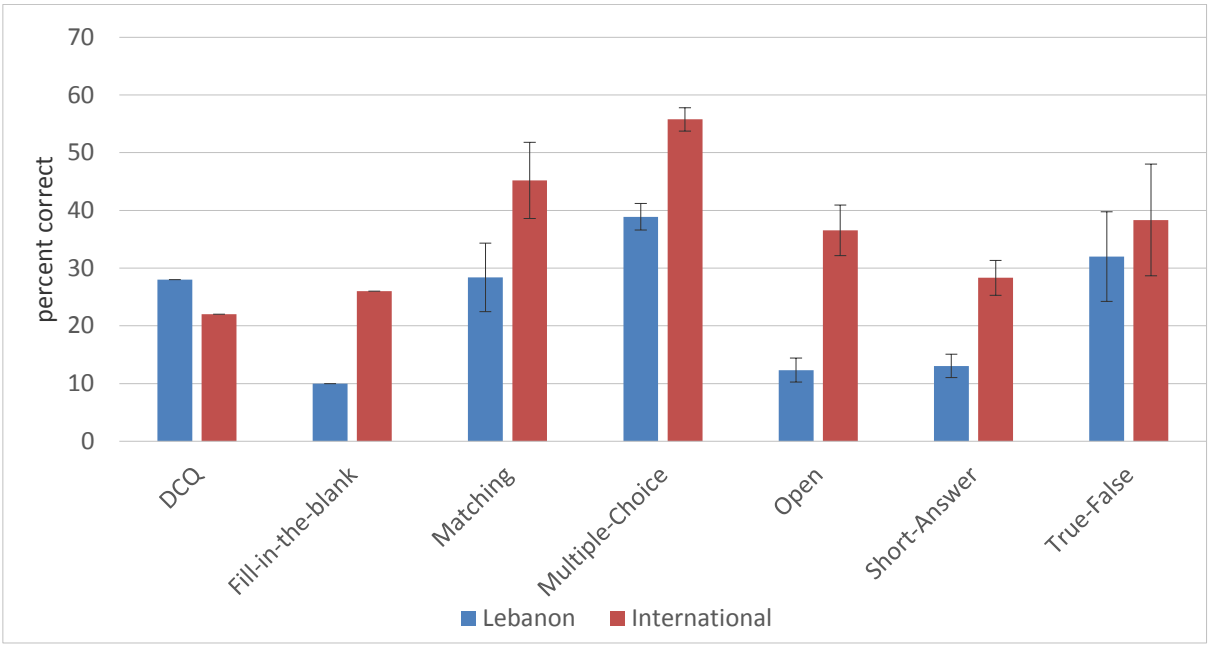
A- Type of Questions

The type of questions asked in TIMSS 2015 took several forms (Table 4.13 and Figure 4.12), the majority being multiple choice questions (47.5%) followed by short answers (23.75%) and open-ended question (16.25%). Results show the variation in performance of students according to the type of questions. Lebanese students tended to perform lower than their international counterparts for these three types of questions. Both Lebanese students and internationally perform highest in MCQs. For the fill in the blanks, DCQ, true-false and matching questions, no comparison was done due to the small sample size sample, although students in Lebanon performed better than their international counterparts when the question type was DCQ (difference of +27.27%).

Table 4.13. Performance in Biology according to Types of Questions in TIMSS Test

Type of question	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
DCQ	1	Mean	28.00	22.00	6.00	.27
		Std. Error				
Fill-in-the-blank	1	Mean	10.00	26.00	-16.00	-.61
		Std. Error				
Matching	5	Mean	28.40	45.20	-16.80	-.39
		Std. Error	5.92	6.58	1.86	.07
Multiple-Choice	38	Mean	38.87	55.76	-16.89	-.31
		Std. Error	2.30	2.03	1.55	.03
Open	13	Mean	12.31	36.54	-24.23	-.67
		Std. Error	2.08	4.39	3.18	.04
Short-Answer	19	Mean	13.05	28.32	-15.26	-.56
		Std. Error	2.04	3.03	1.64	.037
True-False	3	Mean	32.00	38.33	-6.33	-.15
		Std. Error	7.767	9.68	2.603	.04
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.901	1.985	1.097	.027

Figure 4.12. Performance in Biology according to Types of Questions in TIMSS Test



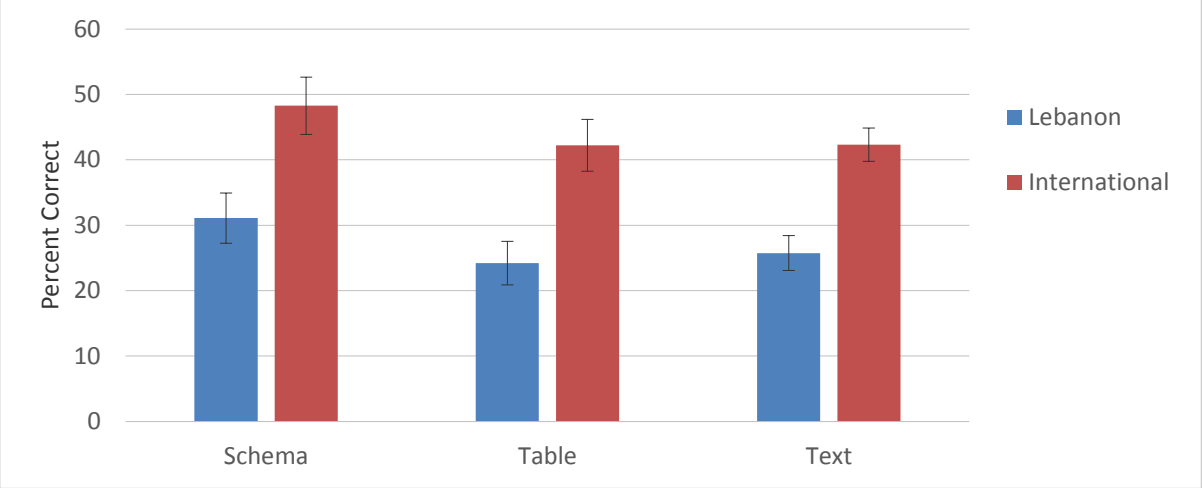
B- Type of Documents

Another parameter to be taken into consideration is the type of document used to analyze a certain question. Findings are revealed in Table 4.14 and Figure 4.13. The types of documents used in TIMSS 2015 items were: Schema, table, and text. Most questions were in the form of text (53.75%) followed by schema (28.75%) then table (17.5%). Results showed that internationally, students performed better than Lebanese students on all types of documents. Moreover, students in Lebanon and internationally performed better in questions presented in schemas (31% and 48% respectively). Results revealed nearly similar performances in the Lebanese sample (less than 2% difference) on questions represented either in tables or texts (24% and 26% respectively). The highest relative change was on questions presented as text (-47%); this observation could be due to a language factor.

Table 4.14. Performance in Biology according to Types of Document in TIMSS Test

Type of document	Number of Test Items	Mean and SE	Leb	Int	Absolute Difference	R.D.
Schema	23	Mean	31.1	48.26	-17.17	-.38
		Std. Error	3.83	4.40	2.04	.05
Table	14	Mean	24.21	42.21	-18.00	-.42
		Std. Error	3.30	3.94	2.93	.06
Text	43	Mean	25.74	42.33	-16.58	-.47
		Std. Error	2.67	2.55	1.47	.04
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.90	1.99	1.09	.03

Figure 4.13. Performance in Biology according to Types of Document in TIMSS Test



C- Type of Action Verbs

The action verb used in asking the question for a given item can also be considered a parameter. The types of questions were classified into "action verbs" or "Wh" questions.

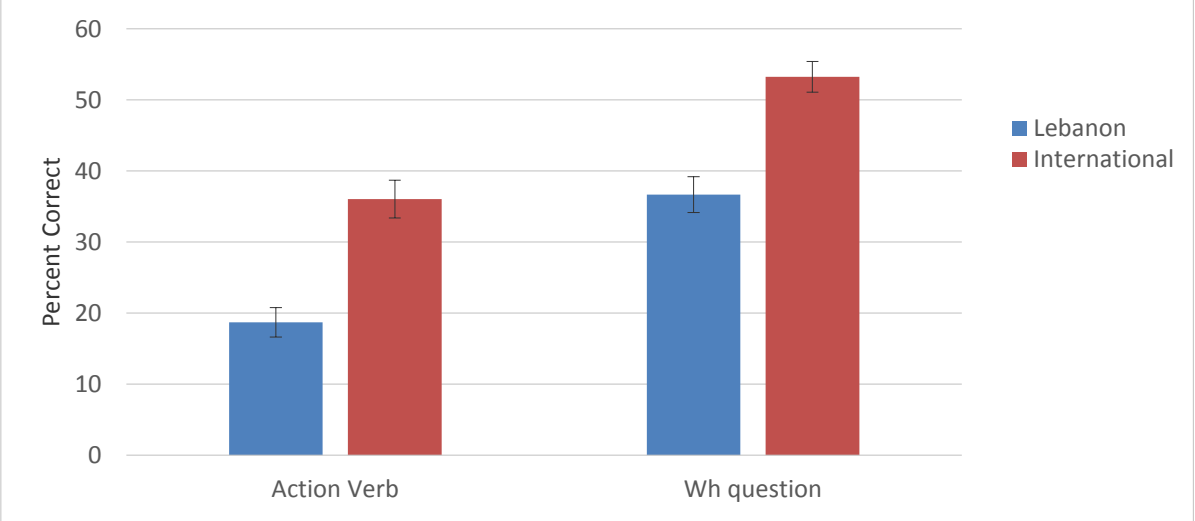
An action verb (e.g. determine, solve, find, calculate...) usually guides the student on the method to be used in answering a question. On the other hand, a "Wh" question (Who, What, When, etc.) doesn't clearly show the method or the action the student needs to take.

Similar to international results, Lebanese students performed the best in "Wh" questions; however, their performance is less than their international counterparts (Figure 4.14). Table 4.15 also shows that the absolute difference between the Lebanese students' percent correct and that of the international is 1.5 times higher for "action verb" questions (-51%) compared to "Wh" questions (-32%). Such results question the validity of Lebanese evaluation system which focus on action verbs in construction test items. Consequently, future research is needed to investigate such unexpected low performance.

Table 4.15. Performance in Biology according to Action Verb used in TIMSS Test

Action Verb	Number of Test Items	Mean and SE	Leb	Int	Absolute Difference	R.D.
Action Verb	43	Mean	18.70	36.05	-17.35	-.51
		Std. Error	2.078	2.659	1.46	.036
Wh question	37	Mean	36.68	53.27	-16.59	-.32
		Std. Error	2.542	2.165	1.68	.03
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.901	1.985	1.09	.027

Figure 4.14. Performance in Biology according to Action Verb used in TIMSS Test



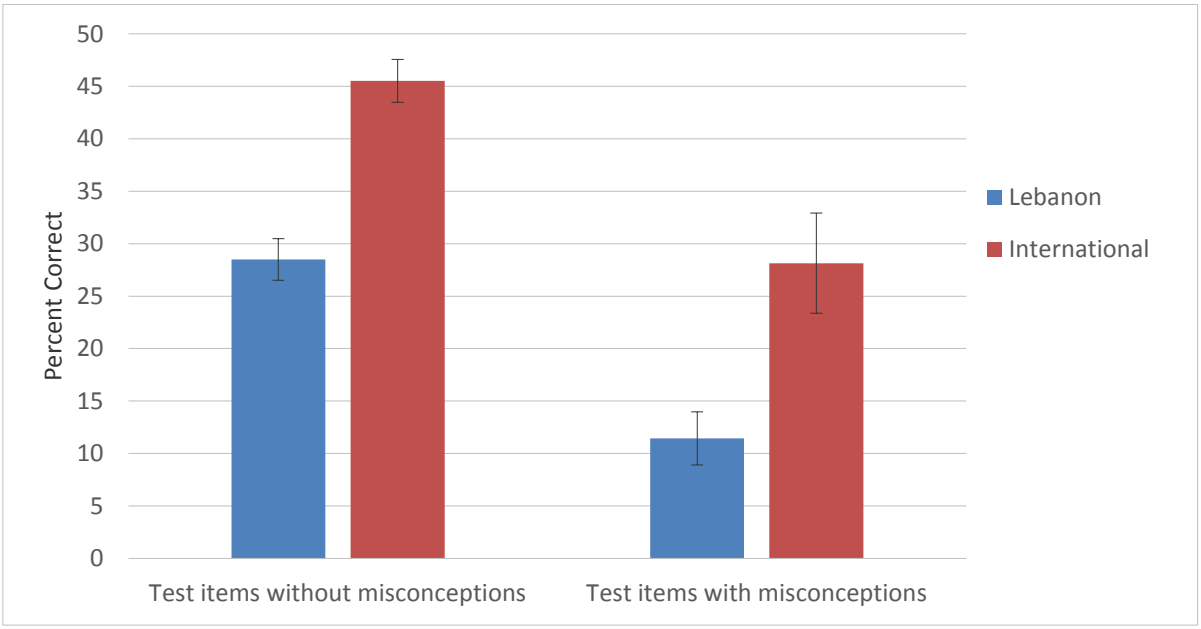
D- Targeting Misconceptions

Table 4.16 shows that only 8.75% of TIMSS test items revealed misconceptions. Results displayed in Figure 4.15 also indicated that percent correct of the questions with misconceptions was lower than the one of questions with no misconception for Lebanon and internationally, which is expected. Further analysis revealed that Lebanese students performed lower than their international counterparts in questions both with and without misconceptions. The relative difference for questions with misconception (-60%), is almost 1.5 times higher than questions with no misconception (-41%) (Table 4.16). The small sample size of the questions revealing misconception necessitates that further research be performed to identify the nature and pattern of misconceptions in students' answers for purpose of generalization.

Table 4.16. Performance in Biology according to whether questions targeted misconceptions in TIMSS Test

Targeted Misconceptions	Number of Test Items	Mean and SE	Leb	Int	Absolute Difference	R.D.
No	73	Mean	28.51	45.53	-17.03	-.41
		Std. Error	1.984	2.05	1.17	.03
Yes	7	Mean	11.43	28.14	-16.71	-.60
		Std. Error	2.543	4.78	3.06	.05
Total	80	Mean	27.01	44.01	-17.00	-.42
		Std. Error	1.901	1.99	1.1	.02

Figure 4.15. Performance in Biology according to whether questions targeted misconceptions in TIMSS Test



Conclusion:

- In Biology, 27% of grade 8 students in Lebanon provided correct answers on the overall test items compared to an average of 44% in other participating countries.
- The percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the six biology topic areas was lower than their international counterparts.
- The greatest difference in performance was in topic III addressing concepts related to life cycles, reproduction, and heredity.
- Grade 8 students in Lebanon outperformed students in the other countries in only two objectives related to Biology which assess student knowledge in identifying organs and organ systems in the human body and comparing them with those in other vertebrates.
- Great deviation in performance from the international mean was highly associated with objectives related to suspended themes or to themes taught in lower grades.
- Grade 8 student performed well on test items related to some biology notions not taught in grade 8 with a relatively small deviation from the international mean.
- In Lebanon and internationally, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question.
- Grade 8 students performed lower in the three cognitive domains (Knowing, Applying, and Reasoning) compared to students internationally.
- Students' performance in D1 was higher than their performance in D2 for both Lebanon and internationally.
- Internationally, the percentage of students who correctly answered test items was 1.5 times and 2 times higher than the percentage of Lebanese students who answered correctly the same D1 and D2 test items respectively.
- Students usually performed lowest on Knowing when the document type was text.
- Students did not perform well on all types of documents (Text, Table, or Schema).

- The lowest performance was observed when "Wh" questions were used.
- Students' achievement remained low when action verbs were used irrespective of the type of question (short answer, open, or multiple choice).
- There was no definite pattern that reflects whether students performed better in the different document types.
- When action verbs were used in any type of question (short answer or open ended), student achievement tended to be the lowest.
- Lebanese students tended to perform lower than their international counterparts for MCQ, short answer, and open-ended questions.
- Both Lebanese students and internationally performed highest in MCQs.
- Internationally, students performed better than Lebanese students on all types of documents.
- Results revealed nearly similar performances in Lebanon on questions represented either in tables or texts. The highest relative change was on questions presented as text.
- Only 8.75% of Biology TIMSS test items revealed misconceptions.
- The percent correct of questions targeting misconception was lower than the one of questions with no misconception for Lebanon and internationally.
- Lebanese students perform lower than their international counterparts in questions with and without misconceptions.

4.3 Achievement of Grade 8 Students in Earth Science

This section summarizes findings that link Grade 8 students' performance in Earth Science with several parameters that could help in analyzing TIMSS 2015 Earth Science test items in a more comprehensive manner. Since students in Lebanon study Biology and Earth Science as one science subject, a comparison with data from Grade 8 student achievement in Biology is also discussed when necessary.

4.3.1. Curriculum matching and alignment of TIMSS Test Items with Lebanese Earth Science Curriculum

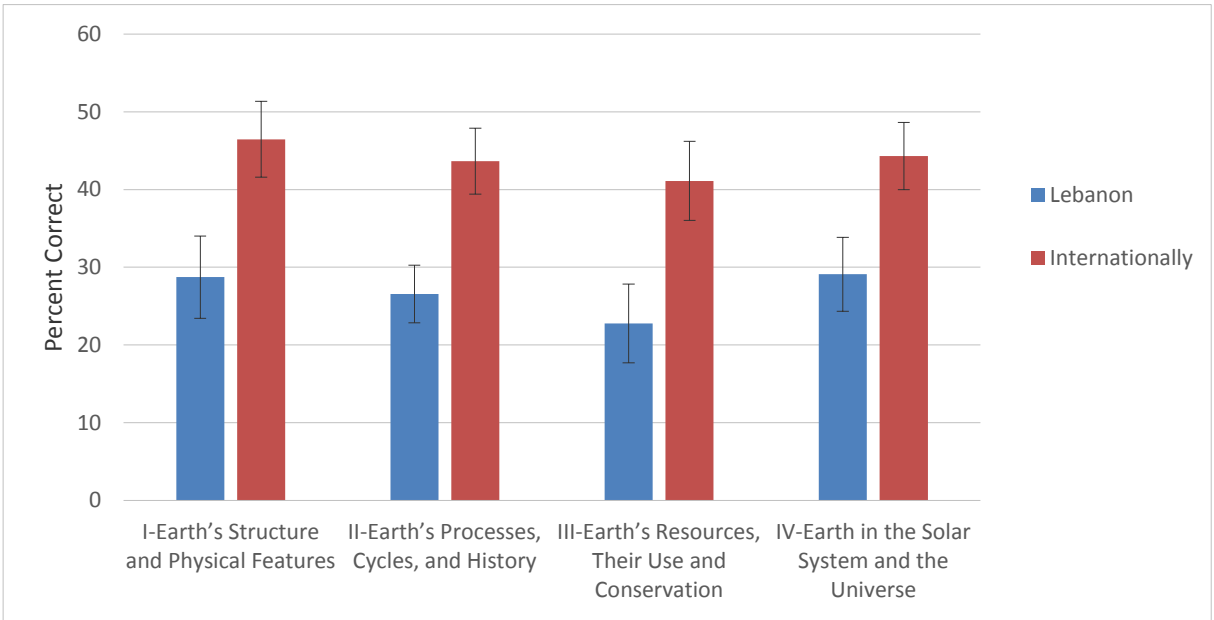
4.3.1.A. Alignment with Topic area and grade level

TIMSS findings reveal that 26.7% of grade 8 students in Lebanon provide correct answers on the overall test items compared to a percent correct of 43.5% in the other participating countries (Table 4.17). Results also show that the percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the four topic areas was always lower than their international counterparts (Table 4.17 and Figure 4.16), with a difference ranging from -36% to -46%. Results also show that the highest relative change (-46%) was in topic III addressing concepts related to earth's resources, their use and conservation. Also, 8th graders in Lebanon performed poorly on test items related to topic II about earth's processes, cycles, and history (-43%) and topic I on earth's structure and physical features (-40%).

Table 4.17. A Comparison of Grade 8 student performance in the different Earth Science topic areas in Lebanon and Internationally

Topic area	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
I-Earth's Structure and Physical Features	11	Mean	28.73	46.45	-17.73	-.40
		Std. Error	5.281	4.88	3.57	.08
II-Earth's Processes, Cycles, and History	14	Mean	26.57	43.64	-17.07	-.43
		Std. Error	3.70	4.23	2.17	.053
III-Earth's Resources, Their Use and Conservation	9	Mean	22.78	41.11	-18.33	-.46
		Std. Error	5.07	5.09	3.43	.09
IV-Earth in the Solar System and the Universe	11	Mean	29.10	44.30	-15.20	-.36
		Std. Error	4.76	4.33	2.76	.06
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.24	1.41	.03

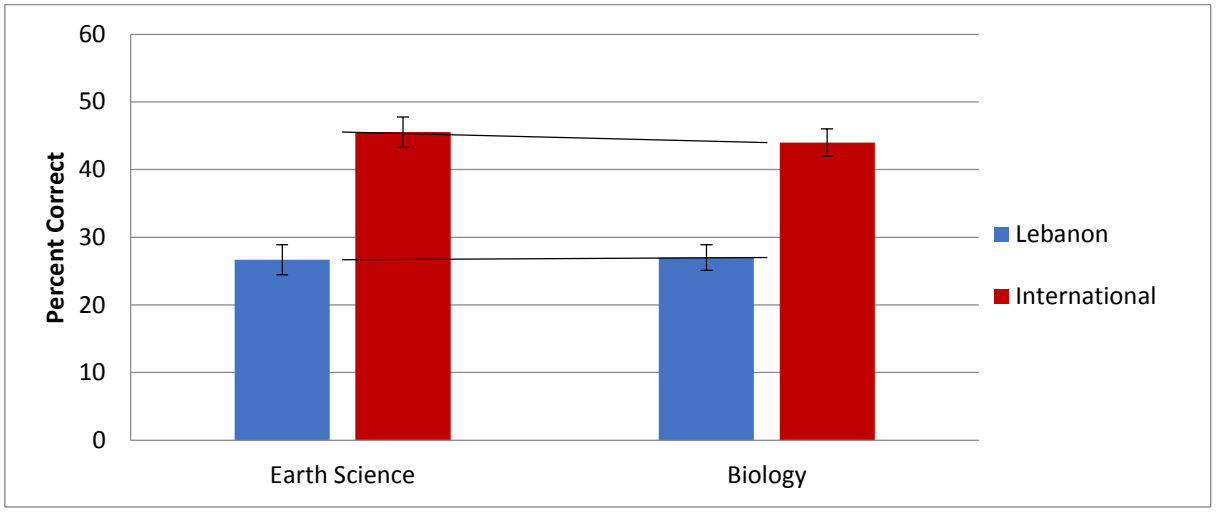
Figure 4.16. A Comparison of Grade 8 student performance in the different Earth Science topic areas in Lebanon and Internationally



Moreover, Table 4.17 reveals that the highest relative change (46.13%) was in topic III addressing concepts related to the use and conservation of earth's resources, where students in Lebanon registered the lowest performance (22.78%); such an observation is expected since this topic is a suspended theme in the Lebanese curriculum. Also, 8th graders in Lebanon registered the highest percent of correct answers on test items related to topic I and IV about earth's structure and physical features, and earth in the solar system (less than 1% difference), while the highest percent of items answered correctly for international counterparts was documented for topic II on Earth's processes, cycles, and history (43.64%). It is worth noting that topic IV is a unit of science curriculum in grade 6 and is rarely taught due to time shortage. This high performance observed could be explained by the fact that students study this unit in depth in geography in grades 7 and 8 and in their native language (Arabic).

Interestingly, the relative change in Earth science (-41.29%) is nearly the same compared to that for Biology (-42.38%). Additionally, results revealed that the difference in performance of Lebanese students in Earth Science (26.67%) and in Biology (27.01%) is less than 1% and only about 1 scale point apart. This observation was replicated at the international level (Figure 4.17).

Figure 4.17. A Comparison of Grade 8 overall student performance in the Earth Science and Biology in Lebanon and Internationally



Explanation discussed above was reinforced with evidence presented in Table 4.18 which reveals the largest discrepancy between student performance in Lebanon and internationally for items not taught in the Lebanese curriculum (47.61%). Although Grade 8 students in both Lebanon and internationally performed better in items that were present in the Lebanese curriculum but suspended (31.67% and 49.67% respectively), the relative change compared to TIMSS items taught within the Earth Science curriculum was nearly the same (0.29% difference). This finding needs to be further investigated, as to when objectives were 'suspended', if they were taught in earlier years, the cognitive level or type of items, etc. With the evident differences in performance between Lebanon and other countries in all three categories, additional analysis needs to be done to explore possible correlations since the sample size of test items in each category was vastly different. Results obtained raise major issues related to language of instruction, teachers' pedagogy, and instructional media applied in science and geography classroom instruction.

Table 4.18. TIMSS Items and Lebanese Earth Science Curriculum (Grades 1-12)

Categories of topics (suspended, not suspended, not within curriculum)	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
TIMSS test items taught in the Lebanese earth science curriculum	27	Mean	27.56	43.67	-16.11	-.39
		Std. Error	3.032	2.96	1.95	.046
TIMSS test items present in the curriculum but suspended	6	Mean	31.67	49.67	-18.00	-.39
		Std. Error	6.57	6.70	2.63	.08
TIMSS test items not within the Lebanese earth science curriculum	12	Mean	22.17	40.17	-18.00	-.47
		Std. Error	3.55	4.01	2.75	.06
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.243	1.41	.03

Nevertheless, further analysis was done to explore the grade level(s) where TIMSS Earth Science test item are taught in the Lebanese curriculum and the extent to which teaching affects student performance.

Table 4.19. : Performance of Lebanese Students and Internationally by Grade Level and Earth Science Topics Taught

Grade levels where TIMSS items are taught in Lebanon	Number of TIMSS test items	Average percent correct in Lebanon	Average percent correct internationally	Absolute Difference	R.D.
Grades 4-5-6-7	22	29.27	44.32	-15.05	**-35.41%**
Grade 8	7	21.71	41.71	-20.00	**-50.64%**
Grades 9-10-11-12	4	34.50	52.50	-18.00	**-38.32%**
Not within Earth Science curriculum	12	22.17	40.17	-18.00	**-47.61%**
Total	45	26.67	43.53	-16.87	**-41.29%**

Unlike data pertaining to Biology, Table 4.19 reveals that Grade 8 students tested on Earth Science topics tended to answer incorrectly compared to their peers from different grade levels (difference of 7.5% compared with Grade<8 and 12.8% compared with Grade>8). Also, the difference in students' performance was less than 0.5% compared to their achievement on items that were not covered in the Earth Science curriculum. In addition, the percentage of correct items in Lebanon for Grade 8 students was two times lower compared to international counterparts (absolute difference accounts for -20%), with achievement being highest for the content taught in secondary grade levels (Grades 9-12) in Lebanon and internationally, although number of items in this category is small (N=4).

The high percentage of students who provided correct answers when tested in topics taught at either a higher level (34.5%) or at lower level (29.27%) but not in grade 8 (21.71%) may draw on several factors:

(a) a low level of student retention of learned concepts taught before grade 8; such a proposition could be due to classroom instruction which favors memorization. This necessitates a change in teaching practices and application of strategies and techniques that foster long retention of studied concepts.

(b) 22.14% of grade 8 Lebanese students were able to correctly answer TIMSS questions that were not within the Lebanese Earth Science curriculum (around 0.5% higher than the percentage of G8 students who answered correctly test items within their curriculum). This percentage could have three possible explanations:

(1) learning could have been acquired from informal sources outside the classroom, mainly from TV, internet, parents, etc.

(2) students answered the questions, particularly MCQs, by guessing

(3) students relied on what they have studied about the topic in different subjects (e.g. geography) at the different grade levels

In addition to advocating for a thorough analysis of scope and sequence, these findings call for the addition to TIMSS test items that cover important concepts taught within the context of the Lebanese earth science curriculum in order to better compare performances with the international counterparts, since one could question the trustworthiness and, in particular, the fairness and reliability of TIMSS results otherwise.

Alternatively, a more viable recommendation would be to have the Lebanese curriculum better aligned with the international global standards.

4.3.1.B. Alignment with Objectives

An extensive analysis of TIMSS items in relation to objectives of the four topic areas was done (Appendix 4.3.I). Additionally, some possible explanations, derived from comparison with the objectives of the Lebanese curriculum, were provided for test items with a large difference in achievement between 8th graders in Lebanon and their international counterparts.

Findings revealed that Grade 8 students in Lebanon could not outperform students in the other countries in any of the objectives related to Earth Science. The deviation in performance from the international mean ranging from (-10.00% to -96.77%) was mainly associated with objectives studied at different grade levels (e.g. III-2-A, percentage difference -96.77%), in different subjects (e.g. II-3-B, percentage difference -54.88%), or related to suspended themes (e.g. II-1-C, percentage difference -46.51%). A similar result was evident for objectives related to concepts taught at a lower grade levels (grades 5 and 6). Surprisingly, Grade 8 student performed well in test items related to some Earth Science notions that are not taught in grade 8 with a relatively small deviation from the international mean (e.g. I-1-C, percentage difference 13.16%).

4.3.2 Grade 8 Student Performance in the different Cognitive Domains-Earth Science

Table 4.20 and Figure 4.18 show that in Lebanon, as is the case internationally, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question, the percentage being the lowest in Reasoning and highest in Knowing.

Moreover, results show that grade 8 students performed lower in the three cognitive domains: Knowing, Applying, and Reasoning, compared to students internationally, with grade 8 students in Lebanon being way behind the international average in reasoning (-60.42%) compared to the other two domains: knowing and applying.

Table 4.20. Performance in different Cognitive Level in Lebanon and Internationally

Cognitive Level	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
Knowing	14	Mean	33.00	49.05	-16.05	-.32
		Std. Error	2.925	2.68	2.21	.042
Applying	22	Mean	25.36	42.57	-17.21	-.42
		Std. Error	3.52	4.382	2.20	.04
Reasoning	9	Mean	13.22	31.56	-18.33	-.60
		Std. Error	3.88	4.056	3.20	.08
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.24	1.41	.03

Figure 4.18. Average percent correct by TIMSS Cognitive Domains in Lebanon and Internationally

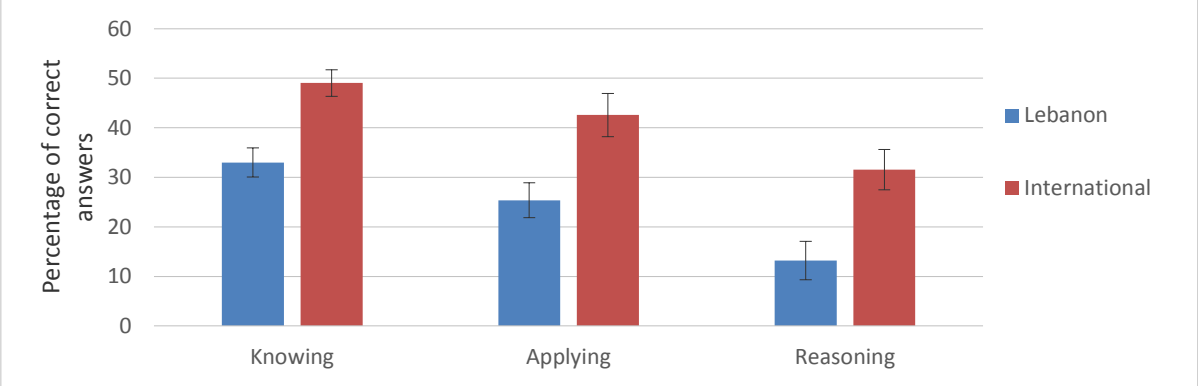
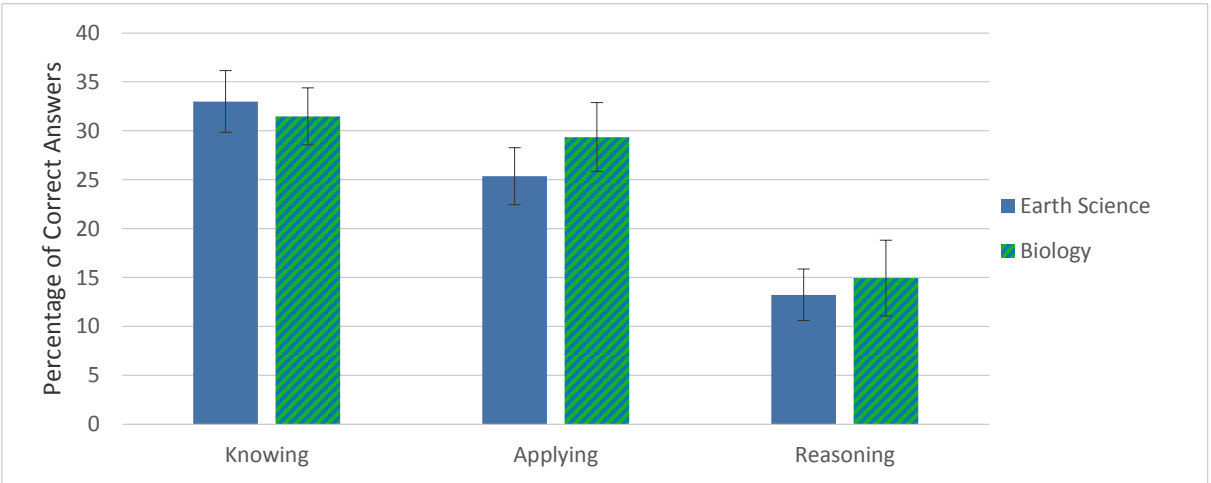


Figure 4.19 shows that in Lebanon, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question for both Earth Science and Biology, although the difference between performance on Knowing and Applying items was more prominent in Earth Science. A comparison between grade 8 student performances in both disciplines also revealed that while students tend to perform 1.5% better in Earth Science, their performance was higher in Biology for both Applying and Reasoning cognitive domains (absolute difference of 4% and 1.72% respectively), but not significantly different on the three domains as comparison of the standard errors revealed overlap.

Figure 4.19. A comparison of the percentage of correct answers per cognitive domain in Lebanon for both Earth Science and Biology



Analysis of TIMSS test items was done in the context of the competencies-based evaluation domains adopted in Lebanon (previously described under biology section).

Table 4.21 and Figure 4.20 show a comparison of Lebanon's and the international performance according to the Lebanese Cognitive domains. Comparison in D3 was not calculated since this domain is not present as a separate category in the identification of the cognitive domains of the TIMSS test items.

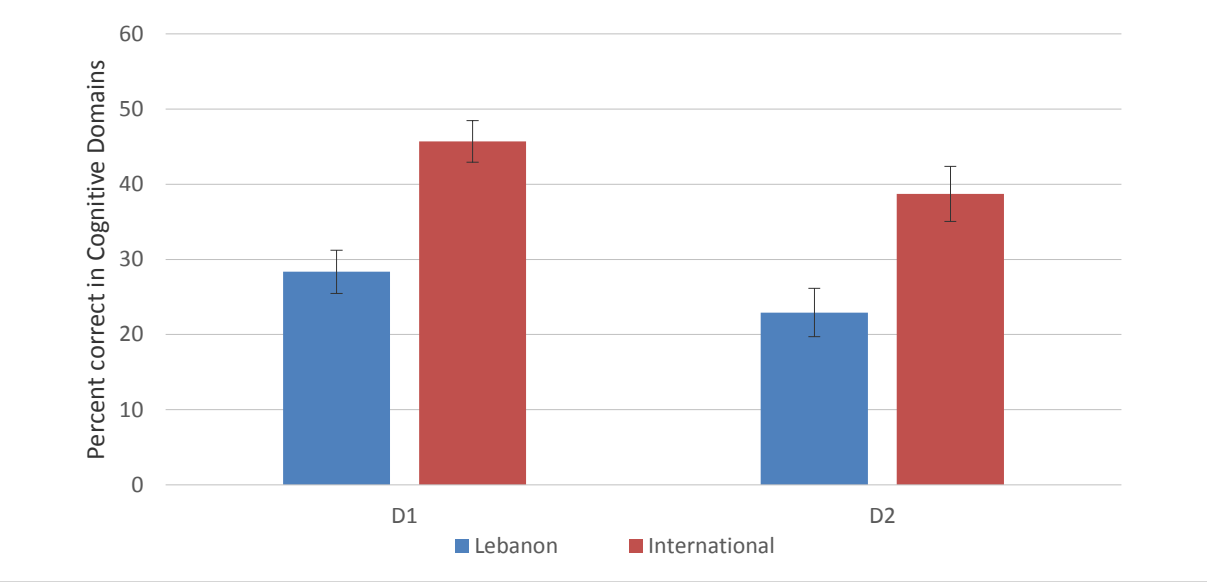
Results show that students' performance in D1 is higher than their performance in D2 for both Lebanon and internationally. Moreover, internationally, the percentage of students (45.71%) who answered correctly test items in D1 is 1.6 times higher than the percentage

of Lebanese students who answered correctly the same test items (28.35%). This difference is approximately the same for D2.

Table 4.21. Performance of Students in TIMSS according to different Cognitive Domains in Lebanon and Internationally

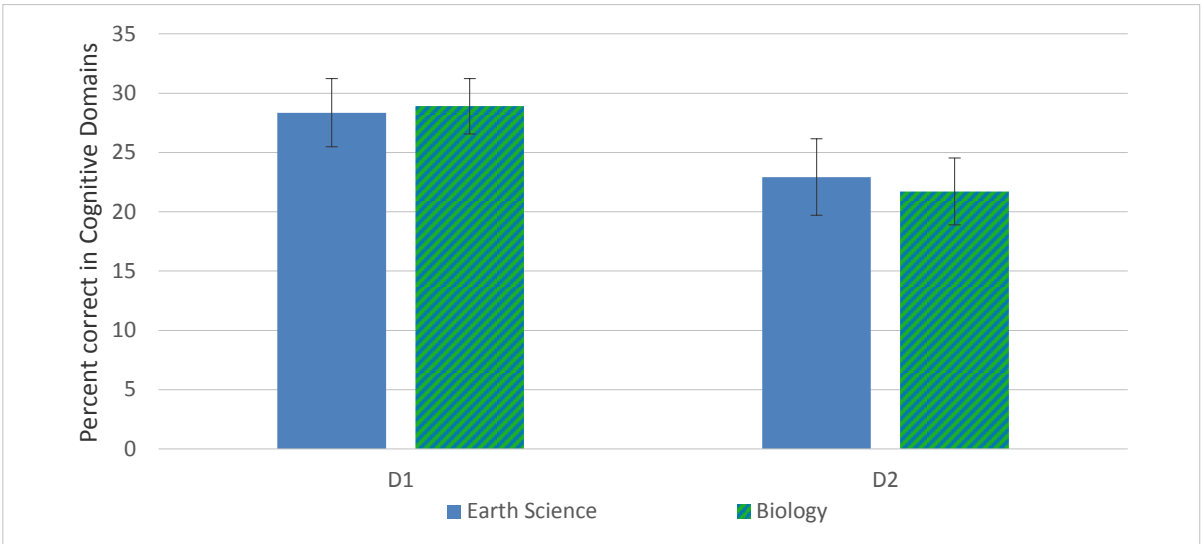
Cognitive Domain	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
D1	31	Mean	28.35	45.71	-17.35	-.40
		Std. Error	2.87	2.76	1.81	.043
D2	14	Mean	22.93	38.71	-15.79	-.43
		Std. Error	3.22	3.65	2.16	.05
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.24	1.41	.03

Figure 4.20. Performance of students in TIMSS according to different cognitive domains in Lebanon and internationally



Results show that students' performance in D1 is higher than their performance in D2 for Earth Science and Biology. However, there was less than 1.5% difference between the performances between the two disciplines for both Lebanese cognitive domains (Figure 4.21), but the difference was not significant as revealed by overlapping standard errors of measurement.

Figure 4.21. A comparison of student performance according to the Lebanese cognitive domains for Earth Science and Biology



To further identify TIMSS test items where there is a big difference between grade 8 students' performance in Lebanon and internationally, we have calculated the average of relative change for each cognitive domain to be our reference point.

A- Item Analysis: Knowing

The average percentage change of student performance (Lebanese and International) in the knowing domain is equal to 32.81%. Table 4.23 below shows the test items with percent change greater than this average with a detailed description of each item (for more details, see appendix 4.3.II).

Table 4.23. Items in Knowing Domain with descriptions

TIMSS Item Number	Item description	Absolute Difference	Type of Question	Type of document	Action verb	Other features	Targeted Misconceptions
S042135	Process of water cycle	-56.36%	Fill-in-the-blank	Table	Action Verb	Grade 5	Yes
S042164	Effect of gravitational pull on moon on Earth	-70.45%	Multiple-Choice	Text	Wh Question	Grade 6	No
S042217	Shadow of tree on sunny day	-56.82%	Multiple-Choice	Text	Wh Question	Grade 6	No
S042301	What causes an earthquake	-69.39%	Short-Answer	Text	Wh Question	Grade 8	No
S052294	Temperature outside an airplane	-57.38%	Multiple-Choice	Schema	Wh Question	Not related to any objective in curriculum	No
S062170	Evidence of earth continents movement	-42.19%	Multiple-Choice	Text	Wh Question	Grade 8	No

TIMSS Item Number	Item description	Absolute Difference	Type of Question	Type of document	Action verb	Other features	Targeted Misconceptions
S062177	Formation of oil	-46.51%	Multiple-Choice	Text	Wh Question	Grade 8 (suspended)	No
S062189	Advantages of recycling paper on environment	-42.42%	Multiple-Choice	Text	Action Verb	Grade 6 (superficial notion, recycling is not well discussed)	No
S062235	Negative effect of fertilizers	-35.56%	Multiple-Choice	Text	Wh Question	Grade 7 (suspended)	No

Results showed that 77.8% (7 questions/9) of the above Knowing items test student knowledge on concepts which are not in their Earth Science curriculum, taught at a different grade level, or suspended. Comparison of performance with the different types of documents was not possible due to discrepancy in the sample size of test items.

B- Item Analysis: Applying

The reference point for this analysis is the average of percentage change in the applying domain (42.33%). Table 4.24 below shows the test items with percent change greater than this average with a detailed description of each item (for more details, see appendix 4.3.III).

Table 4.24. Items in the Applying Domain with descriptions

TIMSS Item Number	Item description	Absolute Difference	Type of Question	Type of document	Action verb	Other features	Targeted Misconceptions
S052289C	Artesian water; temperature	-75.00%	Open	Text	Action Verb	Grade 10 (suspended)	No
S062024B	Shaping rock formation	-72.22%	Short-Answer	Schema	Action Verb	Grade 8	No
S042406	Direction of river flow	-54.84%	Short-Answer	Schema	Action Verb	Not within curriculum (taught in geography)	Yes
S062180	Melting permafrost	-50.00%	Multiple-Choice	Text	Wh Question	Not within curriculum (taught in geography)	No
S062173A	Climate and geography of two cities	-44.19%	Multiple-Choice	Schema	Wh Question	Not within curriculum (taught in geography)	No

Results showed that 80% (4 questions/5) of the above applying items test student knowledge on concepts which are either not in their Earth Science curriculum or suspended. There is no definite pattern that reflects whether students perform better in the different document types. Also, analysis reflects that when action verbs or "Wh" questions were used in any type of question (short answer, open, or multiple choice),

students' achievement still remained low, probably because of unfamiliarity with the material.

C- Item Analysis: Reasoning

The reference point for this analysis is the average of percentage change in the reasoning domain which is 60.42%. Table 4.25 below shows the test items with percentage change greater than this average with a detailed description of each item (for more details, see appendix 4.3.IV).

Table 4.25. Items in the Reasoning Domain with descriptions

TIMSS Item Number	Item description	Absolute Difference	Type of Question	Type of document	Action verb	Other features	Targeted Misconceptions
S052101	Eruption of volcanoes	-78.79%	Short-Answer	Text	Action Verb	Grade 8	No
S052116	Advantages of long roots in soil	-96.77%	Short-Answer	Text	Action Verb	Grade 6	No
S062175	Power plant geographic factor	-83.33%	Short-Answer	Text	Action Verb	Not within curriculum (not well stated in TIMSS objectives)	No
S062211B	Climate data are wrong	-77.78%	Open	Schema	Action Verb	Not within curriculum (taught in geography)	No
S062243	Animals and habitat	-63.41%	Matching	Schema	Action Verb	Not within curriculum (taught in geography)	No

Results showed that 80% (4 questions/5) of the above reasoning items test student knowledge on concepts which are either not in their Earth Science curriculum or taught at a different grade level. There is no definite pattern that reflects whether students perform better in the different document types. Also, analysis reflects that when action verbs were used in any type of question (short answer, open, or matching), students' achievement tend to be the lowest.

The following section describes possible impact of types of questions, types of documents, types of action verbs, and misconceptions on performance.

4.3.3. Other Parameters that Could influence Student Performance in Earth Science

A- Type of Questions

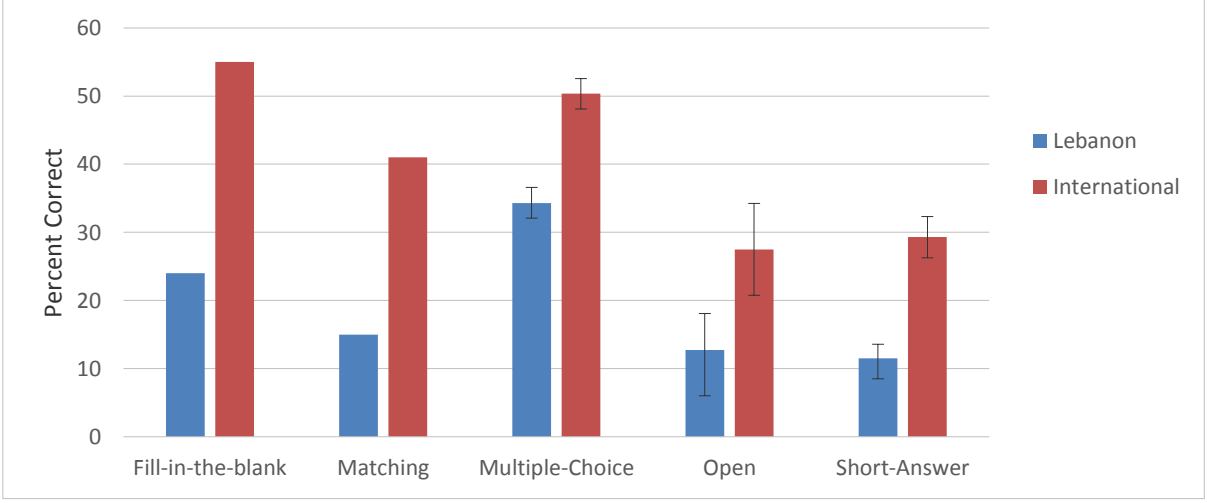
The type of questions asked in TIMSS 2015 take several forms (Table 4.26 and Figure 4.22). The majority being multiple choice questions (64.44%) followed by short answer questions (22.22%). Results show the variation in performance of students according to

the type of questions. Lebanese students tend to perform lower than their international counterparts on all types of questions. Lebanese students perform highest in MCQs and lowest on the short answer type. For the fill in the blanks, matching, and open questions, no comparison was done due to the small sample size sample. All differences were non-significant due to the overlapping standard errors of measurement.

Table 4.26. Performance in Earth Science according to Types of Questions in TIMSS Test

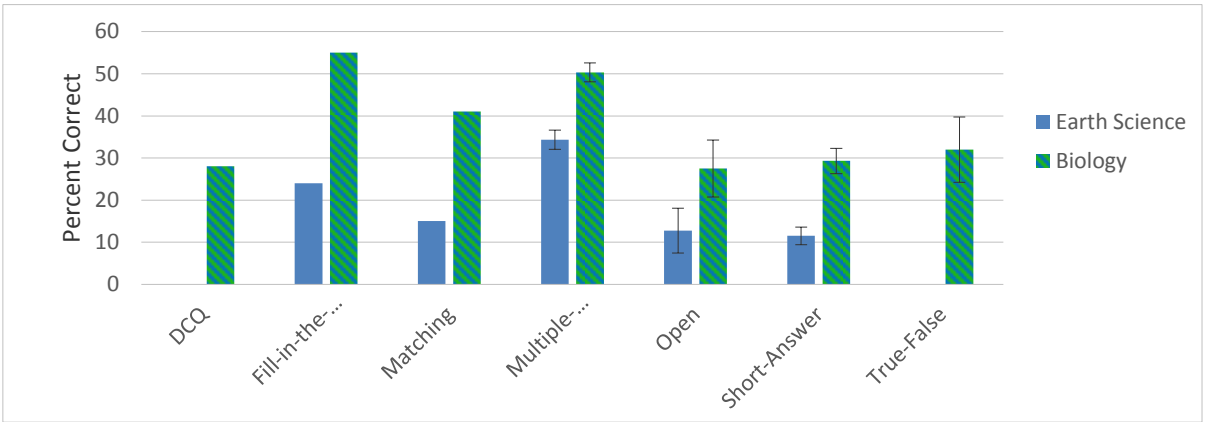
Type of question	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
Fill-in-the-blank	1	Mean	24.00	55.00	-31.00	-.5636
		Std. Error				
Matching	1	Mean	15.00	41.00	-26.00	-.6341
		Std. Error				
Multiple-Choice	29	Mean	34.31	50.34	-16.03	-.3204
		Std. Error	2.269	2.236	1.688	.0310
Open	4	Mean	12.75	27.50	-14.75	-.5923
		Std. Error	5.344	6.739	3.497	.1047
Short-Answer	10	Mean	11.50	29.30	-17.80	-.5722
		Std. Error	2.078	3.019	3.546	.0836
Total	45	Mean	26.67	43.53	-16.87	-.4129
		Std. Error	2.227	2.243	1.407	.0336

Figure 4.22. Performance in Earth Science according to Types of Questions in TIMSS Test



A comparison between Earth Science and Biology shows that there are two types of questions present in Biology but not in Earth Science (DCQ and True-False). However, the major type of question in TIMSS was multiple choice for both disciplines. Figure 4.23 compared the variation in performance of students according to the type of questions in Earth Science and Biology. G8 Lebanese students tend to perform lower in Earth Science than in Biology for all types of questions probably due to the fact that biology is emphasized in the Lebanese science curriculum more than Earth Science. Results also showed that students performed highest in MCQs. For DCQ, fill in the blanks, matching, open questions, and true-false, no conclusion could be drawn due to the small size sample.

Figure 4.23. A comparison of student performance according to types of questions in TIMSS for Earth Science and Biology



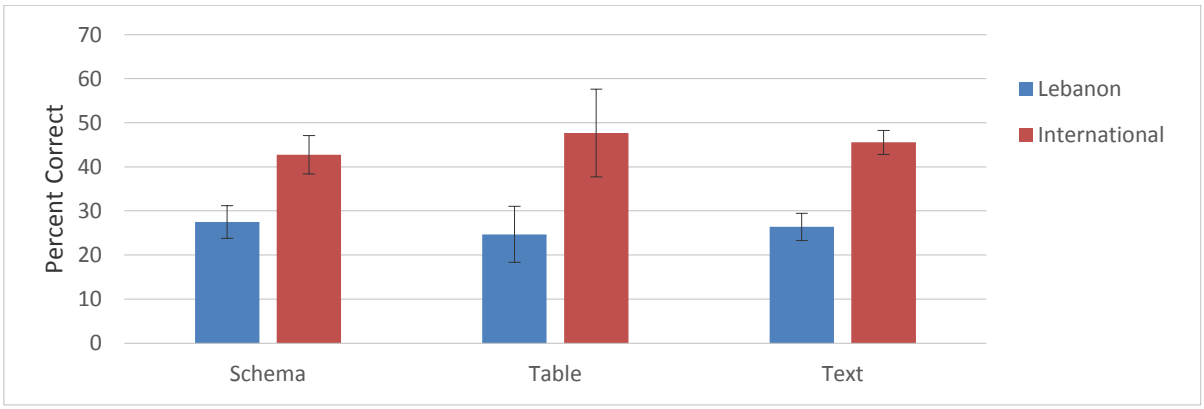
B- Type of Documents

Another parameter to be taken into consideration is the type of document used to analyze a certain question. Findings are shown in Table 4.27 and Figure 4.24. The types of documents used in TIMSS 2015 items were: Schema, table, and text. Most questions were in the form of text (57.8%) followed by schema (35.6%) then table (6.7%). Results showed that internationally, students performed better than Lebanese students in all types of documents. Moreover, while students internationally performed best in questions presented in tables (47.67%), students in Lebanon performed highest when items were presented as either schemas or text (27.5% and 26.38% respectively). Similarly, the international averages of performance in schemas and text was less than 1.2% different.

Table 4.27. Performance in Earth Science according to Types of Document in TIMSS Test

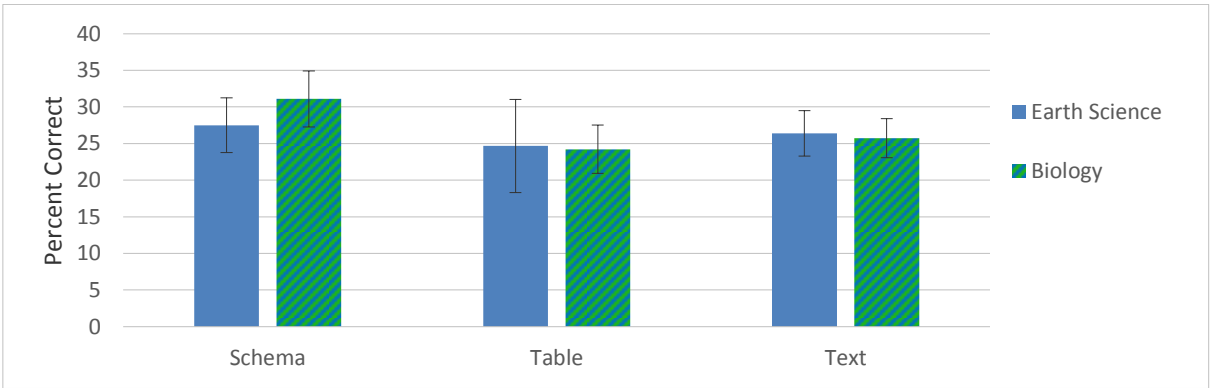
Type of document	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
Schema	16	Mean	27.50	42.75	-15.25	-.39
		Std. Error	3.72	4.38	2.01	.050
Table	3	Mean	24.67	47.67	-23.00	-.488
		Std. Error	6.36	9.94	4.93	.048
Text	26	Mean	26.38	43.54	-17.15	-.41
		Std. Error	3.09	2.69	2.02	.049
Total	45	Mean	26.67	43.53	-16.87	-.413
		Std. Error	2.23	2.24	1.41	.034

Figure 4.24. Performance in Earth Science according to Types of Documents in TIMSS Test



The types of documents used in TIMSS 2015 items were: Schema, Table, and Text for both Biology and Earth Science. In both disciplines most questions were in the form of Text. Schemas and tables were less frequently used. A comparison of student performance according to type of document used revealed a 13.1% increase in percent correct answers for Biology compared to Earth Science when TIMSS items were presented in the form of Schemas. On the other hand, student performance was almost the same when test items were in the form of table or text (Figure 4.25).

Figure 4.25. A comparison of student performance according to types of documents in TIMSS for Earth Science and Biology



C- Type of Action Verbs

The action verb used in asking the question for a given item can also be considered a parameter. The types of questions were classified into "action verbs" or "Wh" questions.

An action verb (e.g. determine, solve, find, calculate...) usually guides the student on the method to be used in answering a question. On the other hand, a "Wh" question (Who, What, When, etc.) doesn't show clearly the method or the action the student needs to take.

Similar to international results, Lebanese students performed better in "Wh" questions; however, their performance is 1.5 times less than their international counterparts and 2.5 times higher than their performance in "Action verbs". Although the absolute difference between the Lebanese students' percent correct and average performance in other countries is only 0.2% apart comparing the two types of questions, students internationally tend to do 55.39% better for "action verbs" questions (Table 4.28 and Figure 4.26).

Table 4.28. Performance in Earth Science according to Action Verb used in TIMSS test

Action Verb	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D.
Action Verb	15	Mean	13.40	30.13	-16.73	-.55
		Std. Error	2.30	2.87	2.61	.06
Wh question	30	Mean	33.30	50.23	-16.93	-.34
		Std. Error	2.33	2.19	1.69	.03
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.24	1.41	.03

Figure 4.26. Performance in Earth Science according to Action Verb used in TIMSS test

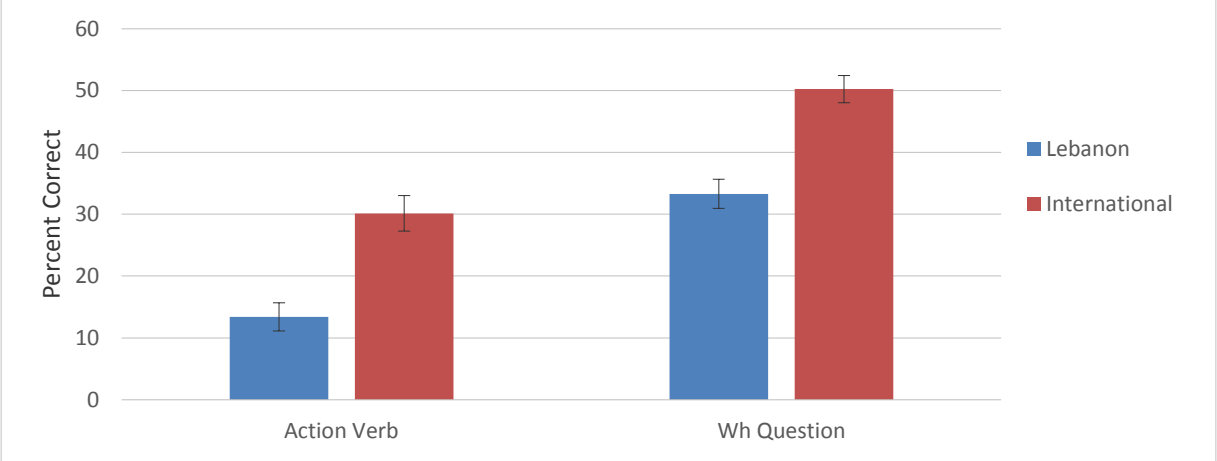
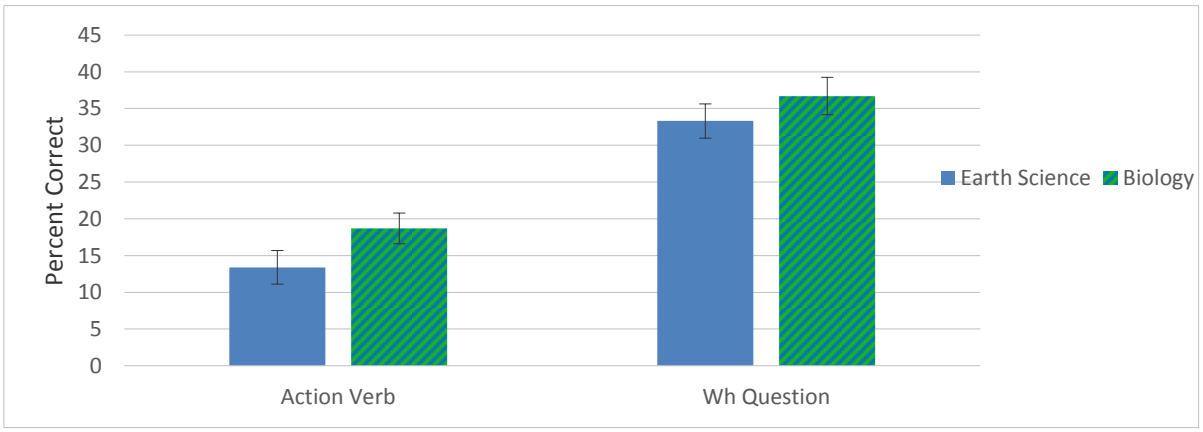


Figure 4.27 revealed that, similar to Biology, Lebanese students performed better in "Wh" questions in Earth Science and at least two times higher than their performance in "Action verbs". Such results question the validity of Lebanese evaluation system which focus on action verbs in construction test items. Consequently, future research is needed to investigate such unexpected low performance. Moreover, results showed that students were more likely to perform better in Biology relative to Earth Science whether "Wh" questions or "Action Verbs" were used (relative difference of 10.15% and 39.5% respectively). This difference can be explained by the fact that biology is more emphasized in the science curriculum than Earth Science.

Figure 4.27. A comparison of student performance according to Action Verb and Wh Question used in TIMSS for Earth Science and Biology



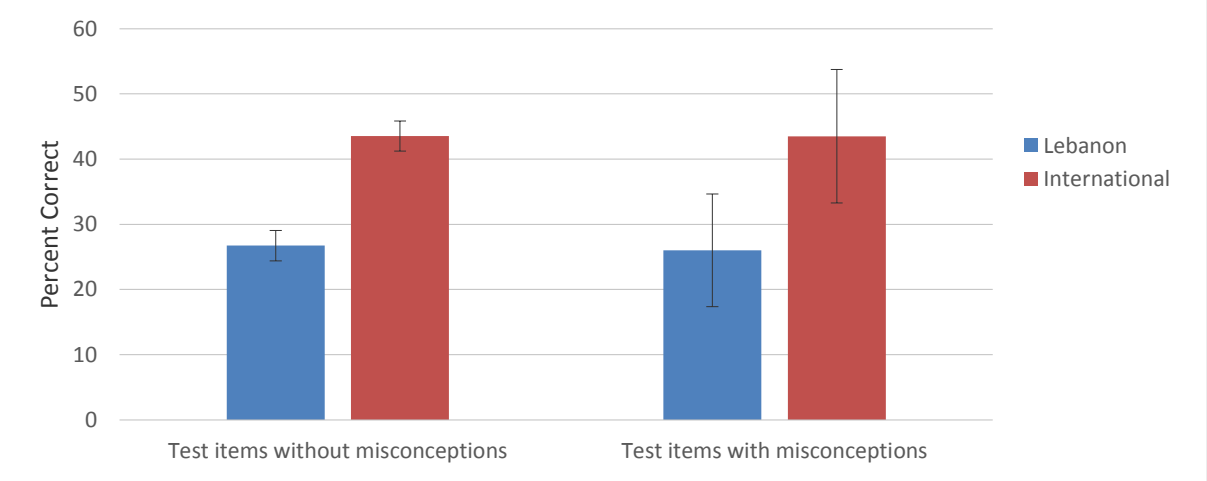
D- Targeting Misconceptions

Table 4.29 shows that only 9% of TIMSS test items reveal misconceptions. Results displayed in Figure 4.28 also indicate that percent correct of the questions with misconceptions is approximately the same as the questions with no misconceptions for Lebanon and internationally (less than 1% different), which is interesting to note. The relative difference for questions with misconception (-41.44%) is approximately the same as that for items that do not target misconception (-41.28%) (Table 4.29). The small sample size of the questions revealing misconception necessitates that further research be performed to identify nature and pattern of misconceptions in students' answers for purpose of generalization.

Table 4.29. Performance in Earth Science according to whether questions targeted misconceptions in TIMSS test

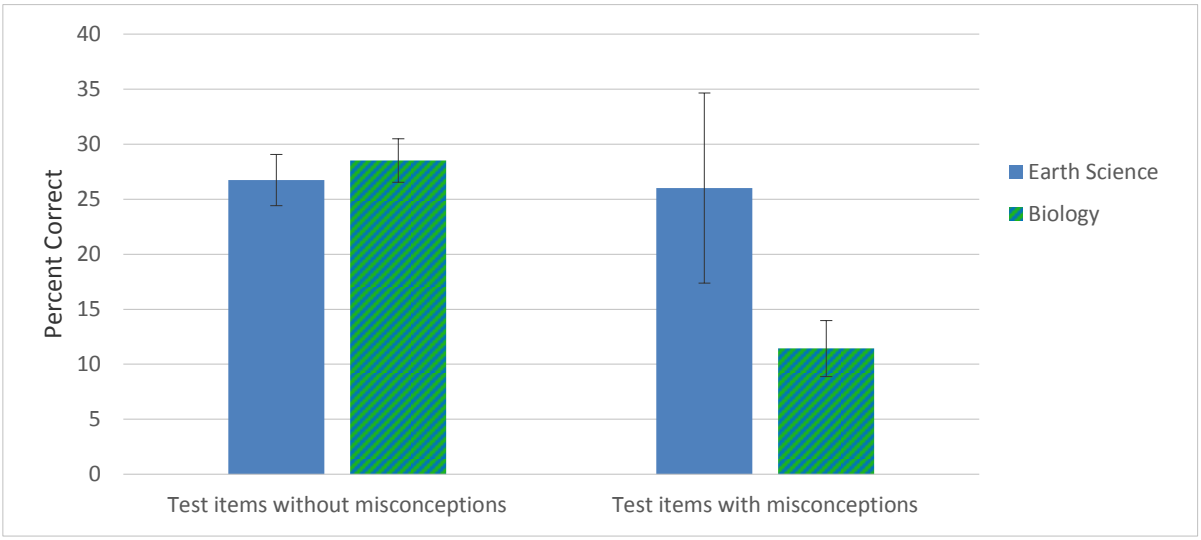
Targeted Misconceptions	Number of Test Items	Mean and SEM	Leb	Int	Absolute Difference	R.D
No	41	Mean	26.73	43.54	-16.80	-.41
		Std. Error	2.33	2.30	1.49	.03
Yes	4	Mean	26.00	43.50	-17.50	-.41
		Std. Error	8.63	10.23	4.99	.08
Total	45	Mean	26.67	43.53	-16.87	-.41
		Std. Error	2.23	2.24	1.41	.03

Figure 4.28. Performance in Earth Science according to whether questions targeted misconceptions in TIMSS test



A comparison between Earth Science and Biology shows that around 9% of TIMSS test items reveal misconceptions in both disciplines. Results illustrated in Figure 4.29 also indicated that percent correct of questions with misconceptions is approximately the same as the questions with no misconceptions for Earth Science (less than 1% different). However, students preformed much lower in Biology on items that target misconceptions (absolute difference of 17.08%). Surprisingly, the relative difference between Earth Science and Biology for items targeting misconceptions (+6.66%) and questions that do not target misconceptions (-56.04%) is approximately 8.5 times smaller. With the small sample size of the questions revealing misconception in both disciplines, further research need to be performed to identify nature and pattern of misconceptions in students' answers for purpose of drawing conclusions and developing action plans to better increase student performance.

Figure 4.29. A comparison of student performance according to whether questions targeted misconceptions in TIMSS test for Earth Science and Biology



Conclusion:

- The percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the four topic areas on Earth Science was lower than their international counterparts.
- 8th graders in Lebanon performed the highest on test items related to topic I (earth's structure and physical features) and topic IV (Earth in the solar system), while the highest percent of items answered correctly for international counterparts was documented for topic II on Earth's processes, cycles, and history.
- 8th graders in Lebanon registered the lowest performance in topic III addressing concepts related to the use and conservation of earth's resources, which is a suspended theme in the Lebanese curriculum.
- Student Performance in Earth science was nearly the same as that for Biology.
- The largest discrepancy between student performance in Lebanon and internationally was observed in items which are not taught in the Lebanese science curriculum.
- Grade 8 students in Lebanon could not outperform students in other countries in any of the objectives related to Earth Science. The deviation in performance from the international mean was mainly associated with objectives studied at different grade levels, in different subjects, or related to suspended themes.
- In Lebanon, as was the case internationally, the average percent correct decreased with the increase in the level of mental processes and thinking required to answer a question, the percentage being the lowest in Reasoning and highest in Knowing.
- 8th graders in Lebanon performed lower in the three cognitive domains: Knowing, Applying, and Reasoning, compared to students internationally; particularly in the reasoning domain.
- In Lebanon, the average percent correct decreased with the increase in the level of mental processes and thinking required to answer a question for both Earth Science and

Biology, although the difference between performance on Knowing and Applying items was more prominent in Earth Science.

- Students' performance was higher in Biology for both Applying and Reasoning cognitive domains, but not significantly different on the three domains as comparison of the standard errors revealed overlap.
- Students' performance in D1 was higher than their performance in D2 for Earth Science and Biology. However, there was less than 1.5% difference between the performances between the two disciplines for both Lebanese cognitive domains, but the difference was not significant as revealed by overlapping standard errors of measurement.
- There was no definite pattern that reflected variation in students' performance in function of the document types.
- Students' achievement remained low irrespective of the action verbs test items or type of question used.
- The major type of question in TIMSS was multiple choice for both disciplines.
- Lebanese students performed highest in MCQs and lowest on the short answer type.
- Lebanese students tended to perform lower in Earth Science compared to Biology for all types of questions.
- Lebanese students performed lower than their international counterparts on all types of questions.
- Students internationally performed best in questions presented in tables, while students in Lebanon performed highest with items presented as either schemas or text.
- In both Biology and Earth Science, most questions were in the form of Text.
- Student performance was almost the same when test items were in the form of table or text.
- Similar to international results, Lebanese students performed better in "Wh" questions.
- Students were more likely to perform better in Biology relative to Earth Science whether "Wh" questions or "Action Verbs" were used.
- The percent correct and relative difference of the questions with misconceptions was approximately the same as the questions with no misconceptions for Lebanon and internationally.
- The relative difference between Earth Science and Biology for items targeting misconceptions and questions that do not target misconceptions was around 8.5 times smaller.

4.4. Achievement of Grade 8 Students in Physics

This section summarizes findings that link Grade 8 students' performance in Physics with several parameters that could help in analyzing TIMSS 2015 Physics test items in a more comprehensive manner.

The abbreviations below, are used in the following tables, where some results may appear inconsistent because of rounding.

Leb % : Mean of Lebanon % correct
Int % : Mean of International % correct
SE : Standard Error
Absolute Difference : Absolute Difference = Mean of [Leb % correct – Int % correct]
R.D.: Relative difference in % = 100 × Mean of [(Leb % correct – Int % correct) / Int % correct]

4.4.1. Physics content domains

The Physics content domains specified by TIMSS 2015 include five topic areas:

I- Physical States and Changes in Matter
II- Energy Transformation and Transfer
III- Light and Sound
IV- Electricity and Magnetism
V- Forces and Motion

In the following sections, performance of grade 8 Lebanese students will be analyzed as compared internationally in terms of content.

4.4.1.1. Lebanon in comparison Internationally for Physics questions

In Physics, 46 questions were to be analyzed. These questions are gathered in the table 4.30 below.

Table 4.30: Performance in Physics Questions in Lebanon and Internationally

Question	Lebanese % correct	International % correct	Absolute Difference	R.D.
S062033	21	32	-11	-34
S042210	37	39	-2	-5
S042094	10	32	-22	-69
S052130	33	38	-5	-13
S062042	38	36	2	6
S052028	39	55	-16	-29
S062043	12	27	-15	-56
S062242	50	77	-27	-35
S042293B	4	11	-7	-64
S042218	43	52	-9	-17
S052233	10	18	-8	-44
S062128	49	52	-3	-6
S042211	34	48	-14	-29
S062159	38	53	-15	-28
S042293A	49	61	-12	-20
S042402	10	22	-12	-55

Question	Lebanese % correct	International % correct	Absolute Difference	R.D.
S062044	17	26	-9	-35
S062047	39	38	1	3
S062153	37	46	-9	-20
S062046	26	47	-21	-45
S052206	32	49	-17	-35
S042182	62	68	-6	-9
S052141	3	25	-22	-88
S062163	2	16	-14	-88
S052217	47	47	0	0
S042216	44	60	-16	-27
S062149	28	37	-9	-24
S052192	25	50	-25	-50
S062262	40	45	-5	-11
S052232	43	38	5	13
S042195	11	16	-5	-31
S062162	8	32	-24	-75
S042249	24	48	-24	-50
S052159	48	63	-15	-24
S042273	29	44	-15	-34
S042280	39	53	-14	-26
S062158	42	55	-13	-24
S062032	42	36	6	17
S062035	45	38	7	18
S042065	64	81	-17	-21
S042400	8	24	-16	-67
S052179	26	40	-14	-35
S062268	45	72	-27	-38
S062037	52	55	-3	-5
S062144	51	68	-17	-25
S052110	16	24	-8	-33
Average	**32**	**43**	**-11**	**-30**

Table 4.30 above shows that the Lebanese students' achievement in % correct (32) is lower than the international student's achievement (43) with an absolute difference of -11 points and a relative difference (in average) of -30%.

4.4.1.2. TIMSS Topics and Subjects in the Lebanese Curriculum

Table 4.31 displays the distribution of the five topic areas according to the objectives and grades as specified by the Lebanese curriculum.

In the table 4.31 below, underlined score means that the objective is suspended for 2019 in the Lebanese Curriculum.

Table 4.31: Distribution of Topic Areas in Physics by Lebanese Curriculum Objectives and Grades

TIMSS Topics and Subjects	Objectives	Lebanese Schools Grades					
		7th	8th	9th	10th	11th	12th
I-Physical States and Changes in Matter							
1	A	1					
	B						
2	A	1					
	B						
	C	1					
	D						
II-Energy Transformation and Transfer							
1	A		1			1	1
	B		0.5			1	
2	A						
	B					1	
	C						
III-Light and Sound							
1	A		0.5		1		
	B		1				
	C		1		1		
	D				1		
2	A		1			1	
	B		0.5			0.5	
	C		1				
IV-Electricity and Magnetism							
1	A	1			1		
	B	1		1	1		
	C			1	1		
2	A					1	
	B					1	
	C					1	
V-Forces and Motion							
1	A		1	1	1		
	B		1	1	1		
	C			1	1		
2	A						
	B			1			
	C			1			
	D			1			
3	A		0.5		1	1	
	B				1	1	
	C				1	1	

In the Lebanese Curriculum, in Physics, the following objectives are covered:

- Until the 8th grade, 14 objectives out of 34 (41% of the TIMSS objectives) which is a low proportion.
- After the 8th grade, 13.5 other objectives out of 34 (40% of the TIMSS objectives).
- Throughout all the grades, 81% of the TIMSS objectives were present in the Lebanese Curriculum.

Note that 6.5 objectives out of 34 were not in the Lebanese Curriculum (19% of the TIMSS objectives)

4.4.1.3. Factors affecting the Lebanese students' performance

4.4.1.3.1. Topic area

The questions corresponding to each topic are distributed as listed below.

I- Physical States and Changes in Matter: 6
II- Energy Transformation and Transfer: 8
III- Light and Sound: 9
IV- Electricity and Magnetism: 8
V- Forces and Motion: 15

Table 4.32: Performance in Physics Topics in Lebanon and Internationally

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
I-Physical States and Changes in Matter	31	(5.5)	36	(1.3)	-5	(4.5)	-14	(13.5)
II-Energy Transformation and Transfer	29	(8.1)	39	(7.8)	-11	(1.8)	-37	(8.3)
III-Light and Sound	36	(2.3)	48	(2.6)	-12	(2.5)	-24	(4.8)
IV-Electricity and Magnetism	34	(6.4)	49	(8.0)	-15	(3.2)	-31	(6.4)
V-Forces and Motion	31	(4.7)	43	(4.4)	-13	(2.4)	-35	(7.8)

Figure 4.30: Performance in the Different Physics Topics

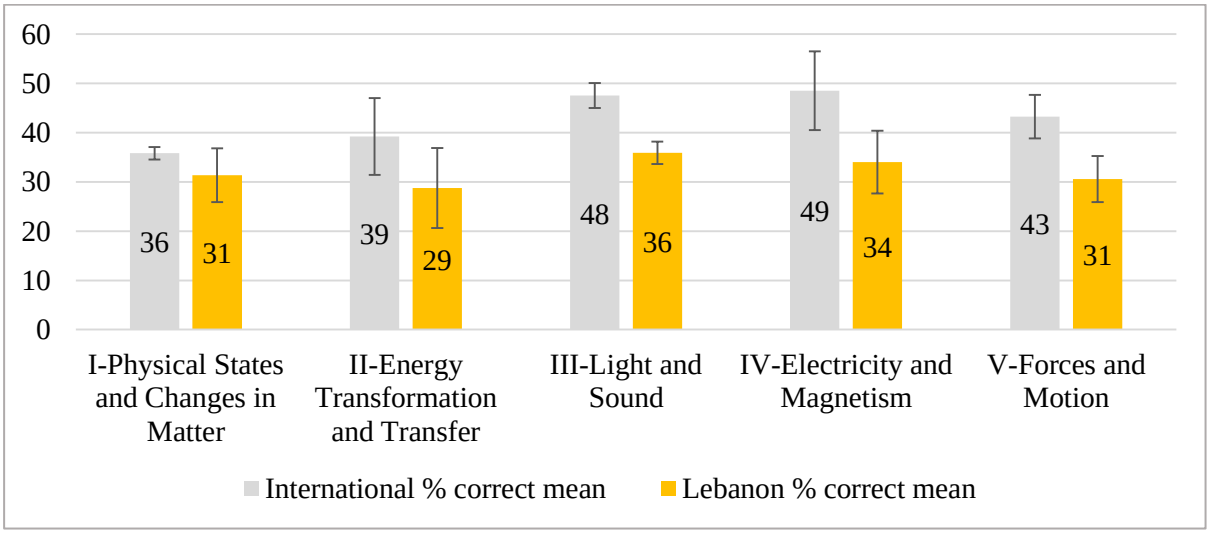


Table 4.32 and figure 4.30 above, show that, as compared to the international average, Lebanese students' achievement in the topic area "I-Physical States and Changes in Matter" is the best (Relative difference of -14%) even though their highest % correct (36) is in the topic area "Light and Sound". The relative difference ranges from -14% to -37% for all topic areas. Lebanon's performance is lower on all topic areas, moreover the differences between Leb % and Int % are statistically significant for all the topics except for "I-Physical States and Changes in Matter" and "II-Energy Transformation and Transfer" where they are not significant due to overlapping standard errors of measurement.

4.4.1.3.2. Grade level

The questions are distributed as listed below.

7th grade (<8th): 13
8th grade (8th): 16
9th, 10th, 11th grade and not included in the Lebanese Curriculum (>8th): 17

Table 4.33: Performance of Lebanese Students and Internationally in Physics by Grade taught

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
<8th	29	(4.9)	43	(5.3)	-14	(2.6)	-35	(7.1)
8th	36	(3.3)	47	(3.9)	-11	(2.1)	-24	(4.7)
>8th	31	(4.5)	41	(3.9)	-10	(2.1)	-31	(7.3)

Figure 4.31: Performance of Lebanese Students and Internationally in Physics by Grade taught

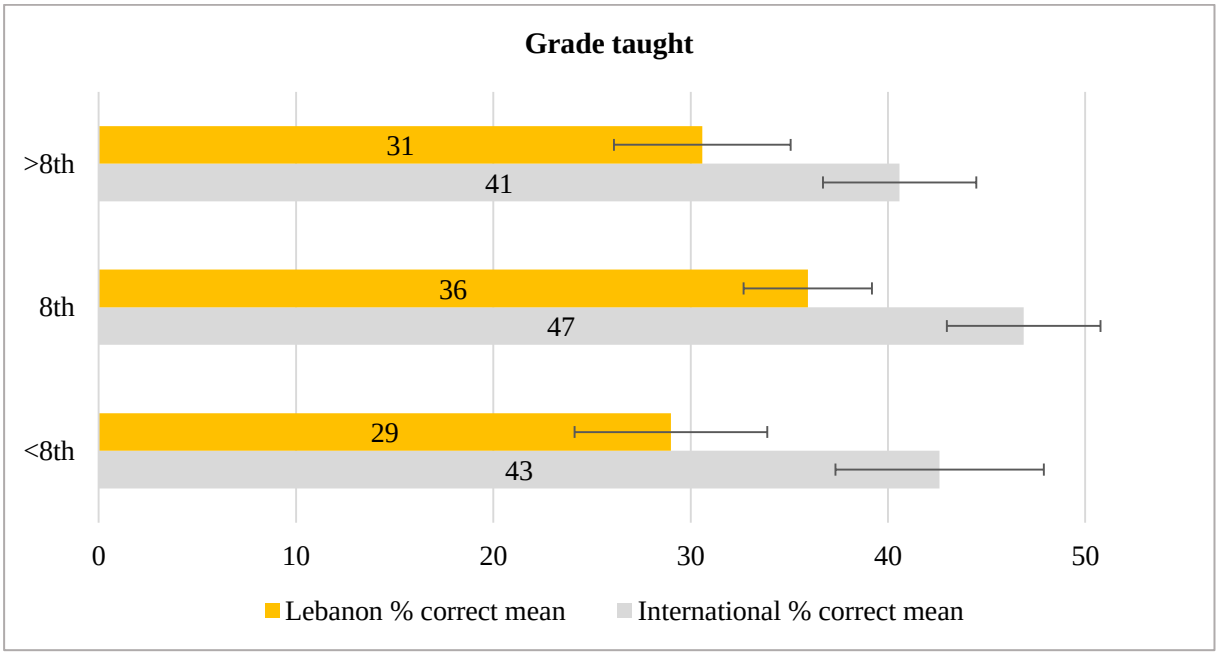


Table 4.33 and figure 4.31 above, show that our 8th grade students' achievement is the highest, which is expected. But what seems quite weird, is that, the questions corresponding to objectives that are not taught yet, got a relatively good mean compared to the ones that are already given in the 8th grade. Note that:

- Differences on the three categories of objectives (<8th, 8th, >8th) are not statistically significant.
- Differences between Leb % and Int % are statistically significant for all the grades.

4.4.1.3.3. Suspended objectives

The questions are distributed as listed below.
- Questions corresponding to objectives that are not suspended: 38
- Questions corresponding to objectives that are suspended: 1
- Questions corresponding to objectives that are not given in the Lebanese Curriculum: 7

Statistically, talking about 1 question is not relevant. Hence the study is reduced to the one of "questions corresponding to objectives that are not suspended" and "questions corresponding to objectives that are not given in the Lebanese Curriculum".

Table 4.34: Performance of Lebanese Students and Internationally in Physics by Objectives in the Lebanese Curriculum and not suspended

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
In the Lebanese Curriculum and not suspended	32	(2.8)	43	(2.8)	-11	(1.3)	-30	(4.0)
Not in the Lebanese Curriculum	30	(5.2)	41	(4.2)	-11	(4.3)	-26	(11.4)

Figure 4.32: Performance of Lebanese Students and Internationally in Physics by Objectives in the Lebanese Curriculum and not suspended

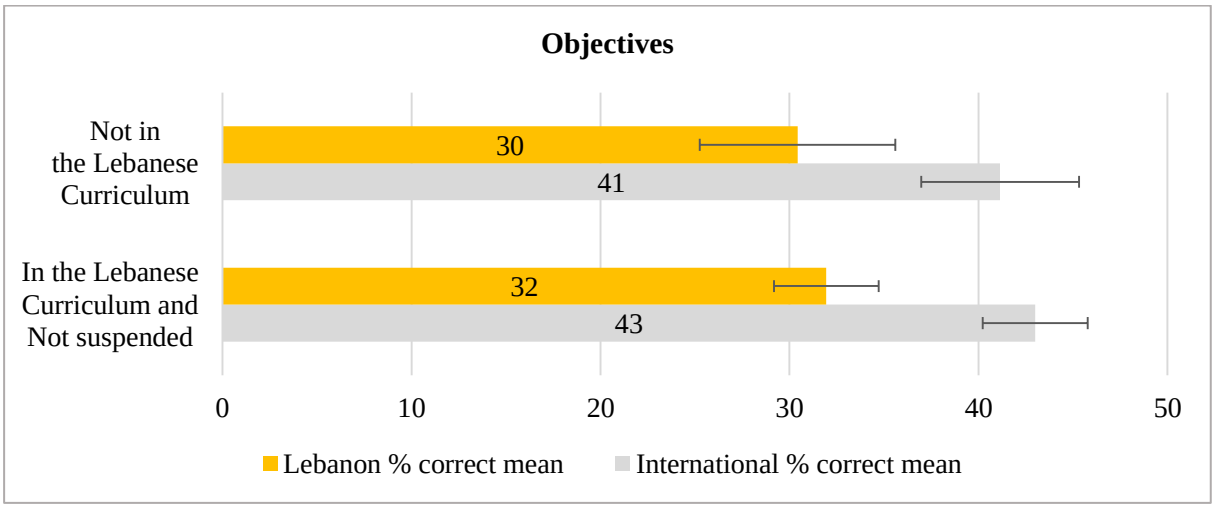


Table 4.34 and figure 4.32 above, show that there is no significant difference between the mean correct % of "objectives that are in the Lebanese Curriculum and not suspended" and "objectives that are not in the Lebanese Curriculum". This observation seems weird.

Note that the differences between Leb % and Int % are statistically significant for "questions corresponding to objectives that are not suspended" and "questions corresponding to objectives that are not given in the Lebanese Curriculum".

4.4.2. Science cognitive domains

4.4.2.1. TIMSS' cognitive domains

The questions, corresponding to the TIMSS' cognitive domains, are distributed as listed below.

- Knowing: 13
- Applying: 22
- Reasoning: 11

Table 4.35: Performance of Lebanese Students and Internationally in Physics by TIMSS' Cognitive Domains

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
Knowing	39	(4.0)	49	(4.3)	-9	(2.4)	-19	(5.6)
Applying	32	(3.6)	45	(3.6)	-13	(1.8)	-34	(5.1)
Reasoning	24	(4.5)	34	(4.4)	-10	(2.8)	-34	(9.2)

Figure 4.33: Performance of Lebanese Students and Internationally in Physics by TIMSS' Cognitive Domains

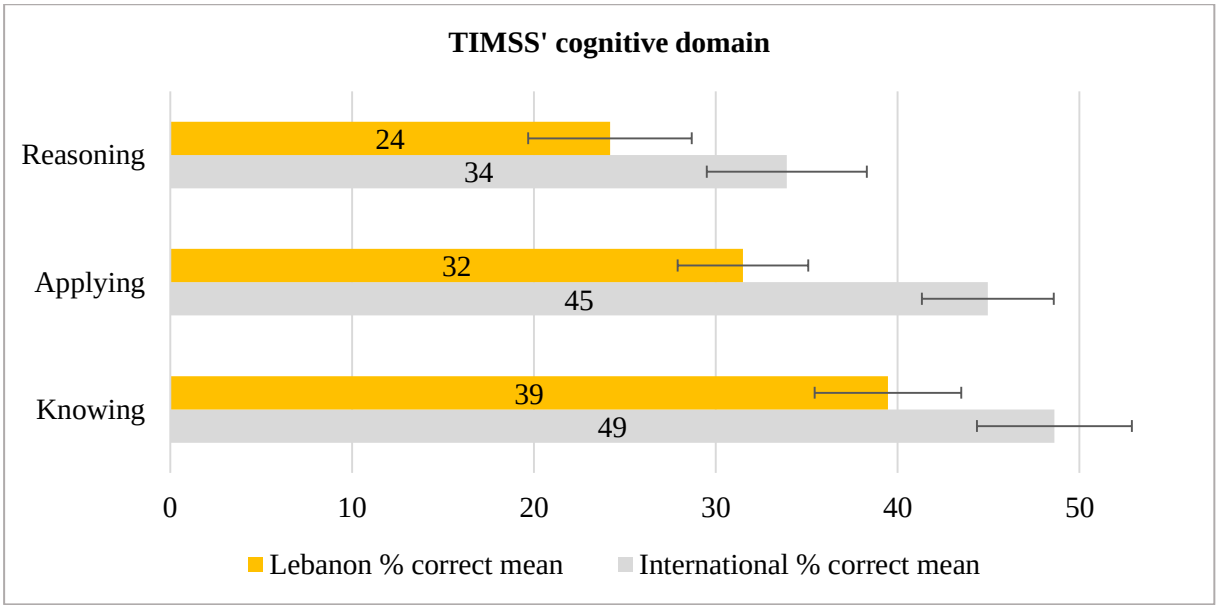


Table 4.35 and figure 4.33 above, show that Lebanese students need to be more trained on "Reasoning". Lebanese students achieve higher in "Knowing" than in "Applying" and achieve higher in "Applying" than in "Reasoning", however the absolute difference is only significant between knowing and reasoning.

Note that the Absolute Differences between Leb % and Int % are statistically significant for all of the three TIMSS' cognitive domains.

4.4.2.2. Lebanese cognitive domains

The Lebanese cognitive domains and their corresponding competencies are listed below:

- D1: Applying knowledge
  - Apply knowledge specific to …
  - Explain physical phenomena related to …
  - Distinguish between closely related physical phenomena and physical quantities.
- D2: Experimentation
  - Use of measuring devices.
  - Measure …
  - Determine …
  - Verify …
- D3: Communication
  - Use an appropriate scientific vocabulary adapted to different modes of representation: verbal, written, diagrams, tables, graphs …
  - Look up information from diversified resources: magazines, encyclopedias, CD ROM, internet, …
  - Read and interpret graphs, tables, …

We have 45 questions corresponding to "D1 Lebanese cognitive domain" and just 1 question corresponding to "D3 Lebanese cognitive domain". Hence one cannot do any study concerning the Lebanese cognitive domains.

4.4.2.3. Type of question

The questions are distributed as listed below.

- Multiple-Choice questions: 26
- Open questions: 17
- Short-Answer questions: 3

Statistically talking about 3 questions is not relevant. Hence the study is reduced to the one of "Multiple-Choice" questions and "Open questions".

Table 4.36: Performance of Lebanese Students and Internationally in Physics by Type of Questions.

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
Multiple-Choice	41	(2.1)	51	(2.5)	-10	(1.8)	-18	(3.6)
Open questions	19	(3.7)	34	(4.1)	-15	(1.5)	-51	(5.2)

Figure 4.34: Performance of Lebanese Students and Internationally in Physics by Type of Questions.

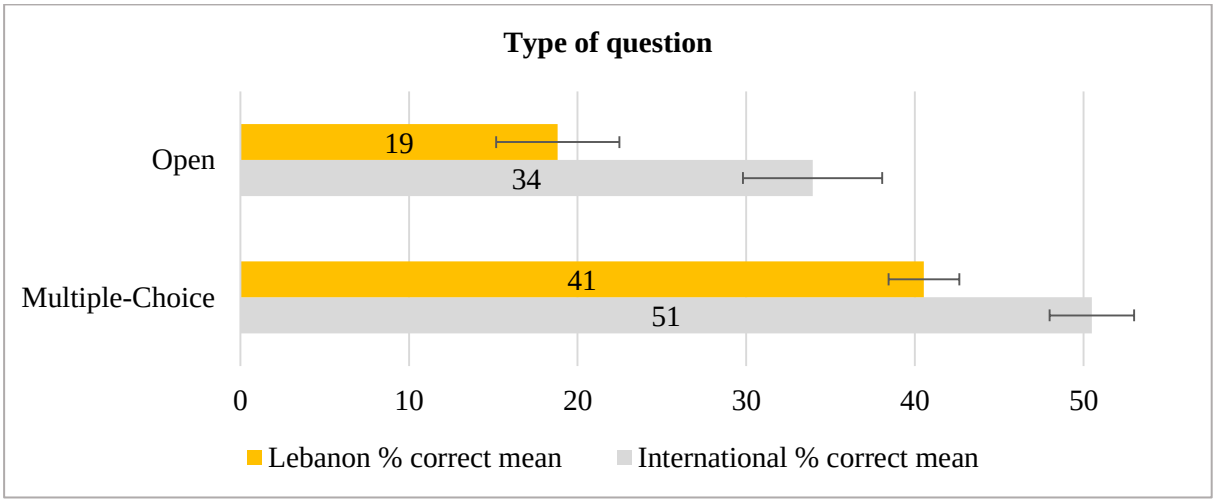


Table 4.36 and figure 4.34 above, show that our students achieve better in "Multiple-Choice" questions than in "Open questions".

Note that:

- The differences between Leb % and Int % are statistically significant for "Multiple-Choice" questions and "Open questions".
- The relative decrease for "Open questions" (-51), is almost 3 times the one for "Multiple-Choice" questions (-18). Our students need to be more trained on "Open questions".

4.4.2.4. Action Verb

The questions are distributed as listed below.

- Wh questions: 32
- Action Verb questions: 14

Table 4.37: Performance of Lebanese Students and Internationally in Physics by Action Verb.

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
Action Verb questions	22	(3.7)	33	(3.1)	-11	(2.1)	-38	(6.8)
Wh question	36	(2.7)	48	(2.9)	-12	(1.6)	-26	(4.3)

Figure 4.35: Performance of Lebanese Students and Internationally in Physics by Action Verb.

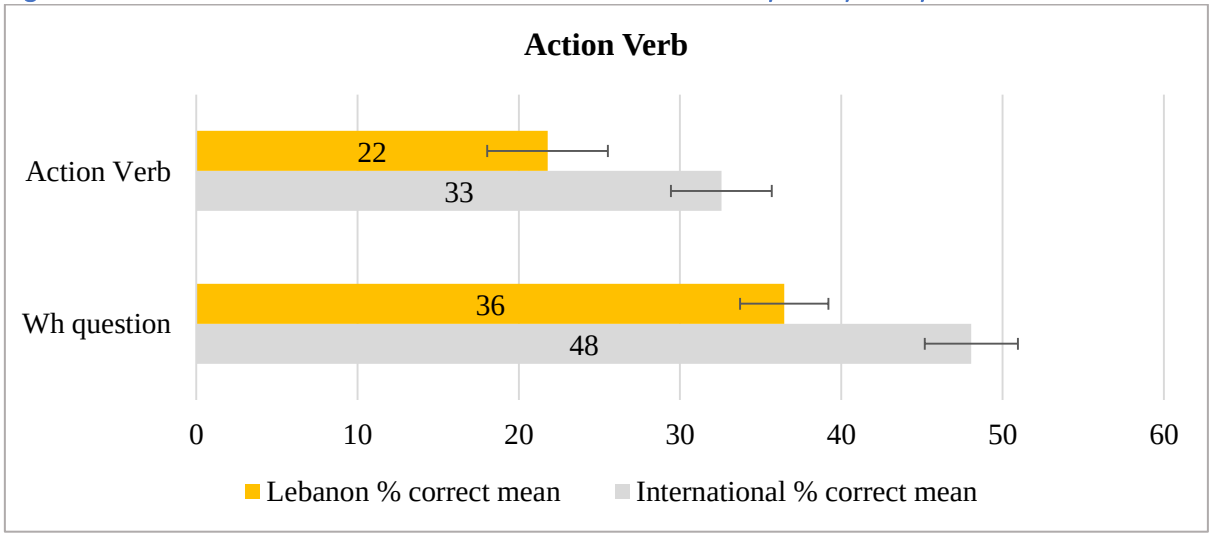


Table 4.37 and figure 4.35 above, show that our students achieve better in "Wh" questions than in "Action Verb" questions.

Note that the differences between Leb % and Int % are statistically significant for "Wh" questions and "Action Verb" questions.

Table 4.38: Performance of Lebanese Students and Internationally in Physics by Type of Questions.

	Action Verb questions	Wh question
Multiple-Choice questions	1	25
Open questions	11	6

Table 4.38 above, show that there are 25 "Wh" questions out of 26 that are "Multiple-Choice" questions too and 11 "Action Verb" questions out of 17 that are "Open questions" too. As we already know that "Multiple-Choice" questions scored higher than "Open questions", this could be an explanation in addition to the use of action verbs.

4.4.2.5. Type of document

The questions are distributed by type of document as listed below.

- Schema questions: 19
- Text questions: 24
- Graph questions: 3

Statistically, talking about 3 questions is not relevant. Hence the study is reduced to the one of "Schema" questions and "Text" questions.

Table 4.39: Performance of Lebanese Students and Internationally in Physics by Type of Document.

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
Schema	28	(3.7)	40	(3.8)	-13	(2.2)	-35	(6.0)
Text	34	(3.4)	44	(3.4)	-10	(1.4)	-27	(4.9)

Figure 4.36: Performance of Lebanese Students and Internationally in Physics by Type of Document.

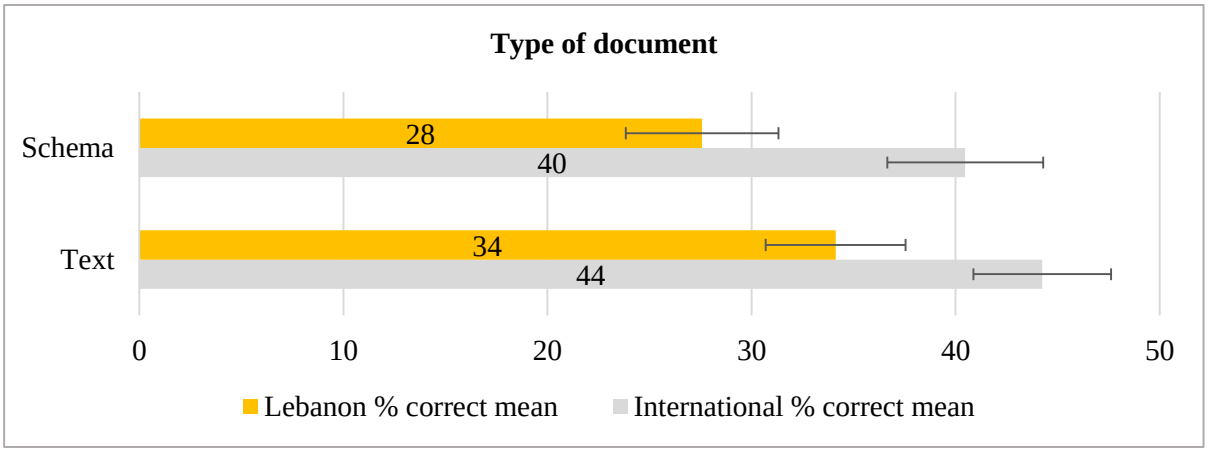


Table 4.39 and figure 4.36 above, show that our students' achievement in "Text" questions is better than the one in "Schema" questions.

Note that the differences between Leb % and Int % are statistically significant for "Text" questions and "Schema" questions.

4.4.2.6. Misconceptions

The questions are distributed as listed below.

- Questions with no misconception: 37
- Questions with misconception: 9

Table 4.40: Performance of Lebanese Students and Internationally in Physics by Misconception

	Leb %	Leb % SE	Int %	Int % SE	Absolute Difference	Absolute Difference SE	R.D.	R.D. SE
Questions with no misconception	36	(2.4)	47	(2.5)	-11	(1.5)	-25	(3.7)
Questions with misconception	16	(4.5)	28	(4.4)	-11	(2.4)	-48	(9.4)

Figure 4.37: Performance of Lebanese Students and Internationally in Physics by Misconception

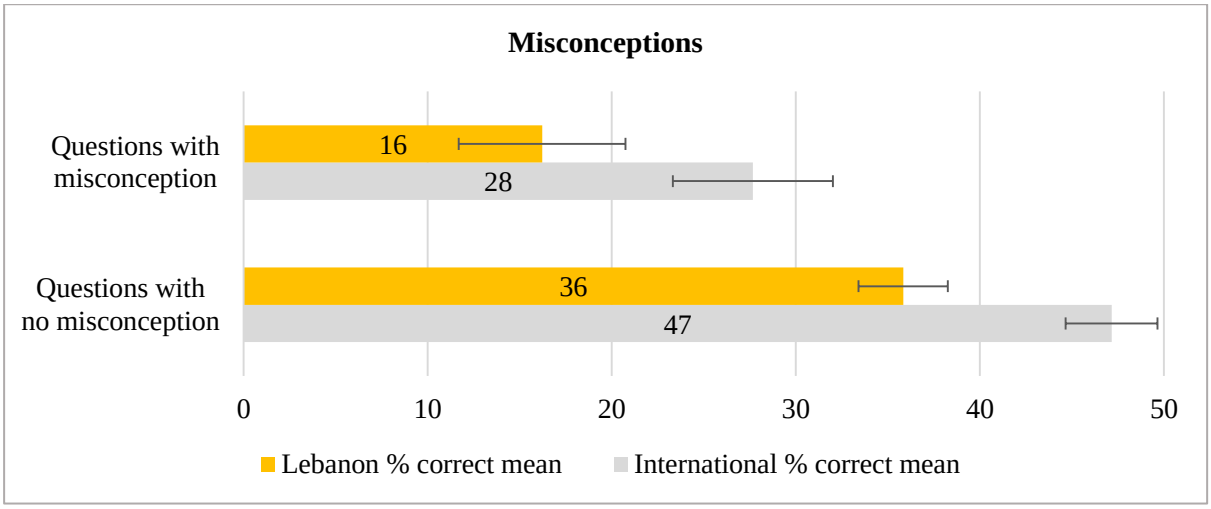


Table 4.40 and figure 4.37 above, show that the % correct mean of the questions with misconception is lower than the one of questions with no misconception for Lebanon and internationally, which is expected.

Note that:

- The differences between Leb % and Int % are statistically significant for questions with misconception and questions with no misconception.
- The relative difference for questions with misconception (-48%), is almost twice the one for questions with no misconception (-25%).
- There are just 3 questions with misconception that are at the same time 8th grade questions. Therefore we do not have enough data to have a clear idea about the nature of mistakes done by our students.

4.4.3. Conclusion:

- The Lebanese student's achievement in % correct is lower than the international student's achievement with a relative difference (in average) of -30%.
- In the Lebanese Curriculum, in Physics, we cover:
  - Until the 8th grade, 41% of the TIMSS objectives, which is a low proportion.

- After the 8th grade, 40% of the TIMSS objectives.
- Throughout all the grades, 81% of the TIMSS objectives.

- Our students' achievement in the topic area "I-Physical States and Changes in Matter" is the best even though their highest % correct is in the topic area "Light and Sound". Lebanon's performance is lower on all topic areas, moreover the difference between Leb % and Int % are statistically significant for all the topics except for "I-Physical States and Changes in Matter" and "II-Energy Transformation and Transfer".
- Students' achievement on grade 8 material is the highest, which is expected. But what seems quite weird, is that, the questions corresponding to objectives that are not taught yet, got a relatively good mean compared to the ones that are already given in the 8th grade, however the differences were not significant among the three categories of objectives.
- There is no significant differences between the mean correct % of "objectives that are in the Lebanese Curriculum and not suspended" and "objectives that are not in the Lebanese Curriculum". This observation seems weird.
  The differences between Leb % and Int % are statistically significant for "questions corresponding to objectives that are not suspended" and "questions corresponding to objectives that are not given in the Lebanese Curriculum".
- Our students need to be more trained on "Reasoning". They achieve higher in "Knowing" than in "Applying" and achieve higher in "Applying" than in "Reasoning", however difference is only significant between knowing and reasoning.
- We have 45 questions corresponding to "D1 Lebanese cognitive domain" and just 1 question corresponding to "D3 Lebanese cognitive domain". Hence one cannot do any study concerning the Lebanese cognitive domains.
- Our students achieve significantly better in "Multiple-Choice" questions than in "Open questions".
  The relative decrease for "Open questions" is almost 3 times the one for "Multiple-Choice" questions. Our students need to be more trained on "Open questions".
- Our students achieve significantly better in "Wh" questions than in "Action Verb" questions.
  This can be explained: 25 "Wh" questions out of 26 are "Multiple-Choice" questions too and 11 "Action Verb" questions out of 17 are "Open questions" too. As we already know that "Multiple-Choice" questions scored higher than "Open questions", this could be an explanation in addition to the use of action verbs.
- Our students' achievement in "Text" questions is better than the one in "Schema" questions.
- The % correct mean of the questions with misconception is lower than the one of questions with no misconception for Lebanon and internationally, which is expected.
  There are just 3 questions with misconception that are at the same time 8th grade questions. Therefore, we do not have enough data to have a clear idea about the nature of mistakes done by our students.

4.5. Chemistry

The chemistry domain includes three topic areas:

- Composition of matter
- Properties of matter
- Chemical change

The study of the composition of matter focuses on differentiating elements, compounds, and mixtures and understanding the particulate structure of matter. The properties of matter topic area focuses on distinguishing between physical and chemical properties of matter and understanding the properties of mixtures and solutions and acids and bases. The study of chemical change focuses on the characteristics of chemical changes, the conservation of matter during chemical changes, and an introduction to the structure and properties of chemical bonds.

Table (A.1) in the appendix represents the comparison between TIMSS cognitive domains and their corresponding objective with those in Lebanese Curriculum.

This table shows that the total number of TIMSS objectives in chemistry are 23, where only 18 objectives (78%) are present in the Lebanese Curriculum (9 objectives in 7th grade, 8 objectives in 8th grade and 1 objective in 9th grade). On the other hand, 2 objectives are partially present and 4 other objectives are out of Lebanese Curriculum. In conclusion, only about 78% of TIMSS objectives intersect with Lebanese Curriculum till the 8th grade. The other 22%, are partially present or not present, or present in a higher grade from 8th grade.

4.5.1 Factors affecting the Lebanese students' performance

Suspended Objectives:

As we mentioned before only about 83% (18+1) of TIMSS objectives intersect theoretically with Lebanese objectives, but in a simple study of chemistry exercises we found that about 8 exercises out of 43 (About 19%) of chemistry questions are classified as "Not Covered" this classification includes the objectives which are:

- Not present in the Lebanese Curriculum (See table A.1)
- Present in the Lebanese Curriculum but that have been recently suspended
- Present in the Lebanese Curriculum, but the question simulates a specific objective which is not stated in the Lebanese Curriculum in the same way.

Table 4.47 presents the 8 "Not Covered" exercises and the situations where they appear, and the percentage of Lebanese and international students that reach the average and above for each question. Lebanese percent correct on these exercises range from 8-64%, while international from 17-81%.

In the comment column we explain the logical reason that may interpret the high relative difference between Lebanese and international percentage in the scores of the exercises.

Table 4.47: References and subjects of chemistry exercises "not covered" by the Lebanese curriculum presented in TIMSS 2015.

Question	leb	Int	Situation	Topic area	Topic	Objective	Comments
S062253	**25**	**37**		Chemical Change	3	A	
S052256	**29**	**43**	Relate the taste of water with its chemical composition as a solution	Properties of Matter	3	B	The relation between the taste of water and the presence of ion is not a specific objective in 7th grade
S062010	**31**	**36**	distinguish between physical and chemical properties	Properties of Matter	1	A	The comparison between chemical and physical properties in not a specific objective in 7th or 8th grade
S042228A	**8**	**17**	experimental determination of the volume of solid	Properties of Matter	2	A	Experiment not mentioned in the L.P of Chemistry for 7th and 8th grade
S042065	**64**	**81**	classify matters according to their connectivity	Properties of Matter	2	A	Specific objective not mentioned in L.P of Chemistry for 7th and 8th grade
S062005	**8**	**33**	show the physical properties of gaz liquid and solid	Composition of Matter	2	A	Specific objective not mentioned in L.P of Chemistry for 7th and 8th grade
S062004	**27**	**37**	explain the physical change in metal at microscopic scale	Composition of Matter	2	A	Specific objective not mentioned in L.P of Chemistry for 7th and 8th grade
S052189	**17**	**39**	rate of dissolving of liquid paint in water	Properties of Matter	3	D	The rate of dissolving of liquid solute not mentioned in L.P of Chemistry for 7th and 8th grade

Some of the exercises in table 4.47 have been suspended according to table 1 (e.g S062010), some other are related to some common topics between TIMSS and Lebanese curriculum but the content of the exercise may contain some different specific objectives (The connectivity as a physical property, the physical change in microscopic scale…..).

4.5.1.1 Topic Area

Table 4.48 represents the comparison in performances of Lebanese and international students in the different Topic Area (Chemical change, Composition of Matter, Properties of Matter).

Table 4.48: Comparison of Lebanon's and international performance across chemistry Topic Areas.

Topic area		% Leb	% int	Absolute Change
Chemical Change	Mean	*40.27*	*48.55*	*-8.27*
	Std. Error of Mean	*5.23*	*4.87*	*2.51*
Composition of Matter	Mean	*48.75*	*51.90*	*-3.15*
	Std. Error of Mean	*4.63*	*4.22*	*1.93*
Properties of Matter	Mean	*35.74*	*45.45*	*-9.71*
	Std. Error of Mean	*3.21*	*3.05*	*1.31*
Total	Mean	*40.74*	*48.08*	*-7.34*
	Std. Error of Mean	*2.45*	*2.21*	*1.06*

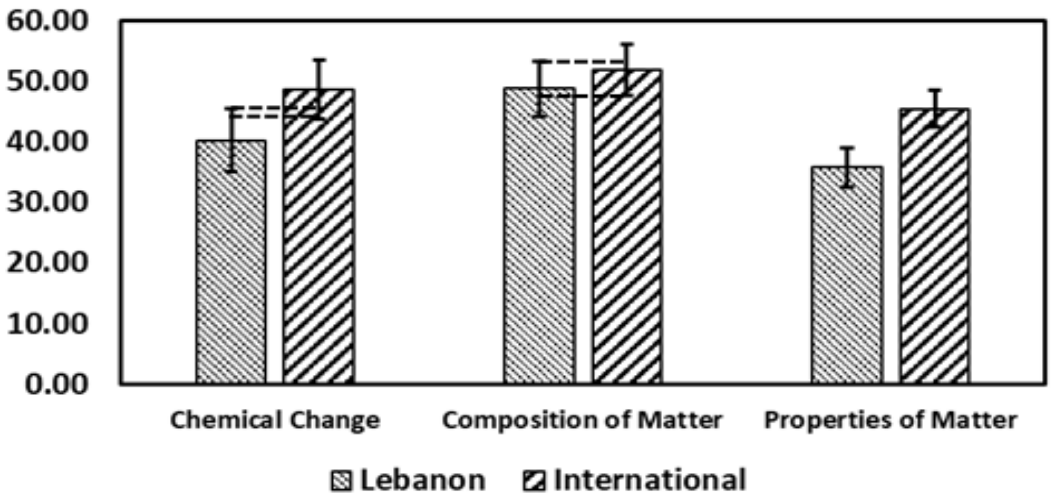
This table compares the mean percentage correct items in each topic area of Lebanese grade 8 students with that of their counterparts internationally.

Results show that the percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the three Topic areas was always lower than their international counterparts.

For better analysis of the results of this parameter, the values of this table are illustrated in figure 4.48.

Figure 4.38: The comparison of Lebanon's and the international performance in % of students who succeeds across chemistry Topic Area.

In this figure we will compare graphically the standard error of mean of each couple. Overlapping nature of the bar error can help us to interpret the data of table 4.48.



In **Chemical Change** topic, the standard errors of the means of Lebanese and international scores slightly overlap, this means that there is no significant evidence of similarities or difference between Lebanon's and international performances. In **Composition of Matter** topic, the standard errors of means highly overlap and the overlap contains the mean of the sample which is a strong evidence of no significant difference between the Lebanon's and international performance in this topic. As for the third topic, there is a strong evidence of significant difference between Lebanon and international performance in the topic of **Properties of Matter**, since there is no overlapping between the standard errors of the two populations, so Grade 8 Lebanese

students performed significantly lower than the international students in **Properties of Matter** Topic, and Lebanon's significantly lower score is due to this component.

4.5.1.2 TIMSS and Lebanese Cognitive level

Table 4.49 represents the comparison in performances of Lebanese and international students in the different TIMSS cognitive level (Knowing, Applying, Reasoning).

Table 4.49: The comparison of Lebanon's and the international performance across TIMSS Cognitive levels.

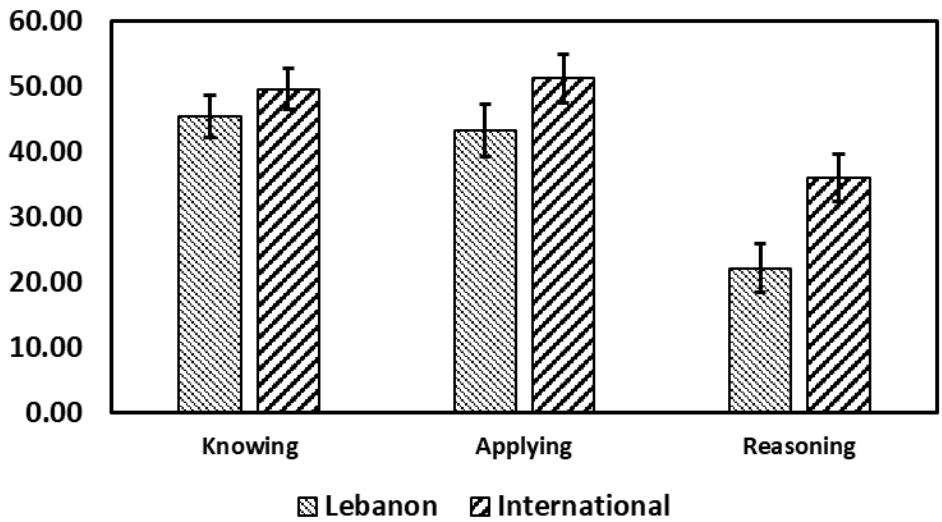
Cognitive level		%leb	%int	Absolute Difference
Knowing	Mean	*45.38*	*49.58*	*-4.19*
	Std. Error of Mean	*3.246*	*3.156*	*1.646*
Applying	Mean	*43.27*	*51.23*	*-7.96*
	Std. Error of Mean	*4.030*	*3.748*	*1.362*
Reasoning	Mean	*22.10*	*36.00*	*-13.90*
	Std. Error of Mean	*3.704*	*3.679*	*2.558*
Total	Mean	*40.74*	*48.08*	*-7.34*
	Std. Error of Mean	*2.458*	*2.218*	*1.060*

This table compares the mean percentage correct items in each cognitive domain of Lebanese students with that of their counterparts internationally.

Results shows that the percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the three cognitive level was always lower than their international counterparts. This difference (Absolute Change) increases from knowing to reasoning as following: (knowing (-4.19), Applying (-7.96), reasoning (-13.9)). The difference in performance between knowledge and application of -2.11 is not significant, so Lebanese students performed equally well on both but their performance on these was significantly higher than on reasoning.

The values of table 4.49 are illustrated in figure 4.39.

Figure 4.39: The comparison of Lebanon's and the international performance in % of students who succeed across TIMSS Cognitive Domains



In this figure, and as we did before, the standard error of means will be compared graphically and the overlapping nature can help us to interpret the data of table 4.49.

In **Knowing** cognitive level, the standard error of means of the two populations (Leb. vs Inter.) slightly overlaps, this means that there is no strong evidence of significant similarities or differences, moreover they are almost identical because of the proximity of the two means from the overlapping with respect to the other two domains, no overlapping is seen between the standard errors of both **Applying** and **Reasoning** cognitive levels which indicates that there is a significant difference in favor to the international mean. This means that Grade 8 Lebanese students performed significantly lower in these two cognitive domains compared to the international mean.

Similar results were observed if we approach this comparison according to the Lebanese Competencies in the curriculum. The booklets exercises were classified according to the Lebanese competencies:

D1: **Applying Knowledge**;
D2: **Designing an Experiment**;
D3: **Mastery- Communicating.**

Table 4.50 and figure 4.40 shows the numerical values and the graphical representation for the comparison of Lebanon's and the international performance across Lebanese Cognitive domains.

Table 4.50: Comparison of Lebanon's and the international performance across Lebanese Cognitive levels.

Leb Cognitive Domain		Number of Items	leb	int	Absolute Change
D1	Mean	*19*	*40.59*	*45.12*	*-4.53*
	Std. Error of Mean		*4.129*	*4.130*	*2.173*
D2	Mean	*7*	*23.00*	*34.00*	*-11.00*
	Std. Error of Mean		*5.064*	*6.078*	*2.769*
D3	Mean	*17*	*30.41*	*41.41*	*-11.00*
	Std. Error of Mean		*3.368*	*2.393*	*2.532*
Total	Mean	*43*	*40.74*	*48.08*	*-7.34*
	Std. Error of Mean		*2.458*	*2.218*	*1.060*

Figure 3 shows that the Lebanese and TIMSS Cognitive domains follow the same trends but with different percentages. This is expected since in the classification of the assessment exercise we considered that D1 in the Lebanese Cognitive domain corresponds to Knowing in TIMSS Cognitive domain and so on D2= Applying , D3=Reasoning. So, similar to TIMSS Cognitive level approach, Lebanese students do significantly relatively better only with the exercises that correspond to the first Cognitive domain D1 (Applying Knowledge) as compared to the other domains, however the difference in performance between D3 and D2 is insignificant.

For the next factors we will represent directly the graph comparison which is more expressive in our case.

4.5.1.3 Grade taught:

Figure 4.41 represents the comparison of Lebanon's and the international performance across the grade taught of the objectives according to the Lebanese curriculum.

Figure 4.41: The Comparison of Lebanon's and the International by Grade Taught

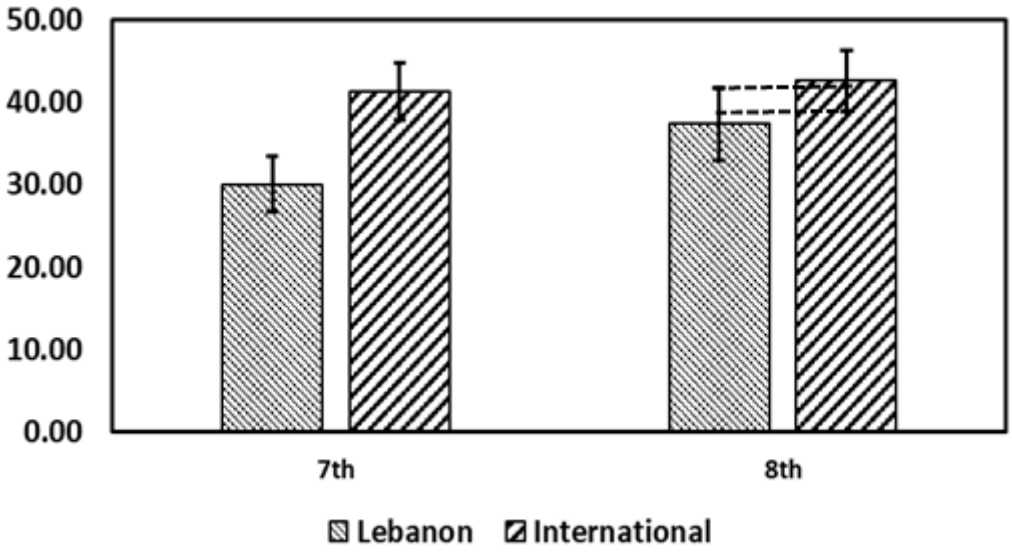
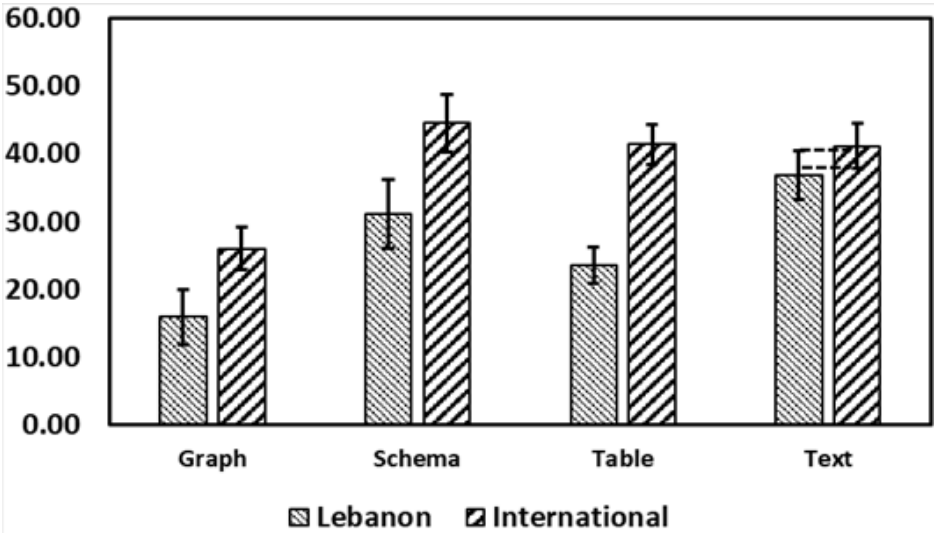


Figure 4.41 shows an overlapping between the standard error of Lebanese and international mean at 8th grade and a significant difference in favor of the international students in the exercises that belong to 7th grade objectives. This result can be considered as "logical", given that the students applying for TIMSS exam are in the eighth grade and that the grade 7 objectives are not reviewed before the exam. Lebanese students perform similarly to international students on objectives taught in grade 8.

4.5.1.4 Type of Document:

Figure 4.42 represents the comparison of Lebanon's and the international performance across the types of documents presented in the exercises of TIMSS assessment.

Figure 4.42: The Comparison of Lebanon's and the international by Type of Document



From figure 4.42, and according to the same approach as above, we notice that the Lebanese students performed significantly better only when the exercises are given as

text, and they performed much lower when the exercises contained other types of documents like (graphs, schema or tables). There was no significant difference between Lebanese students and international students when exercise was given in text format, but showed significant differences in other document types. These types of documents are often associated with exercises of types **Applying** and **Reasoning**. This explains the relative low performance of Lebanese students when the exercises contain such type of documents.

4.5.1.5 Using Action Verbs:

Figure 4.43: The Comparison of Lebanon's and the International Performance by Action Verb

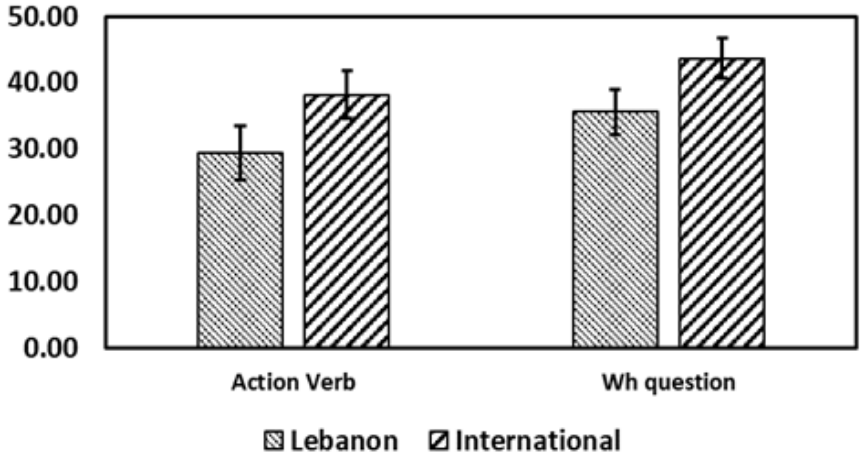


Figure 4.43 represents the comparison of Lebanon's and the international performance across the using of action verbs in the exercises of TIMSS assessment.

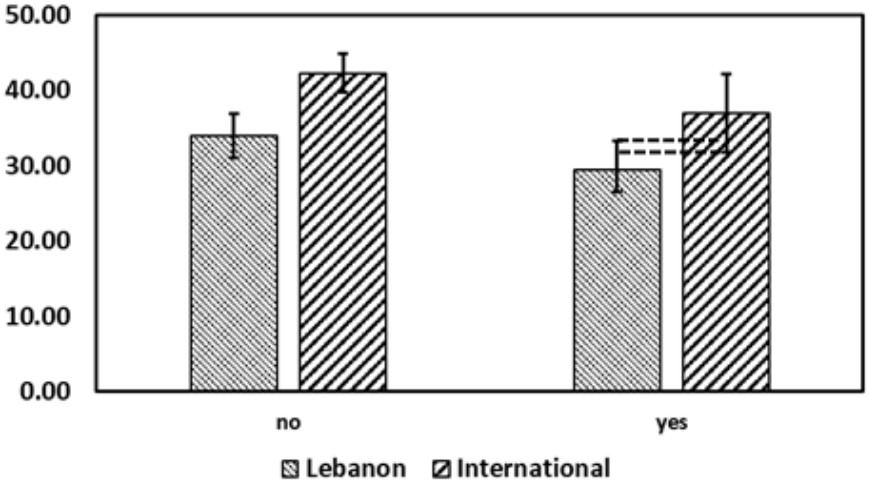
Figure 4.43 shows that there is no effect of how we ask the question for our students in TIMSS exam, if it is with or without an action verb (Wh question). A significant difference appears in both types (no overlapping of standard error of mean). The Lebanese students performed lower whatever the type of question (with or without an action verb),but they perform better on wh questions than on ones with action verbs.

4.5.1.6 Misconception:

Some of the exercises of TIMSS assessment simulate scientific misconceptions in students. TIMSS scoring guide classify exercises into two categories (with or without targeted misconception).

Figure 4.44 represents the comparison of Lebanon's and the international performance across the presence of targeted misconception in the exercises of TIMSS assessment.

Figure 4.44: The Comparison of Lebanon's and the International Performance by Targeted Misconception



Contrary to expectations, figure 4.44 shows an overlapping between the standard error of Lebanon's and international means of the exercises that contains a scientific misconception, and significant difference in favor of the international students in the exercises with no miscomputation. As a result, and Contrary to expectations, there is no strong evidence on the effect of scientific misconception on the relative low performance of our students in this assessment. The Lebanese students performed relatively lower in the exercises with misconception.

4.5.2 Conclusion:

After discussing all the factors that may have led to the low performance of Lebanese students in the TIMSS exam. We can know recapitulate this discussion as following:

1- Lebanon's score in chemistry, though significantly lower than international average, yet is highest among the sciences. Apparently, it is the significantly low score in properties of matter that is lowering Lebanon's score.

2- About 19% of the assessment exercises are classified as "Not Covered" **suspended** for different reasons, which is to be considered a contributing factor on the performance of students in chemistry part.

3- The discussion of TIMSS cognitive level shows a significant difference in **Applying** and **Reasoning** performance. This factor has contributed significantly to the overall performance of students in chemistry, knowing that more than 50% of the exercises are classified as Applying and Reasoning (Table 4.51).

Table 4.51: Percentage distribution of chemistry exercises by Cognitive domains

Cognitive level		
Knowing	**Applying**	**Reasoning**
42%	**42%**	**16%**
	58%	

These results open the discussion about the structure of the Lebanese Curriculum and the competencies approach and invite all responsible to reformulate the competencies in order to simulate the higher thinking level.

4- Topic Area shows a significant difference, "Lebanese students performed lower than the international students in **Properties of Matter** Topic". Table 4.52represent the percentage distribution of chemistry exercise by Topic area and cognitive domains.

Table 4.52: Percentage distribution of Chemistry exercises by Topic area and Cognitive domains

Topic area								
Chemical change			**Composition of matter**			**Properties of Matter**		
17%			31%			**52%**		
Knowing	Applying	Reasoning	Knowing	Applying	Reasoning	Knowing	**Applying**	**Reasoning**
18%	55%	27%	55%	45%	0%	29%	**48%**	**23%**
							71%	

This table shows that more than 50% of the Assessment exercises belong to "Properties of Matter Topic Area" where more than 70% simulate the **Applying** and **Reasoning** cognitive domains.

The statistical distribution of this table explains the relative low performance in **Properties of Matter** Topic Area. The contributing factor is not the Topic Area of the exercise alone but the type of this exercise in terms of Cognitive level, as 71% reflect Reasoning and Application. This result is added to the previous results and highlights the importance of the **Cognitive level** factor in the achievement of Lebanese students in chemistry.

Finally, we can say that the results of the Lebanese students in this exam provided clear evidence that the teaching of chemistry in Lebanese schools depends mainly on the **Knowledge** and they are unable to deal with more complex analytical and practical situations. This is proved by the inability of our students to deal with all exercises classified as **Applying** and **Reasoning** and that contains several documents other than text document, which opens a wide discussion about the structure of the Lebanese Curriculum and the **competencies approach** and invite all responsible to reformulate the competencies which simulate the higher thinking level.

Appendix 4.2.I

Summary of indicators under Biology

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
I. Characteristics and life processes of organisms	I.1. Differences among major taxonomic groups of organisms.	A. Identify the defining characteristics that differentiate among major taxonomic groups of organisms (plants vs. animals vs. fungi; mammals vs. birds vs. reptiles vs. fish vs. amphibians).	33.67	52.17	-18.50	-35.08%	
		B. Recognize and categorize organisms that are examples of major taxonomic groups of organisms (plants vs. animals vs. fungi; mammals vs. birds vs. reptiles vs. fish vs. amphibians).	17.50	41.50	-24.00	-57.79%	Classification is taught in grade 4 in a very simplified way
	I.2. Structure and function of major organ systems	A. Locate and identify major organs and the components of major organ systems in the human body.	28.00	22.00	+ 6.00	+ 27.27%	
		B. Compare and contrast organs and organ systems in humans and other vertebrates.	53.00	47.00	+ 6.00	+12.77%	
		C. Explain the role of organs and organ systems in sustaining life, such as those involved in circulation and respiration.	37.00	44.00	-7.00	-14.58%	

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
	I.3 Physiological processes of animals	A. Recognize responses of animals to external and internal changes that work to maintain stable body conditions, such as increased heart rate during exercise, feeling thirsty when dehydrated, feeling hungry when requiring energy.	26.00	50.00	-24.00	-48.00	Taught in grade 7 and suspended
		B. Explain why it is important for most animals to maintain a relatively stable body temperature and how animals maintain a stable body temperature when the external temperature changes, such as sweating in heat and shivering in cold.	25.00	41.00	-16.00	-44.06	Grade 7, suspended
II. Cells and their functions	II.1 The structure and function of cells	A. Explain that living things are made of cells that carry out life functions and undergo cell division.	39.00	52.00	-13.00	-25.00	
		B. Explain that tissues, organs, and organ systems are formed from groups of cells with specialized structures and functions.	32.50	44.50	-12.00	-36.72	
		C. Identify major cell structures (cell wall, cell membrane, nucleus, chloroplast, vacuole, and mitochondria) and describe the	27.50	40.00	-12.50	-35.00	

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		primary functions of these structures.					
		D. Recognize that cell walls and chloroplasts differentiate plant cells from animal cells.	16.00	31.33	- 15.33	-52.40	Studied in grade 6
	II.2. The processes of photosynthesis and cellular respiration	A. Describe or model the basic process of photosynthesis (requires light, carbon dioxide, water, and chlorophyll; produces food; and releases oxygen).	19.50	30.75	-11.25	-47.84	Studied in grade 7
		B. Describe or model the basic process of cellular respiration (requires oxygen and food, produces energy, and releases carbon dioxide and water).	20.75	25.75	-5.00	-23.19	
III. Life cycles, reproduction, and heredity	III.1. Life cycles and patterns of development	A. Compare and contrast the life cycles and patterns of growth and development of different types of organisms (mammals, birds, amphibians, insects, and plants).	18.60	33.60	-15.00	-51.52	Taught in grade 6 in a very simplified way, not comparing stages of life cycle
		B. Describe factors that affect the growth of plants and animals.	9.00	27.00	-18.00	-66.67	Only factors affecting growth of plants is studied in grade 7
	III.2. Sexual reproduction and inheritance in plants and animals	A. Recognize that sexual reproduction involves the fertilization of an egg cell by a sperm cell to produce offspring that are similar but not identical to either parent.					We weren't able to sort any test item related to this objective

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		B. Relate the inheritance of traits to organisms passing on genetic material to their offspring.	40.00	63.00	-23.00	-36.42	An objective for grade 9
		C. Distinguish inherited characteristics from acquired or learned characteristics.	15.00	37.50	-22.50	-62.78	An objective for grade 9
IV. Diversity, adaptation, and natural selection	IV.1. Variation as the basis for natural selection	A. Recognize that variations in physical and behavioral characteristics among individuals in a population give some individuals an advantage in surviving and passing on their characteristics to their offspring.	18.71	45.00	-26.29	-60.49	Objective in grade 12 (suspended)
		B. Relate species survival or extinction to reproductive success in a changing environment (natural selection).	40.67	52.67	-12.00	-24.34	
	IV.2. Fossils as evidence for changes in life on Earth over time	A. Draw conclusions about the relative length of time major groups of organisms have existed on Earth using fossil evidence.	40.00	58.00	-18.00	-31.03	
		B. Describe how similarities and differeces among living species and fossils provide evidence of the changes that occur in living things over time and explain that the degree of similarity of characteristics provides evidence of common ancestry.	28.00	42.00	-14.00	-33.54	Suspended, Grade 12
V. Ecosystems	V.1. The flow of energy in ecosystems	A. Identify and provide examples of producers, consumers, and decomposers.	64.00	76.00	-12.00	-15.24	

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		B. Describe the flow of energy in an ecosystem (energy flows from producers to consumers and only part of the energy is passed from one level to the next).					Weren't able to sort any test item related to this objective
		C. Draw or interpret energy pyramids or food web diagrams.	59.00	77.00	-18.00	-23.38	
	V.2. The cycling of nutrients in ecosystem	A. Describe the role of living things in the cycling of oxygen and carbon through an ecosystem.					We weren't able to sort any test item related to this objective
		B. Describe the role of living things in the cycling of water through an ecosystem.					We weren't able to sort any test item related to this objective
	V.3. Interdependence of populations of organisms in an ecosystem	A. Describe and provide examples of competition among populations of organisms in an ecosystem.	11.00	34.00	-23.00	-67.65	Grade 7 (suspended)
		B. Describe and provide examples of predation in an ecosystem.	44.00	67.40	-23.40	-35.01	Grade 7 (suspended)
		C. Describe and provide examples of symbiosis among populations or organisms in an ecosystem, such as birds or insects pollinating flowers, birds eating insects on deer or cattle, or a tapeworm living in human intestines.	10.00	34.00	-24.00	-70.59	Grade 7 (suspended)
	V.4. Factors affecting population size in an ecosystem	A. Identify factors that limit population size, such as disease, predators, food resources, and drought.	16.00	56.00	-40.00	-74.06	Grade 12 (suspended)

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		B. Predict how changes in an ecosystem, such as water supply, population changes, or migration, can affect available resources, and thus the balance among populations.	13.00	31.14	-18.14	-60.60	
VI. Human health	VI.1. Causes, transmission, prevention, and resistance to diseases	A. Describe causes, transmission, and prevention of common diseases, such as influenza, measles, malaria, and HIV.	34.67	44.67	-10	-32.60	
		B. Describe the role of the body's immune system in resisting disease and promoting healing.					We weren't able to sort any test item related to this objective
	VI.2. The importance of diet, exercise, and lifestyle in maintaining health	A. Explain the importance of diet, exercise, and lifestyle in maintaining health and preventing illness, such as heart disease, high blood pressure, diabetes, skin cancer, and lung cancer.					We weren't able to sort any test item related to this objective
		B. Identify the dietary sources and role of nutrients in a healthy diet (vitamins, minerals, proteins, carbohydrates, and fats).	27.00	48.00	-21.00	-47.19	

Appendix 4.2.II

Items in Knowing Domain with high discrepancy in performance

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average difference in percent correct	Percent change
S062093	9	34	-25	-73.53
S062089	10	34	-24	-70.59
S062101	10	30	-20	-66.67
S052090B	7	19	-12	-63.16
S062094	21	50	-29	-58.00
S052069	26	55	-29	-52.73
S062274	6	12	-6	-50.00
S042016	15	30	-15	-50.00
S062064	31	61	-30	-49.18
S052267	23	45	-22	-48.89
S062279	31	57	-26	-45.61
S062106	46	73	-27	-36.99

Appendix 4.2.III

Items in Applying Domain with high discrepancy in performance

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average Difference in percent correct	Percentage Change
S062118	8	51	-43	-84.31%
S052265	7	30	-23	-76.67%
S052006	9	32	-23	-71.88%
S042030	7	24	-17	-70.83%
S062098B	3	10	-7	-70.00%
S052071	16	47	-31	-65.96%
S042222B	10	28	-18	-64.29%
S042049A	26	68	-42	-61.76%
S062111	10	26	-16	-61.54%
S042408	14	35	-21	-60.00%
S042005	14	33	-19	-57.58%
S042222A	9	19	-10	-52.63%
S052095Z	26	54	-28	-51.85%
S042222C	35	64	-29	-45.31%
S052094	16	29	-13	-44.83%
S062100	24	43	-19	-44.19%
S052095D	39	69	-30	-43.48%
S052095C	45	79	-34	-43.04%

Appendix 4.2.IV

Items in Reasoning Domain with high discrepancy

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average difference in percent correct	Percent Change
S052273	0	17	-17	-100.00%
S042049B	6	44	-38	-86.36%
S062103B	2	13	-11	-84.62%
S052085A	6	19	-13	-68.42%
S052021	11	34	-23	-67.65%
S042319	9	27	-18	-66.67%
S052085B	20	52	-32	-61.54%
S052303B	15	36	-21	-58.33%

Appendix 4. 3.I

Summary of indicators under Earth Science

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
I. Earth's Structure and Physical Features	I.1. Physical characteristics of Earth's surface	A. Describe the structure and physical characteristics of Earth's crust, mantle, and core as provided by observable phenomena, such as earthquakes and volcanoes.	11.00	41.00	-30.00	-74.09%	
		B. Describe the characteristics, uses, and formation of soils.					We weren't able to sort any test item related to this objective
		C. Describe the distribution of water on Earth in terms of its physical state (ice, water, and water vapor), and fresh versus salt water.	33.00	38.00	-5.00	-13.16%	Topic taught in Grade 4
		D. Describe the movement of water from higher to lower elevation or below ground to above ground.	27.00	46.75	-19.75	-47.40%	Not taught in the Earth Science curriculum but in Geography
	I.2. Components of Earth's atmosphere and atmospheric conditions	A. Recognize that Earth's atmosphere is a mixture of gases; and identify the relative abundance of its main components (nitrogen, oxygen, water vapor, and carbon dioxide), and relate these components to everyday processes.	42.33	47.67	-5.33	-11.81%	
		B. Relate changes in atmospheric conditions (temperature and pressure) to the altitude.	26.00	61.00	-35.00	-57.38%	Not related to any objective in Earth Science curriculum
II. Earth's Processes, Cycles, and History	II.1. Geological processes during Earth's history	A. Describe the general processes involved in the rock cycle, such as the cooling of lava, heat and pressure transforming sediment into rock, and weathering.	25.33	43.33	-18.00	-47.86%	

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		B. Identify or describe physical processes and major geological events that have occurred over millions of years, such as plate movement, volcanic activity, mountain building, and weathering.					We weren't able to sort any test item related to this objective
		C. Explain the formation of fossils and fossil fuels.	23.00	43.00	-20.00	-46.51%	Suspended
	II.2 Earth's water cycle	A. Diagram or describe the processes in Earth's water cycle (evaporation, condensation, and precipitation) and recognize the Sun as the source of energy for the water cycle.	34.00	50.25	-16.25	-32.01%	Taught in Grade 5
		B. Describe the role of cloud movement and water flow in the circulation and renewal of fresh water on Earth's surface.	45.00	50.00	-5.00	-10.00%	Not taught in the Earth Science curriculum but in Geography
	II.3. Weather and climate	A. Distinguish between weather (day-to-day variations in temperature, humidity, precipitation in the form of rain or snow, clouds, and wind) and climate (long-term typical weather patterns in a geographic area).					We weren't able to sort any test item related to this objective
		B. Interpret data or maps of weather patterns to identify different climates and relate differences in weather to global and local factors.	QA	33.50	-16.50	-54.88%	Not taught in the Earth Science curriculum but in Geography
		C. Compare seasonal climates in relation to latitude, altitude, and geography.	20.00	31.00	-11.00	-35.48%	Not taught in the Earth Science curriculum but in Geography (Also question language is incorrect)

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		D. Identify or describe possible causes and/or sources of evidence for climate changes, such as those that occur during ice ages or that are related to global warming.	27.00	54.00	-27.00	-50.00%	Not taught in the Earth Science curriculum but in Geography
III. Earth's Resources, Their Use and Conservation	III.1. Managing Earth's resources	A. Provide examples of renewable and nonrenewable resources.	45.00	65.00	-20.00	-30.77%	Taught in Grade 6
		B. Discuss advantages and disadvantages of different energy sources.	15.50	46.50	-31.00	-69.74%	Not taught in the Earth Science curriculum and not well stated in TIMSS objectives
		C. Describe methods of conservation of resources and methods of waste management, such as recycling.	19.00	33.00	-14.00	-42.42%	Taught in Grade 6 (superficial notion, recycling not well discussed)
		D. Propose ways that humans can address the negative effects of their activities on the environment.	21.00	31.00	-10.00	-29.54%	Taught in Grade 6
	III.2. Land and water use	A. Explain how common methods of land use, such as farming, logging, or mining can affect land and water resources.	1.00	31.00	-30.00	-96.77%	Taught in Grade 6
		B. Explain the importance of water conservation, and describe how purification, desalinization, and irrigation ensure that fresh water is available for human activities.	44.00	54.00	-10.00	-18.52%	Taught in Grade 10 and suspended
IV. Earth in the Solar System and the Universe	IV.1. Observable phenomena on Earth resulting from movements of Earth and the Moon	A. Distinguish between the effects of Earth's daily rotation about its axis and its annual revolution around the Sun, including how Earth's rotation and revolution relate to the appearance of constellations in the sky.	31.33	39.67	-8.33	-25.65%	Taught in Grade 6

Topic	Sub-Topic	Objectives	Average Percent correct in Lebanon	Average percent correct interna-tionally	Absolute Difference in percent correct	Percentage change	Possible cause(s) for Absolute Differences
		B. Explain that for most places away from the equator, the combination of the tilt of Earth's axis and its annual revolution around the Sun results in changing seasons.	33.67	48.33	-14.67	-31.22%	Not in Earth Science curriculum
		C. Recognize that tides are caused by the gravitational pull of the Moon and relate phases of the Moon and eclipses to the relative positions of Earth, the Moon, and the Sun.					We weren't able to sort any test item related to this objective
	IV.2. Features of Earth, the Moon, and other planets	A. Compare and contrast certain physical features of Earth (atmosphere, temperature, water, distance from the Sun, period of revolution and rotation, and ability to support life) with the Moon and other planets.	27.67	45.00	-17.33	-39.93%	Taught in Grade 6
		B. Recognize that it is the force of gravity that keeps the planets and moons in orbits as well as pulls objects to Earth's surface.	14.50	34.00	-19.50	-51.89%	Taught in Grade 6
Average			**26.67**	**43.53**	**-16.87**	**-41.29%**	

Appendix 4. 3.II

Items in Knowing Domain with high discrepancy in performance

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average difference in percent correct	Percent change
S042135	24	55	-31	-56.36%
S042164	13	44	-31	-70.45%
S042217	19	44	-25	-56.82%
S042301	15	49	-34	-69.39%
S052294	26	61	-35	-57.38%
S062170	37	64	-27	-42.19%
S062177	23	43	-20	-46.51%
S062189	19	33	-14	-42.42%
S062235	29	45	-16	-35.56%

Appendix 4. 3.III

Items in Applying Domain with high discrepancy in performance

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average difference in percent correct	Percentage Change
S042406	14	31	-17	-54.84%
S052289C	8	32	-24	-75.00%
S062024B	5	18	-13	-72.22%
S062173A	24	43	-19	-44.19%
S062180	27	54	-27	-50.00%

Appendix 4. 3.IV

Items in Reasoning Domain with high discrepancy in performance

TIMSS Item Number	Average correct percent Lebanon	Average correct percent internationally	Average difference in percent correct	Percent Change
S052116	1	31	-30	-96.77%
S062175	6	36	-30	-83.33%
S052101	7	33	-26	-78.79%
S062211B	2	9	-7	-77.78%
S062243	15	41	-26	-63.41%

Appendix 4. 3. V

Table A-1 : Distribution of TIMSS objective according to Lebanese school grades

- *Present in the Lebanese Curriculum have a score = 1*
- *Partially present in the Lebanese Curriculum have a score = 0.5*
- *Not present in the Lebanese curriculum have a score = 0*

TIMSS Topics and Subjects: Chemistry - G8	Objectives	Lebanese Schools Grades								Total
		5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade	
Composition of Matter										
Elements, compounds, and mixtures:	Identify examples of elements, compounds, and mixtures.	0	0	0.5	1	0	0	0	0	**1.5**
	Differentiate between pure substances (elements and compounds) and mixtures (homogeneous and heterogeneous) on the basis of their formation and composition.	0	0	0	0	0	0	0	0	**0**
Structure of atoms and molecules:	Describe the structure of matter in terms of particles (atoms and molecules).	0	0	0	1	0	0	0	0	**1**

TIMSS Topics and Subjects: Chemistry - G8	Objectives	Lebanese Schools Grades								Total
		5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade	
	Describe atoms as composed of subatomic particles (electrons surrounding a nucleus containing protons and neutrons).	0	0	0	1	0	0	0	0	**1**
	Describe molecules as combinations of atoms, such as H2O, O2, and CO2.	0	0	0	1	0	0	0	0	**1**
Properties of Matter										
Physical and chemical properties of matter:	Distinguish between physical and chemical properties of matter.	0	0	0	0	0	0	0	0	**0**
	Relate uses of materials to their physical properties, such as melting point and boiling point, the ability to dissolve many substances, and thermal conductivity.	0	0	0	0	0	0	0	0	**0**
	Relate uses of materials to their chemical properties, such as rusting and flammability.	0	0	0	0	0	0	0	0	**0**
Physical and chemical properties as a basis for classifying matter:	Classify substances according to physical properties that can be demonstrated or measured, such as density, melting or boiling point, solubility, magnetic properties, and electrical or thermal conductivity.	0	0	0.5	1	0	0	0	0	**1.5**
	Classify substances according to their chemical properties (metals/ nonmetals, and acids/bases).	0	0	0	0.5	0	0	0	0	**0.5**
Mixtures and solutions:	Explain how physical methods can be used to separate mixtures into their components.	0	0	1	0	0	0	0	0	**1**
	Describe solutions in terms of substance(s) (solid, liquid, or gas solutes) dissolved in a solvent.	0	0	1	0	0	0	0	0	**1**
	Relate the concentration of a solution to the amounts of solute and solvent present.	0	0	1	0	0	0	0	0	**1**
	Explain how temperature, stirring, and surface area affect the rate at which solutes dissolve.	0	0	1	0	0	0	0	0	**1**

TIMSS Topics and Subjects: Chemistry - G8	Objectives	Lebanese Schools Grades								Total
		5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade	
Properties of acids and bases:	Recognize everyday substances as acids or bases based on their properties (acids have a sour taste, react with metals and have pH less than 7; and bases usually have a bitter taste, feel slippery, do not react with metals, and have pH greater than 7)	0	0	0	1	0	0	0	0	1
	Recognize that both acids and bases react with indicators to produce different color changes.	0	0	0	1	0	0	0	0	1
	Recognize that acids and bases neutralize each other.	0	0	0	1	0	0	0	0	1
Chemical Change										
Characteristics of chemical changes:	Differentiate chemical from physical changes in terms of the transformation (reaction) of one or more pure substances (reactants) into different pure substances (products).	0	0	1	0	0	0	0	0	1
	Provide evidence (temperature changes, gas production, precipitate formation, color change, or light emission) that a chemical change has taken place.	0	0	1	0	0	0	0	0	1
	Recognize that oxygen is needed in common oxidation reactions (combustion, rusting, and tarnishing) and relate these reactions to everyday activities such as burning wood or preserving metal objects.	0	0	1	0	0	0	0	0	1
Matter and energy in chemical changes:	Recognize that matter is conserved during a chemical change and that all of the atoms present at the beginning of the reaction are present at the end of the reaction, but they are rearranged to form new substances.	0	0	1	0	0	0	0	0	1

TIMSS Topics and Subjects: Chemistry - G8	Objectives	Lebanese Schools Grades								Total
		5th Grade	6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade	
	Recognize that some chemical reactions release energy (heat and/or light) while others absorb it and classify familiar chemical reactions (such as burning, neutralization, and cooking) as either releasing heat or absorbing heat.	0	0	1	0	0	0	0	0	1
Chemical bonds:	Recognize that a chemical bond is caused by the forces between atoms in a compound and that the atoms' electrons are involved in this bonding.	0	0	0	0	1	0	0	0	1
Number of objectives from TIMMS present in LP (Score = 1)		0	0	9	8	1	0	0	0	18
Number of objectives from TIMSS partially present in LP (Score = 0.5)					1	0	0	0	0	1
Number of objectives from TIMSS not present in LP (Score = 0)										4
Total number of TIMMS Objectives for Grade 8	23									

CHAPTER 5

School Composition and Resources

This chapter draws on responses from the school principals to report on two demographic characteristics of their schools which are:

- Economic home background (reported by principals); and
- Language home background. (reported by principals) as well as
- School Shortages (Reported by principals)
- Problems in school conditions and resources as reported by teachers.

TIMSS previous results revealed that students coming mainly from disadvantaged backgrounds have a higher achievement if they attend schools with students from advantaged backgrounds (Mullis et. al., 2011) . Previous TIMSS assessments also showed that students from home backgrounds supportive of learning are likely to have more positive attitudes toward learning (Martin et. al., 2011). Similar results were held if students spoke the language of the test as their first language. Math and science achievement was highest for students in schools where most students spoke the language of the TIMSS assessment as their first language, and was progressively lower as percentages of students not having the TIMSS language as their first language increased.

5.1 – Economic home background

The students' economic categorization according to the principals' responses were classified as:

- More Affluent - Schools where more than 25% of the student body comes from economically affluent homes and not more than 25% from economically disadvantaged homes.
- More Disadvantaged - Schools where more than 25% of the student body comes from economically disadvantaged homes and not more than 25% from economically affluent homes
- Neither more affluent nor more disadvantaged.

The results were extracted from the principals' questionnaire (Figure 1). Based on principals' responses to these statements, their students were assigned to one of three categories: more affluent, more disadvantaged or neither more affluent nor more disadvantaged.

Figure 1. Questionnaire for School Principals about Students' Economic Background

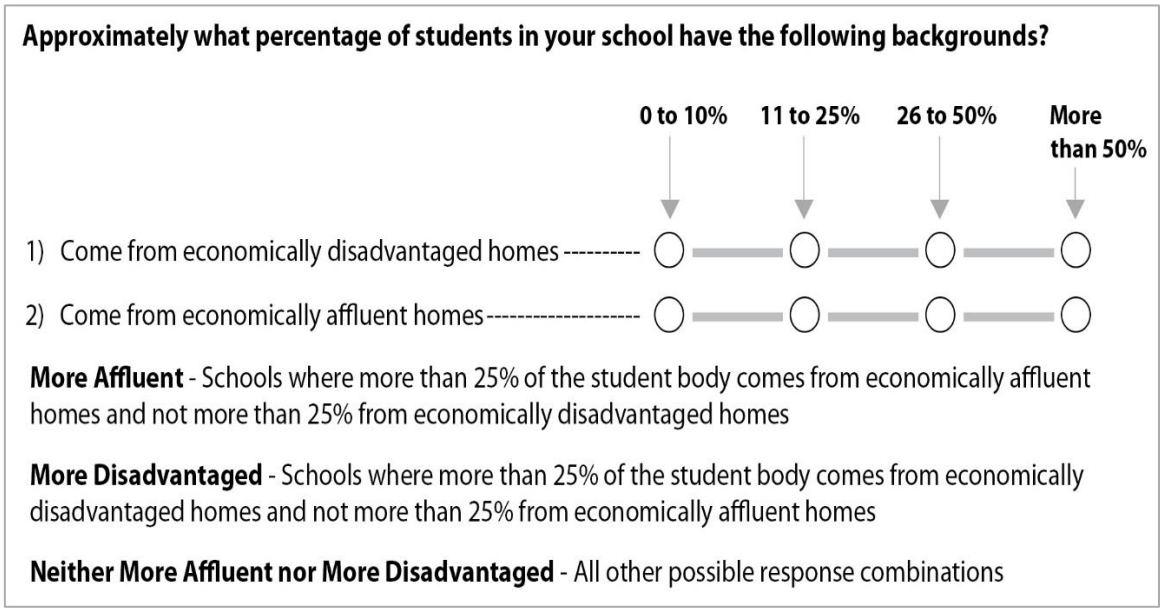


Figure 1. TIMSS questionnaire *assessing principals' views on their schools' economic categorization in Grade 8 Science and Mathematics*

Table 1 shows the school composition by student background and its association with achievement in math and science. Results show a decrease in the average achievement on the international level as the degree of economically disadvantaged homes increases. However, this does not seem the case in Lebanon. Average achievement is highest in Lebanon for both math and science for students whose economic background was classified as neither more affluent nor more disadvantaged and not for the "more affluent" schools as reported internationally. Table 1 also shows that 53% of Lebanese students come from a background that is more disadvantaged compared to 36% internationally, a high percentage that needs to be studied thoroughly in future studies in which sample stratification is to be implemented. Moreover, this category got the lowest averages, so the results are affected a lot by the economic variable and this is the trend internationally also. Lebanese average is significantly lower at every category and performance in medium category significantly higher.

Results also reveal that percentage of students with a background that is "more disadvantaged" is 15% percent higher than those in the international sample, while and the percentage of "more affluent" is higher internationally than it is for Lebanon.

Table 1. School composition by economic background in grade 8 Science and Math (Principal Data)

Subject	Country	More Affluent		Neither More Affluent nor More Disadvantaged		More Disadvantaged	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	19(3.9)	405(16.6)	29 (4.1)	439 (9.6)	53 (4.5)	375 (8.6)
	International Average	31(0.5)	517 (1.4)	34 (0.6)	491 (1.2)	36 (0.5)	462 (1.3)
Math	Lebanon	19 (3.9)	452 (11.9)	29 (4.1)	470 (6.9)	53(4.5)	426(6.3)
	International Average	31 (0.5)	513 (1.4)	34 (0.6)	486 (1.2)	36 (0.5)	457 (1.3)

5.2. Students having the language of the test as their native language

The TIMSS test in Lebanon is taken either in English or in French though mainly the language spoken at home is Arabic. The results for this section depends on the principals' responses. The categorization of responses was:

- School has more than 90% of students with language of test as their native language.
- School has 51-90% of students with language of test as their native language.
- School has 50% or less of students with language of test as their native language.

Table 2 displays the distribution of sample of schools in Lebanon compared to the international average of students having the language of the test as their native language associated with the average achievement in math and science in Lebanon and internationally.

Table 2. Schools with Students Having the Language of the Test as Their Native Language

Subject	Country	More than 90% of the Students		51% - 90%		50% of students or Less	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	4(1.6)	377 (32.3)	9 (2.6)	425 (19.7)	87 (3.1)	398 (5.9)
	International Average	64 (0.4)	485 (1.2)	14 (0.4)	491 (2.1)	22 (0.3)	477 (2.5)
Math	Lebanon	4(1.6)	423 (22.4)	9 (2.6)	465 (14.9)	87 (3.1)	442 (3.9)
	International Average	64 (0.4)	478 (1.0)	14 (0.4)	483 (1.9)	22 (0.3)	475 (2.6)

A striking difference between the percentages of students having the language of the test as their native language in Lebanon and internationally is due to the fact that students in Lebanon mainly study mathematics and science at school in English or French and not in their native language. That is why only 4% of the Lebanese students were in schools where almost all students (more than 90%) have the language of the test as their native language as compared with 64% internationally. Actually most of the Lebanese students (87%) were in schools where less than 50% of students have the language of the test as their native language as compared to 22% internationally. On the other hand, there is no considerable association between the average achievement and language of test as native language since students of schools where 50 to 90% with language of test as their native language tended to perform better in mathematics and science than students of schools where more than 90% have their language of the test as their native language this applies both to international and Lebanese results, though differences in international sample are smaller.

5.3 – Instruction affected by mathematics and sciences resource shortages

The extent to which teaching is affected by resource shortages is also reported by school principals. Students were scored according to their principals' responses concerning thirteen school and classroom resources on the mathematics and sciences resource shortages scales. The questionnaire is shown in figures 2 and 3.

The principals' questionnaire focuses on the extent to which the school's capacity to provide instruction is affected by a shortage or inadequacy of resources. For each subject, there is the same set of initial statements focused on general school resources and a second set focused specifically on the subject in question (see Figure 2 below). In science, the statements are the same for mathematics with just the subject name changed, except for year 9 for which there is an additional statement relating to the availability of calculators.

Based on principals' responses to these statements, students were assigned to one of three categories; those taught in schools in which the capacity to provide instruction was: not affected, affected or affected a lot by resource shortages, though for math the difference between 'instruction affected' and 'instruction affected a lot' was not significant..

Figure 2. Questionnaire for School Principals about Mathematics Resources Shortage

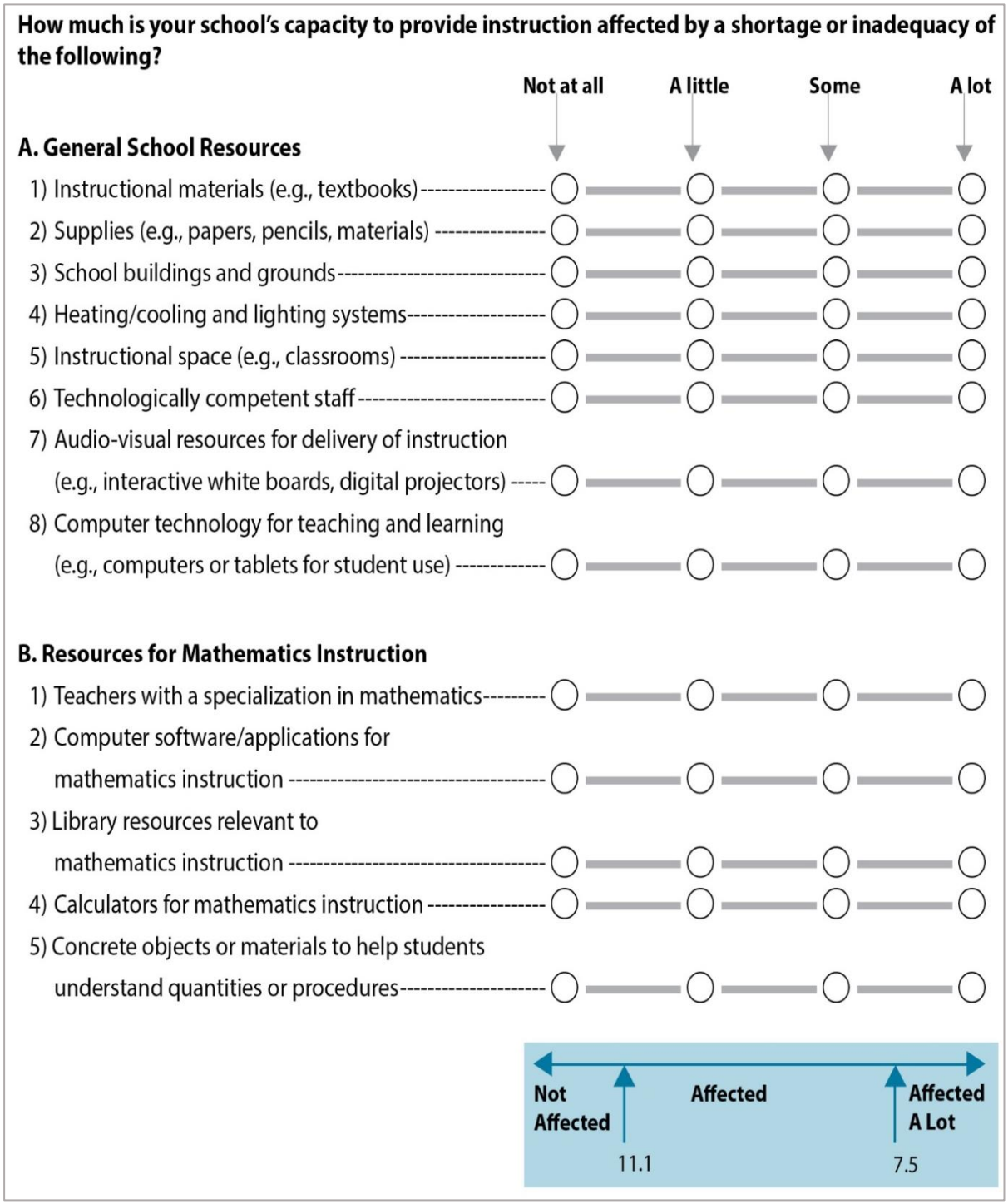


Figure 3. Questionnaire for School Principals about Sciences Resources Shortage

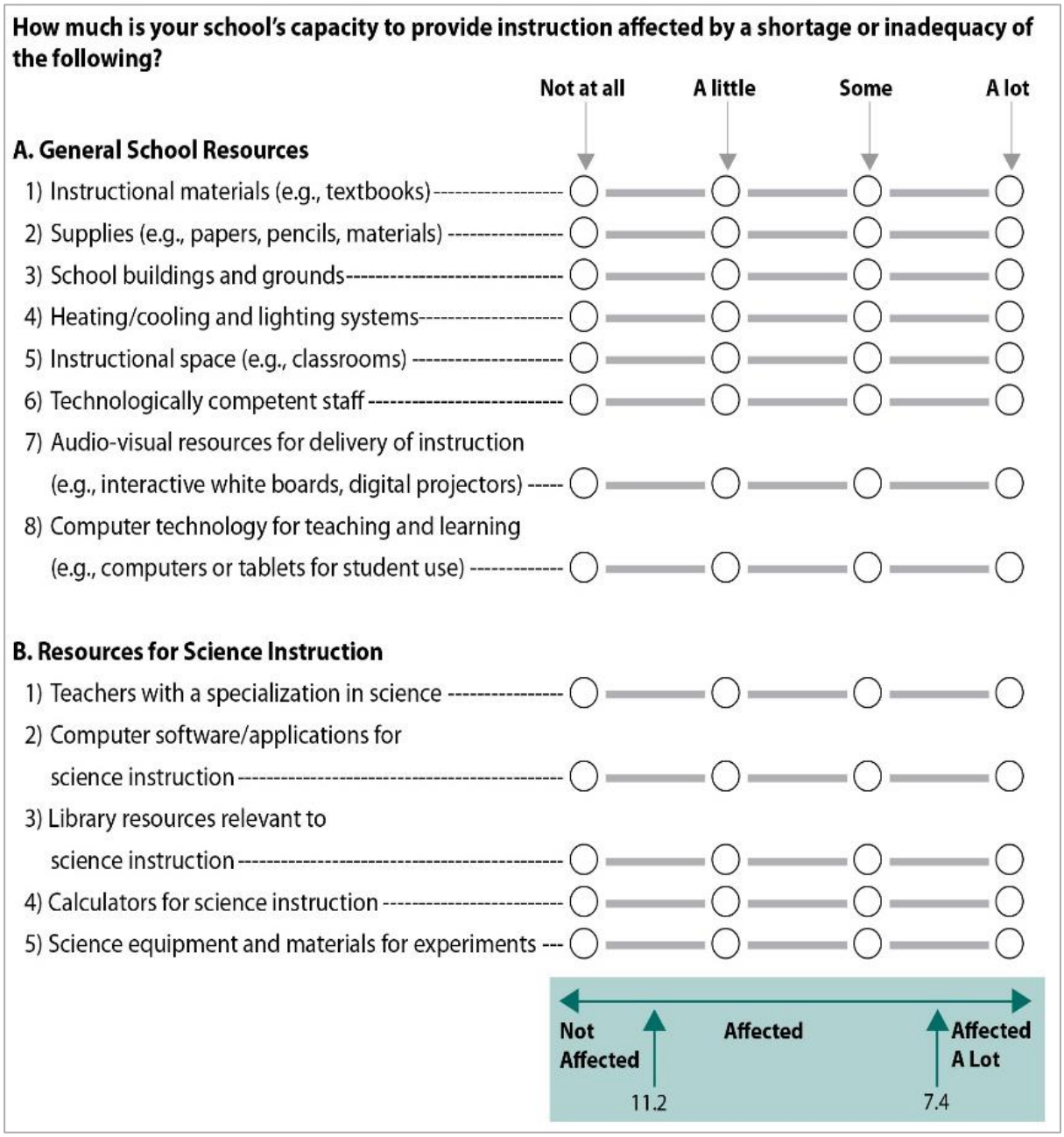


Table 4. Category criteria for students whose school principals reported on effect of resource shortages on mathematics and sciences instruction.

Category	Subject	Scale Score	Category criteria
Instruction not affected by resource shortages	Mathematics	Score of at least 11.1	Students in schools with principals reporting that shortages affected instruction "not at all" for seven of the thirteen resources and "a little" for the other six, on average
	Biology, Chemistry and Physics	Scale score of at least 11.2	Students in schools with principals reporting that shortages affected instruction "not at all" for seven of the thirteen resources and "a little" for the other six, on average
Instruction affected a lot by resource shortages	Mathematics	Scale score no higher than 7.5	Students in schools with principals reporting that shortages affected instruction "a lot" for seven of the thirteen resources
	Biology, Chemistry and Physics	Scale score no higher than 7.4	Students in schools with principals reporting that shortages affected instruction "a lot" for seven of the thirteen resources
Instruction affected by resource shortages		All other students in schools	

The effect of resource shortages in mathematics and sciences instruction is revealed in table 5 together with the average achievement in Lebanon and internationally. Results show that majority of Lebanese (more than 50%) and international students were affected by resource shortages in instruction as reported by the school principals while the minority were not affected (less than 30%) or affected a lot (less than 20%). However, though the international trend shows that the less the effect of shortages the higher the achievement, this is not the case in Lebanon. Highest achievement was for students whose instruction was not affected by resource shortages followed by those whose instruction was affected a lot by resource shortages and the least achievement was for students whose instruction was affected by resource shortages.

Table 5. Effect of Resource Shortages on Mathematics and Sciences Instruction and achievement in grade 8 Science and Math (Principal Data)

Subject	Country	Instruction Not Affected by Resource Shortages		Instruction Affected by Resource Shortages		Instruction Affected A Lot by Resource Shortages	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	15 (2.7)	456 (12.8)	73 (3.0)	384 (6.7)	12 (2.5)	411 (15.1)
	International Average	27 (0.5)	509 (1.8)	65 (0.5)	480 (0.7)	7 (0.3)	465 (2.6)
Math	Lebanon	14 (2.8)	469 (9.2)	78 (3.0)	436 (4.4)	8 (1.5)	443 (9.3)
	International Average	27 (0.5)	506 (1.8)	66 (0.5)	476 (0.7)	6 (0.3)	448 (2.9)

5.4 – Problems with school conditions and resources

In this section, resources involved:

- School buildings and ground and services related to these
- Instructional materials and supplies
- Staff
- Audio-visual resources and computer technology

Teachers reported their views on the levels of school conditions and resource problems using a questionnaire (see Figure 4 below). Students were scored according to their teachers' responses concerning seven conditions and resources on the problems with school conditions and resources scale. Teachers' responses were classified as: hardly any problem, moderate to severe problems or minor problems (see table 6).

Figure 4. Questionnaire for Teachers about Problems in School Conditions and Resources

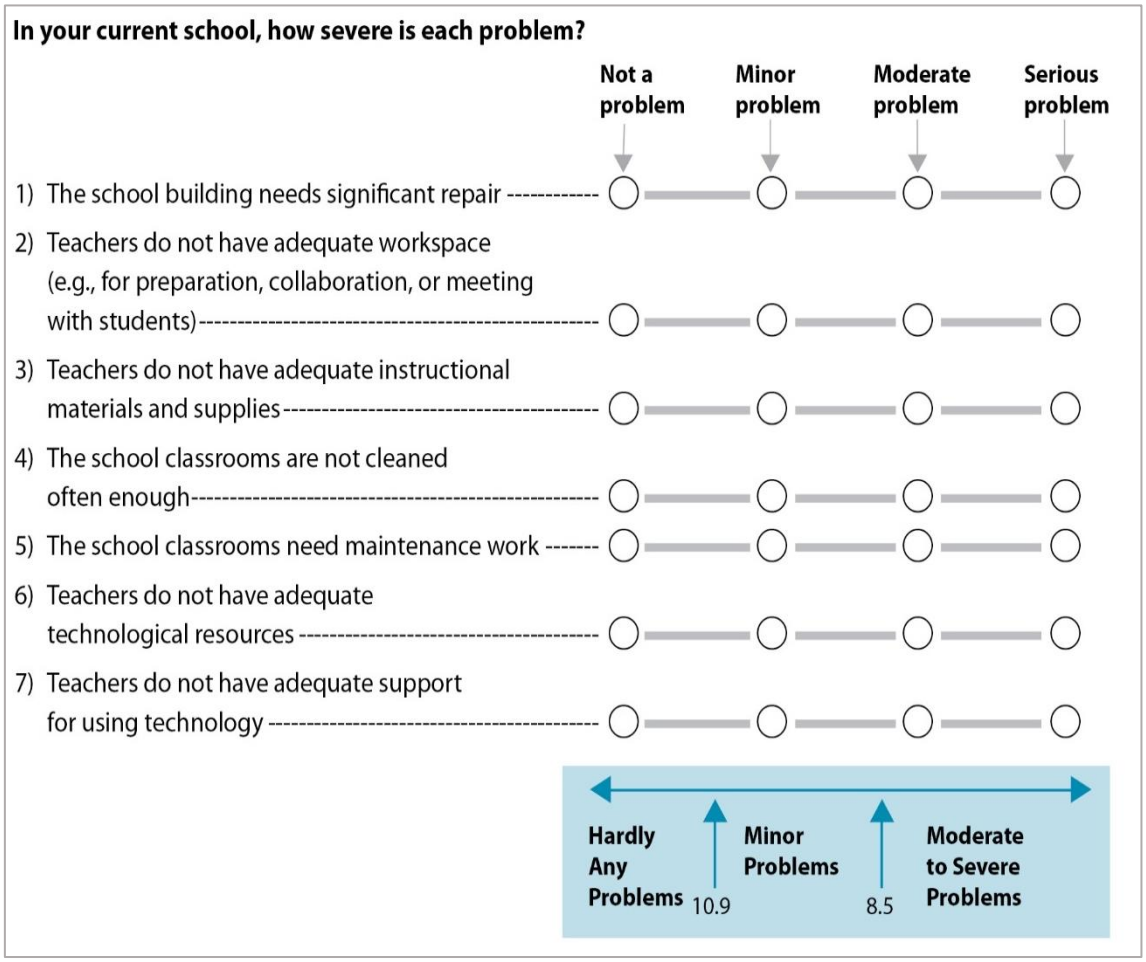


Table 6. Category criteria for students taught Science by teachers facing challenges

Category	Scale Score	Category criteria
Hardly any problems	Scale score of at least 10.9	Students with teachers reporting "not a problem" for four of seven conditions and resources and "minor problem" for the other three, on average
Moderate to severe problems	Scale score no higher than 8.5	teachers reporting "moderate problem" for four of seven conditions and resources and "minor problem" for the other three, on average
Minor problems	All other students in schools	

Association between percentages of students whose teachers reported school problems and average achievement for Lebanon and internationally in mathematics and sciences is displayed in Table 7.

Results reveal that 50% of students whose science teachers claimed that there is hardly any problem in their school resources and conditions while there were only 34% internationally who stated there was hardly any problem in their schools. Similar results in mathematics, 45% of students have their teachers reporting no problem in their schools in Lebanon compared to 34% internationally. Only 14% of students in Lebanon have their science teachers reporting moderate to severe problems in their schools as compared to 23% internationally. A similar result applies to math teachers.

Association of achievement with the decrease of problems in school conditions and resources is consistent in Lebanon and internationally, overall. It is clear that the less the problems, the higher the average achievement. However, in science the difference among 'hardly any problem' and 'minor problems' is not significant; similarly in math, the difference among 'minor problems' and 'moderate to severe problems' is not significant.

Table 7. Effect of Problems with School Resources and Conditions on Mathematics and Sciences achievement in grade 8 Science and Math (Teacher Data)

Subject	Country	Hardly any problem		Minor problems		Moderate to severe problems	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	50 (4.6)	412 (10.7)	36 (3.9)	394 (7.8)	14 (3.1)	358 (13.3)
	International Average	34 (0.5)	500 (1.2)	43 (0.5)	486 (0.9)	23 (0.5)	475 (1.3)
Math	Lebanon	45 (4.6)	451 (5.8)	37 (4.1)	438 (6.1)	19 (3.2)	426 (11.9)
	International Average	34 (0.5)	493 (1.2)	44 (0.6)	481 (0.9)	22 (0.5)	470 (1.5)

This chapter dealt with issues related to school composition and resources. The variables discussed were economic home background of students as reported by principals; language home background as reported by principals, school shortages as reported by principals also and problems in school conditions and resources as reported by teachers. Results showed that majority of Lebanese students came from more disadvantaged homes and their average was the lowest. As for students having their native language as the language of the test, results in Lebanon were opposing to those on the international level. Less than 5% of the Lebanese students were in schools where the majority of students have the language of the test as their native language as compared with 64% internationally. Most of the Lebanese students were in schools where the minority have the language of the test as their native language as compared to 22% internationally. It was noticed that there was a weak association between language of the test being the native language of students and the average achievement. Concerning the school shortages as reported by the principals and the problems in school conditions and resources as reported by teachers were contradictory. On one hand 73% of Lebanese students whose principals reported that they have school shortages in sciences and 78% of students whose principals reported that they have school shortages in mathematics, 50% of students have their science teachers and 45% having their mathematics teachers reporting that they have hardly any problem in school resources and conditions. It was also noted that school conditions as reported by teachers were compatible with students' achievements whereas that was not the case when the shortage in the resources was reported by principals. The minimal averages were attained by students whose principals reported that their schools were affected by shortage in resources not those who were affected a lot by resources.

CHAPTER 6

School Climate

This chapter draws on responses from the principal questionnaire, teacher questionnaire, and student questionnaire to analyze data about the climate in Lebanese schools, and how these compare internationally. Indices include:

I- Parents' perception of school performance (***not available for Grade 8 Science or Math***)
II- School emphasis on academic success (principals' report)
III- School emphasis on academic success (teachers' report)
IV- Teacher job satisfaction
V- Challenges facing teachers
VI- Students' sense of school belonging

Data analysis will help probe:

- The extent to which schools in Lebanon emphasize academic success
- Whether or not teachers are satisfied in their teaching
- The extent to which teaching is affected by challenges
- The extent to which students have a sense of belonging to their schools

6.1 – Emphasis on Academic Success

The extent to which grade 8 students were taught Science and Math in schools that emphasize academic success was determined using attitudinal questionnaires which assessed the views of principals and teachers separately. Both questionnaires included the 13 statements shown in Figure 6.1 below, with the teacher questionnaire having an additional item (numbered 14: 'Collaboration between school leadership and teachers to plan instruction'). Participants rated items on a five-point scale (Figure 6.2).

Figure 6.1. TIMSS Questionnaire Assessing Principals' Views on Their Schools' Emphasis on Academic Success in Grade 8 Science and Mathematics

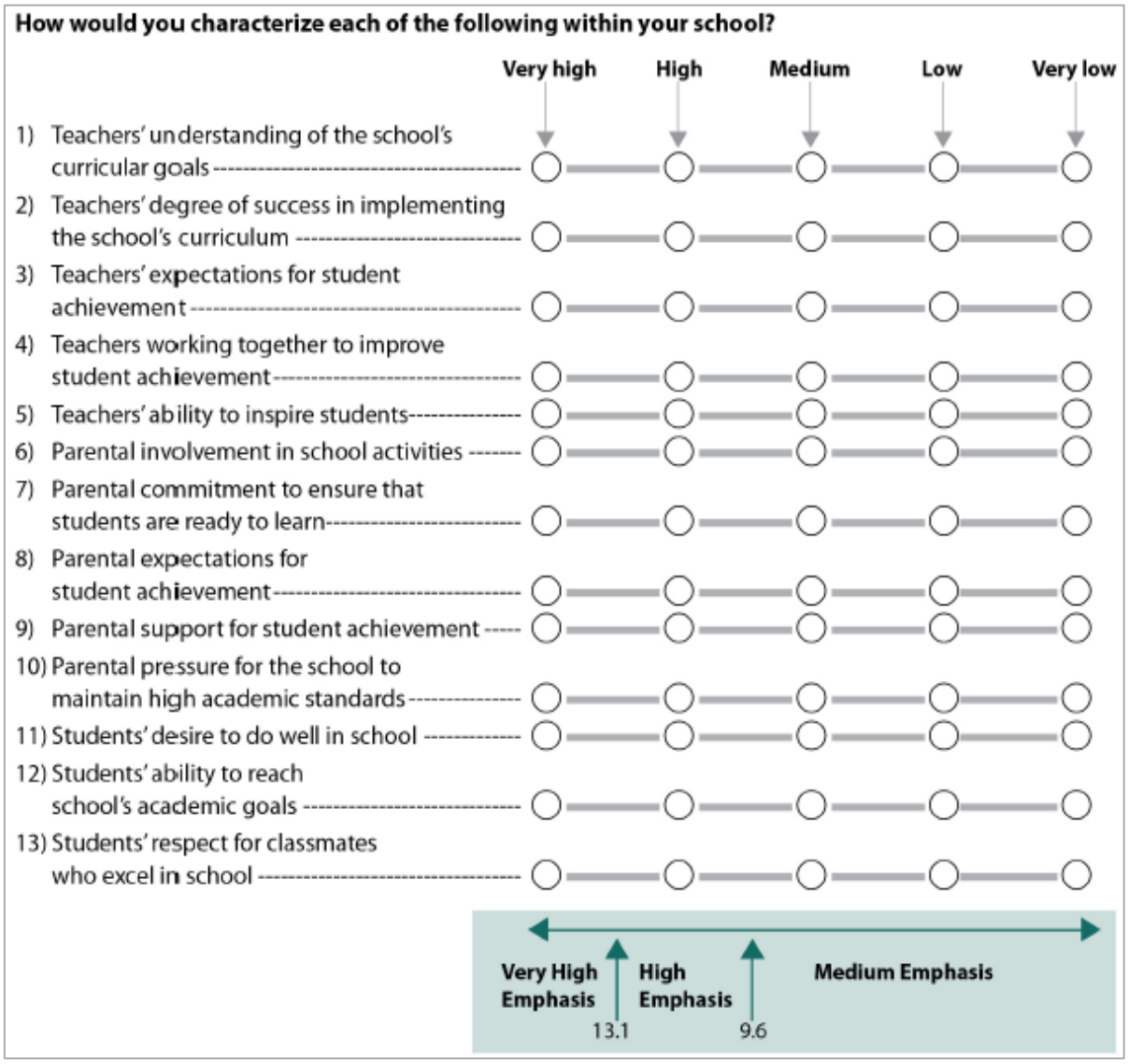
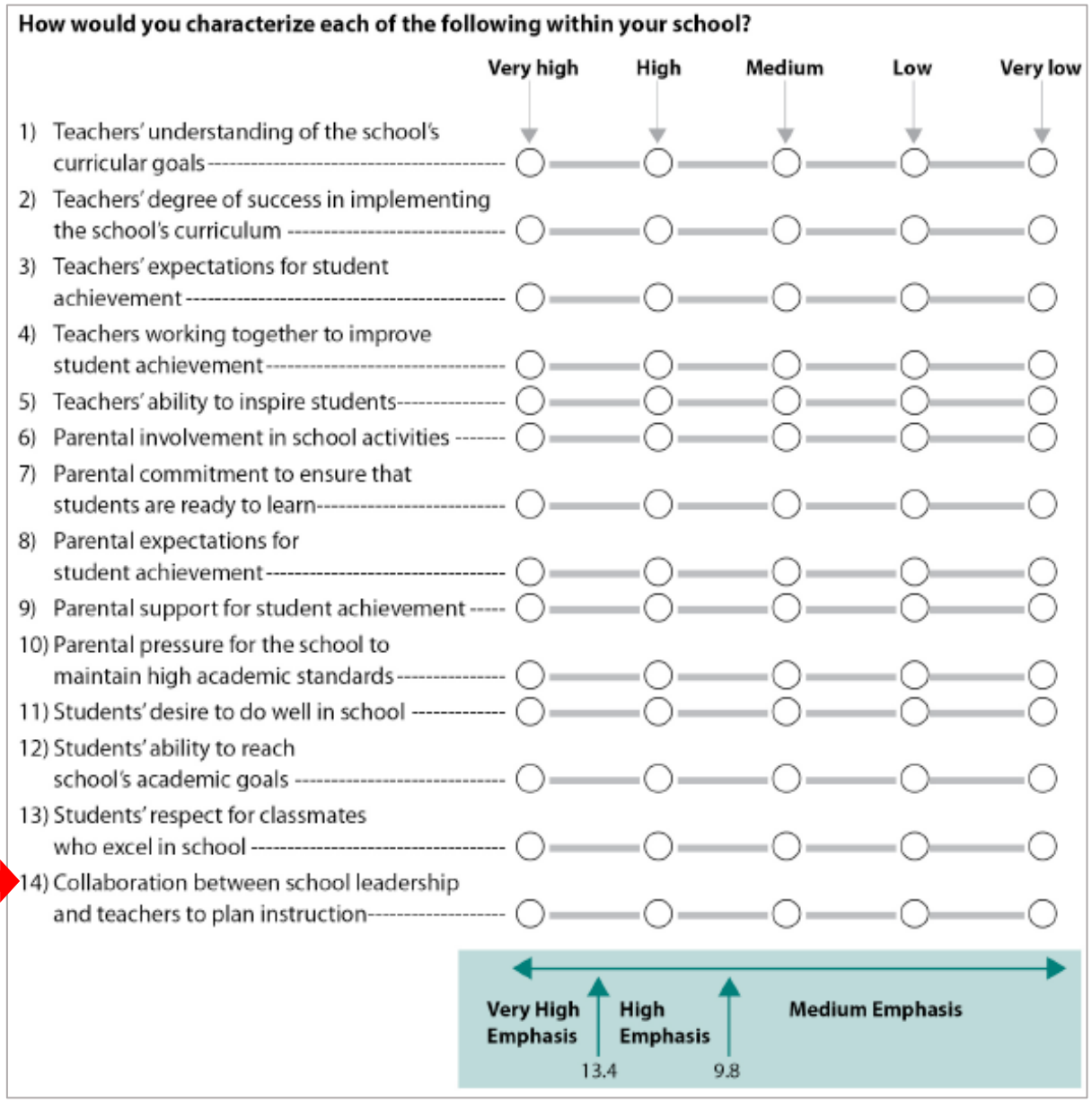


Figure 6.2. TIMSS questionnaire assessing teachers' views on their schools' emphasis on academic success in Grade 8 Science and Mathematics



Based on principals' responses to these statements, their students were assigned to one of three categories: very high emphasis, high emphasis, or medium emphasis (Tables 6.1 and 6.2). The findings from the principals' and teachers' questionnaires are presented in the following sections with reference to results that are notably different for both Science and Mathematics. Full findings can be found in the TIMSS International Report 2015. *https://nces.ed.gov/timss/*

Table 6.1. Category Criteria for Students Taught Science and Mathematics in Schools that Emphasize Academic Success (based on principals' questionnaire responses)

Category	Scale Score	Category criteria
Very high emphasis	Scale score ≥ 13.1	Characterizing seven of the 13 statements as 'very high' and the other six as 'high'
Medium emphasis	Scale score ≤ 9.6	Characterizing seven of the 13 statements as 'medium' and the other six as 'high'
High emphasis	All students with scores ≥9.6 and <13.1	

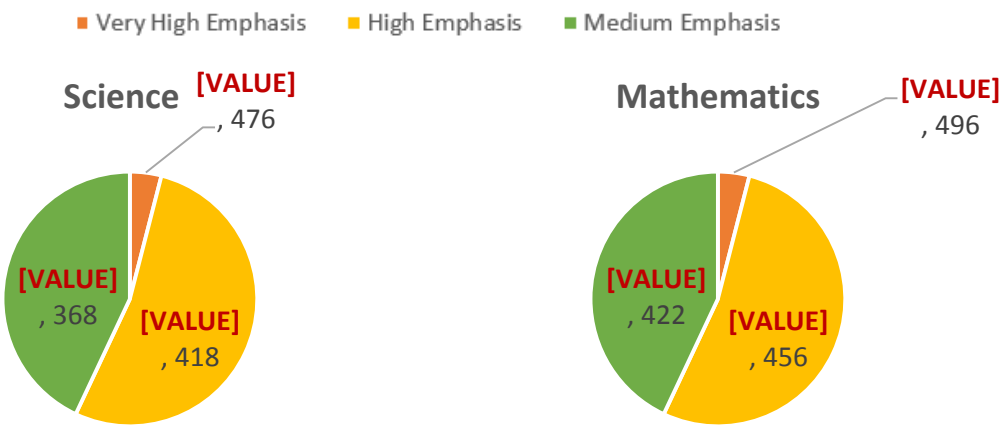
Table 6.2. Category Criteria for Students Taught Science and Mathematics in Schools that Amphasize Academic Success (based on teachers' questionnaire responses)

Category	Scale Score	Category criteria
Very high emphasis	Scale score ≥ 13.4	Characterizing seven of the 14 statements as 'very high' and the other seven as 'high'
Medium emphasis	Scale score ≤ 9.8	Characterizing seven of the 14 statements as 'medium 'and the other seven as 'high'
High emphasis	All students with scores >9.8 and <13.4	

6.1.1 – Emphasis on Academic Success: Principals' Report

Despite the variation in the mean of Lebanese Grade 8 students' academic achievement, the percentage of students taught in schools with emphasis on academic success (very high, high, and medium) was the same in both Science and Math, according to the principals' questionnaire (Figure 6.3).

Figure 6.3. Percentage and Average TIMSS Scores of Lebaense Grade 8 students taught Science and Mathematics according to their principals' relative emphasis on academic success



A positive association between school principals' emphasis on academic success and students' average achievement in Lebanon may be noted: the more the emphasis on academic success, the higher the academic achievement of students (Table 6.3). This relation is also observed internationally. Moreover, findings revealed that the difference in students' average achievement in Science where school principals have a very high emphasis on academic success compared to a medium emphasis is greater in Lebanon compared to the international average of other participating countries (108 scale points compared to 67 internationally). Though such a difference is lower in Mathematics (74 scale points compared to 69 internationally), yet achievement was significantly higher as we move from medium emphasis to very high emphasis.

Table 6.3 also reveals that Lebanese student achievement in Math was consistently higher than their achievement in Science for all levels of emphasis on academic success. In addition, international achievement in Science and Math was always higher compared to achievement of Grade 8 students Lebanon.

Table 6.3. School emphasis on academic success in grade 8 Science and Math (Principal Data)

Subject	Country	Very High Emphasis		High Emphasis		Medium Emphasis	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	4(1.7)	476(18.5)	53(4.4)	418(8.7)	43(4.0)	368(7.5)
	International Average	7(0.3)	533(3.0)	48(0.6)	499(1.0)	45(0.5)	466(0.9)
Math	Lebanon	4(1.7)	496(18.7)	53(4.4)	456(5.7)	43(4.0)	422(5.3)
	International Average	7(0.3)	531(3.2)	48(0.6)	494(0.9)	45(0.5)	462(0.8)

6.1.2 – Emphasis on Academic Success: Teachers' Report

Findings reveal that the percentages of students taught by Math teachers who put very high and medium emphasis on academic success are higher than those in Science. On the other hand, the percentage is lower for students whose Math teachers place a high emphasis on academic success (Figure 6.4).

Figure 6.4. Percentage and average TIMSS Scores of Grade 8 students taught Science and Mathematics according to their teachers' relative emphasis on academic success

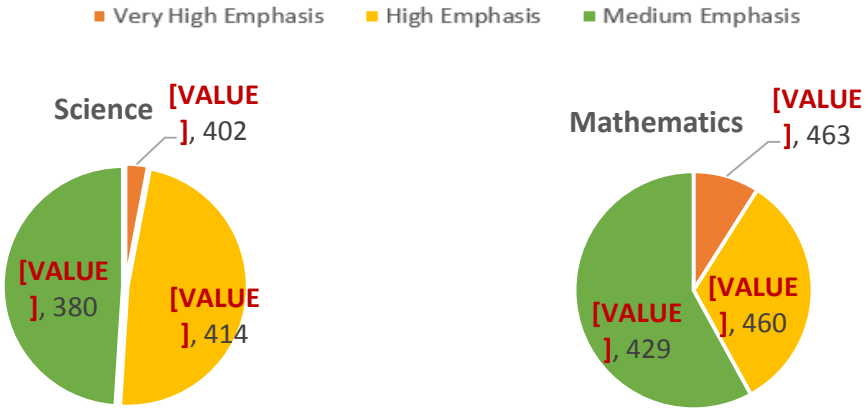


Table 6.4 reveals that the average achievement of Grade 8 students taught Math is consistently higher than achievement of students taught by Science teachers across all levels of emphasis on academic success. Grade 8 students studying Science in Lebanon, however, achieved highest in Science when teachers at schools put High and Very High Emphasis on academic success compared to Medium Emphasis (414 and 402 scale points compared to 380 respectively). Having Very High and High Emphasis has same impact on achievement in science.

On the contrary, an international comparison showed that the average achievement of Grade 8 students taught by Science teacher was higher than achievement of students taught by Math teachers across all levels of emphasis on academic success. A positive association between school teachers' emphasis on academic success and students' average achievement internationally may be noted: the more the emphasis on academic success, the higher the academic achievement of students (Table 6.4).

Unlike data from principals' questionnaires, the difference in average achievement between Grade 8 students taught in schools that have a very high emphasis and a medium emphasis on academic achievement according to the teachers' questionnaire is lower in Lebanon compared to the international average of other participating countries for both science and math (22 scale points compared to internationally 49, and 34 scale points compared to 51 internationally respectively).

Table 6.4. School emphasis on academic success in grade 8 Science and Math (Teacher Data)

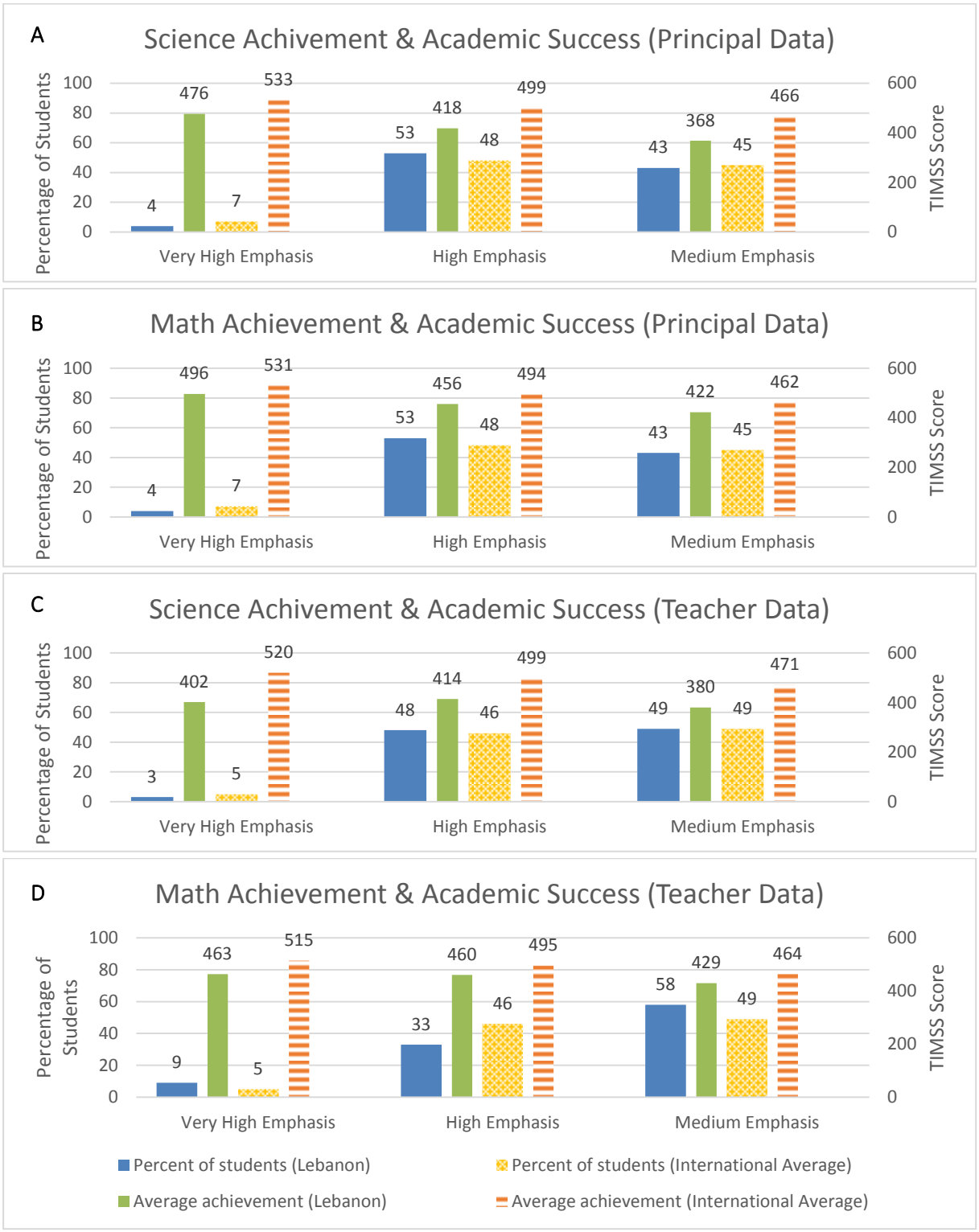
Subject	Country	Very High Emphasis		High Emphasis		Medium Emphasis	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	3 (1.1)	402 (28.3)	48 (4.3)	414 (10.2)	49 (4.2)	380 (7.7)
	International Average	5 (0.2)	520 (3.5)	46 (0.5)	499 (0.9)	49 (0.5)	471 (0.8)
Math	Lebanon	9 (2.5)	463 (12.7)	33 (3.5)	460 (5.7)	58 (3.8)	429 (5.3)
	International Average	5 (0.2)	515 (3.6)	46 (0.5)	495 (0.9)	49 (0.5)	464 (0.8)

6.1.3 – Emphasis on Academic Success: Principals vs. Teachers' Report

According to data presented in Table 6.4 and Figure 6.5, the general trend of Grade 8 students in Lebanon taught in schools with a high emphasis on academic success was similar, according to both principal and teacher questionnaire responses. However, fewer students were taught in schools with a high emphasis (very high and high) on academic success according to their Science teachers compared to their principals (51% compared to 57% in Science and 42% compared to 57% in Mathematics).

As in data collected from principals' questionnaires, there is a general positive association between an emphasis on academic success and average achievement, both in Lebanon and, on average, across all participating countries, with a clearer association according to principal results.

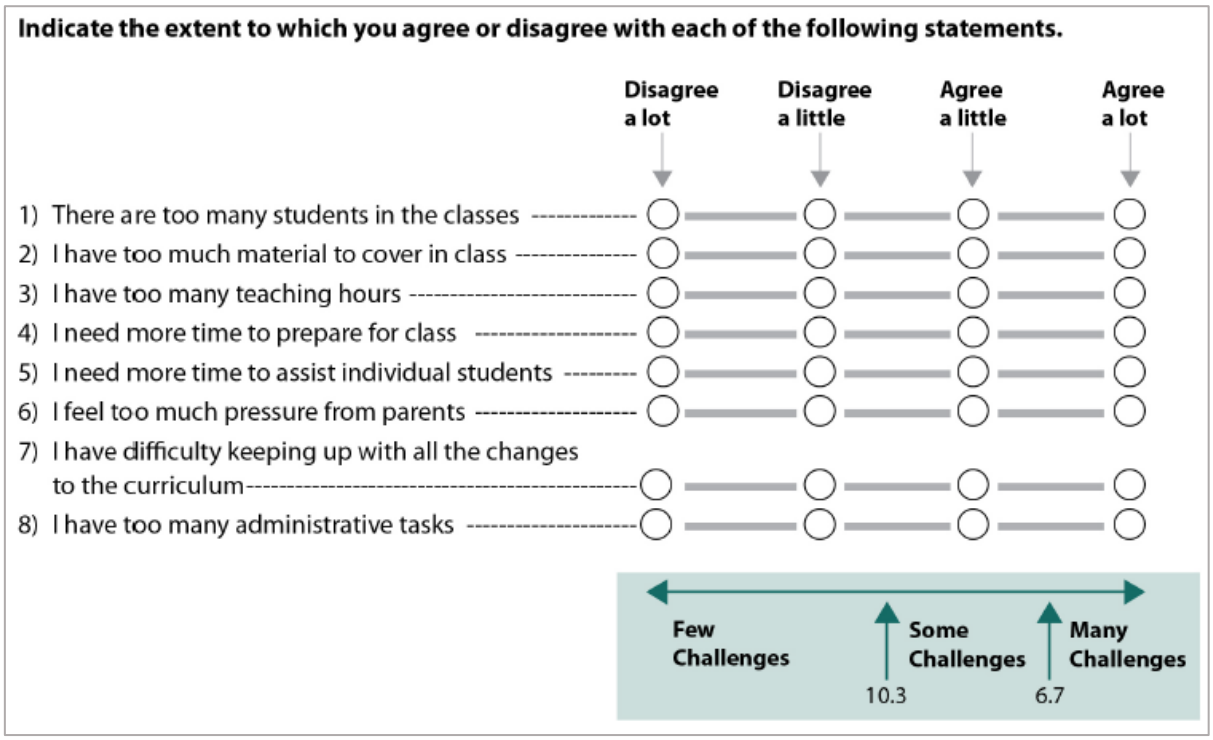
Figure 6.5. Grade 8 students' percentages and achievement in Science and Math according to the level of emphasis on academic success (Lebanon and international comparison)



6.2 – Teachers Facing Challenges

The extent to which grade 8 students were taught in schools where teachers faced different levels of challenges was assessed through a teachers' questionnaire. The same questionnaire comprised of 8 statements rated on a four-point scale was used in both subjects (Science and Mathematics). Figure 6.6 shows the questionnaire and the challenges it focuses upon, including the number of students in class, preparation time and materials that need to be covered, the teaching hours, and pressure from parents and the administration.

Figure 6.6. TIMSS 2015 Questionnaire Assessing the Extent to Which Teachers Face Challenges (teacher report)



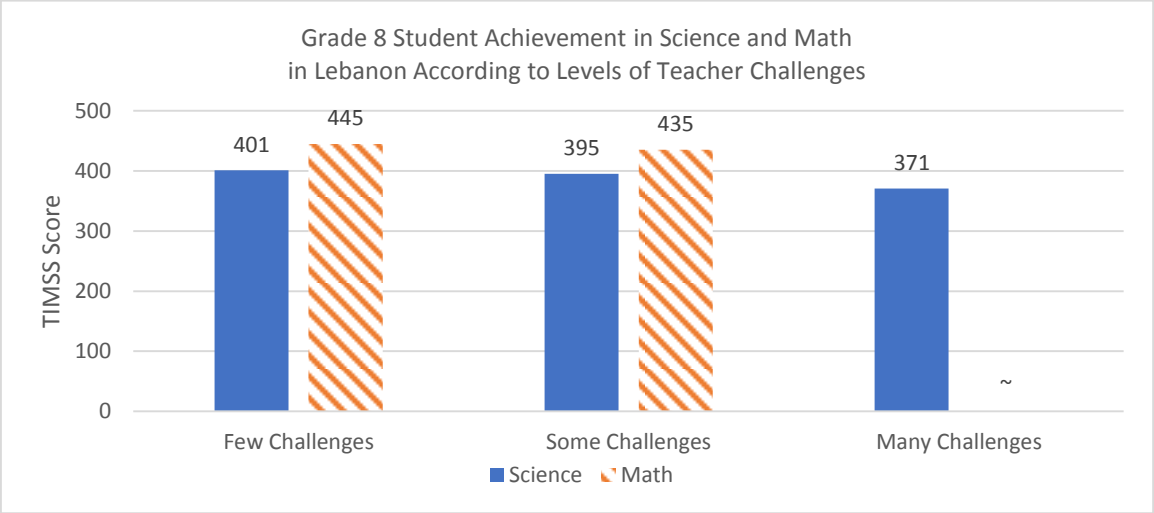
Based on how much teachers agreed with these statements, students were assigned to one of three categories: those taught by teachers facing few challenges, some challenges, or many challenges (Table 6.5).

Table 6.5. Category Criteria for Students Taught Science by Teachers Facing Challenges

Category	Scale Score	Category criteria
Few challenges	Scale score ≥ 10.3	Disagreeing a little' with four of the eight statements and 'agreeing a little' with the other four, on average
Many challenges	Scale score ≤ 6.7	'Agreeing a lot' with four of the eight statements and 'agreeing a little' with the other four, on average
Some challenges	All student with scores >6.7 and <10.3	

In Lebanon, there was a negative association between student achievement in Science and the number of challenges teachers face (as challenges increase, average achievements decrease). This observation was replicated in math, but only for teachers facing few and some challenges (since there was insufficient data to report achievement in Lebanon for teachers facing many challenges) (Figure 6.7).

Figure 6.7. Grade 8 Student Achievement in Science and Math according to the Extent to Which Teachers Face Different Levels of Difficulty in Lebanon



A Tilde (~): insufficient data to report achievement

Table 6.6 shows that the percentage of grade 8 students in Lebanon who were taught by teachers facing at least some challenges was 33% in Science and 32% in Mathematics, around 1.5 times less than the international counterparts. Similarly, the percentage of students in Lebanon who were taught by Science teachers facing many challenges is 1.5 times less than internationally (6% compared 4%). This ratio becomes 5 times less for Lebanese students who are taught Mathematics (5% compared to 1%). Correspondingly, a larger proportion of Lebanese students were taught by teachers facing few challenges (63% in science and 67% in math) compared to the international average (Table 6.6).

Similarly, table 6.6 reveals a negative association across all countries in Science (as challenges increase, average achievements decrease). However, this observation was not replicated in Mathematics; students achieved better internationally (scale score of 481) with teachers facing many challenges compared to teachers facing some challenges (scale score of 476) and had a similar performance when taught by teachers facing few challenges (scale score of 480). For Lebanon, despite the trend of lower achievement with increasing challenges, yet the differences among categories are not significant both in math and sciences.

Table 6.6. Teacher Challenges and Academic Achievement in Grade 8 Science and Math

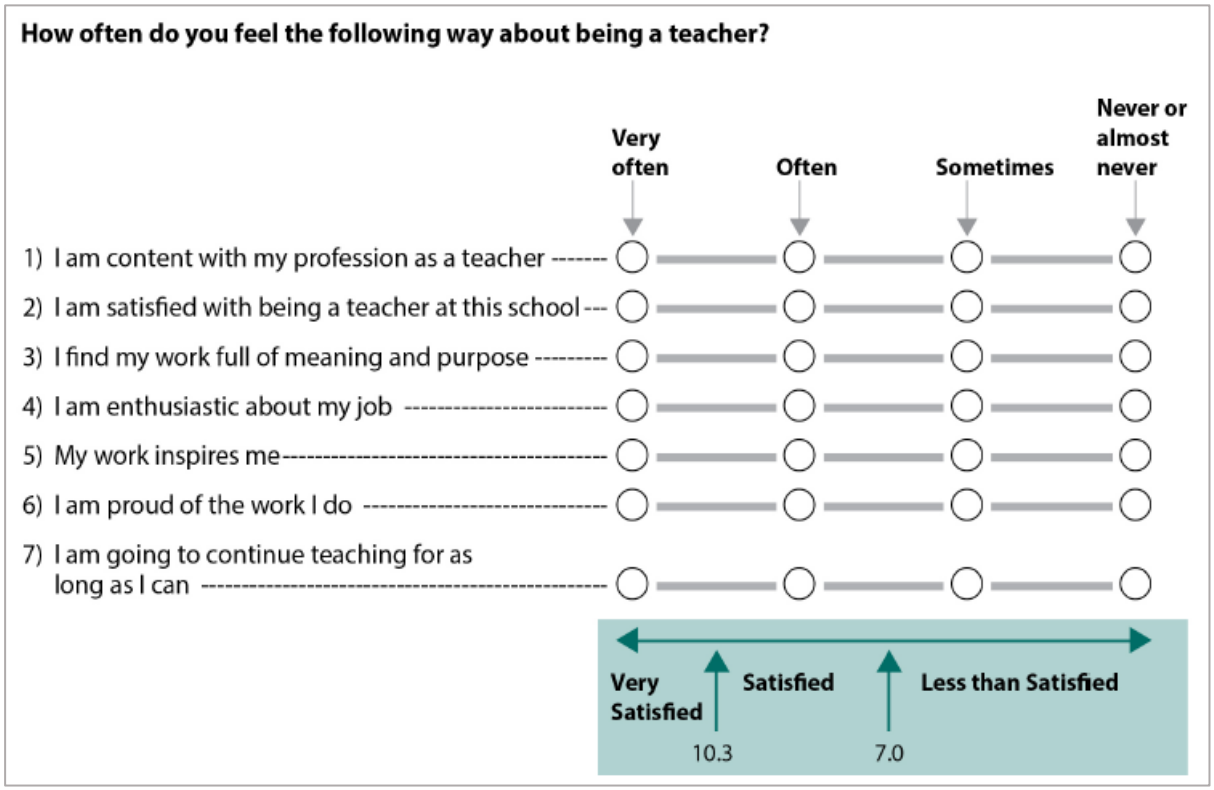
Subject	Country	Very High Emphasis		High Emphasis		Medium Emphasis	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Science	Lebanon	63(4.1)	401(8.0)	33(4.2)	395(9.3)	4(1.5)	371(28.9)
	International Average	45(0.5)	487(1.0)	49(0.5)	481(0.9)	6(0.3)	473(2.7)
Math	Lebanon	67 (4.1)	445 (5.4)	32 (4.1)	435 (6.9)	1 (0.5)	~ ~
	International Average	45 (0.6)	480 (1.0)	49 (0.6)	476 (0.9)	5 (0.3)	481 (2.8)

A Tilde (~): insufficient data to report achievement

6.3 – Teachers' Job Satisfaction

The extent to which teachers were satisfied with their jobs was assessed through a questionnaire comprising seven statements rated using a four-point scale (Figure 6.8). The same questionnaire was used in both subjects.

Figure 6.8. TIMSS Questionnaire Assessing Teachers' Views on Job Satisfaction



Based on how much teachers agreed with these statements, students were assigned to one of three categories: those taught by teachers who were Very Satisfied, Satisfied, or Less than Satisfied with their jobs (Table 6.7). In this section, both data on Science and Mathematics are presented.

Table 6.7. Category Criteria for Students Taught Science and Math by Level of Teachers' Job Satisfaction

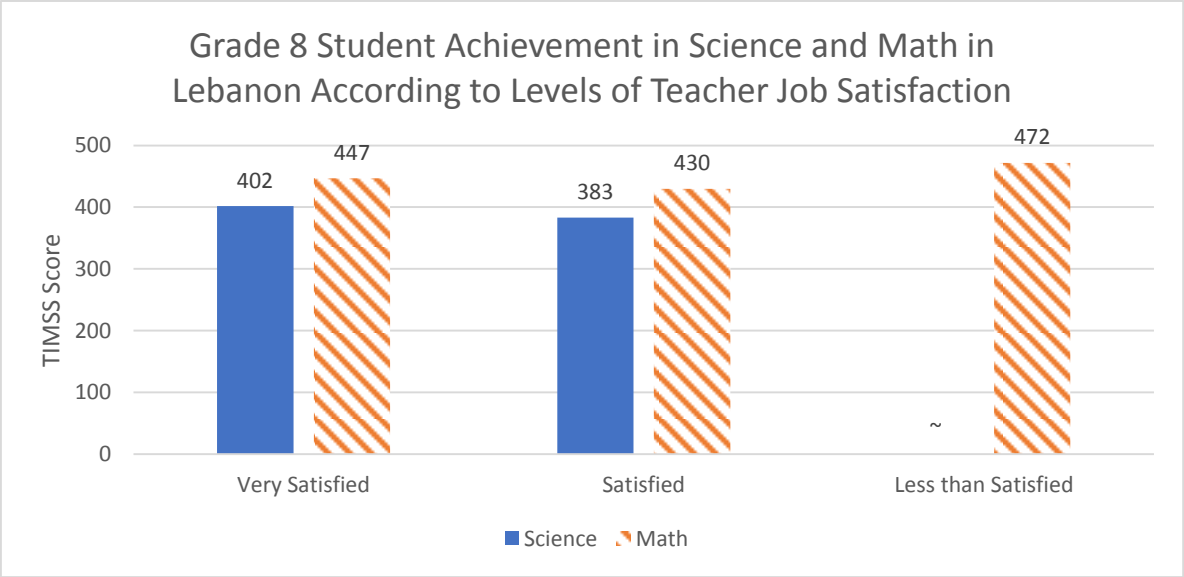
Category	Scale Score	Category criteria
Very Satisfied	Scale score ≥ 10.3	Teachers responding 'very often' to four of the seven statements and responding 'often' to the other three, on average
Less than Satisfied	Scale score ≤ 6.7	Teachers responding 'sometimes' to four of the seven statements and responding 'often' to the other three, on average
Satisfied	All student with scores >6.7 and <10.3	

According to figure 6.9, the average achievement of students in Lebanon taught by Math teachers who are very satisfied with their jobs (447) is greater than the average achievement of students who are taught by Math teachers who are satisfied with their job (430). However, due to missing data we can't tell whether this difference is significant or not. Surprisingly, the average achievement of students who were taught by Math teachers who are less than satisfied with their job tends to be higher than student achievement in

the other two categories. As for Science, the average achievement of students taught by teachers who are very satisfied with their jobs (402) is greater than the average achievement of students who are taught by teachers who are satisfied with their job (383). This observation was replicated in Science, but only for teachers who were very satisfied and satisfied in their jobs (since there was insufficient data to report achievement in Lebanon for the category of teachers who were less than satisfied with their jobs in Science).

Despite the differences mentioned above, it was still not clear whether such variations were significant.

Figure 6.9. Grade 8 Student Achievement in Science and Math according to the Degree of Level of Teacher Job Satisfaction



A Tilde (~): insufficient data to report achievement

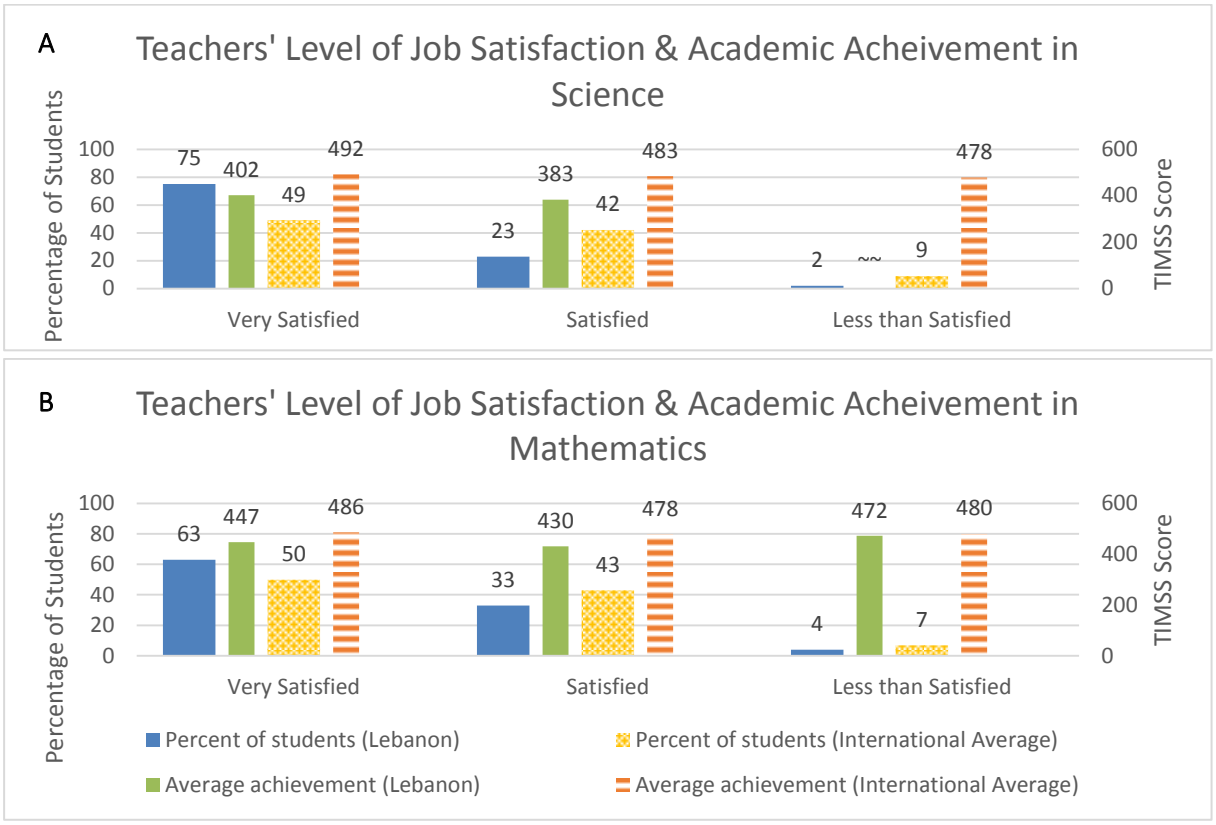
The percentage of grade 8 students in Lebanon taught by teachers who are very satisfied with their work was 75% in Science and 63% in Mathematics, around 1.5 times more than the international counterparts. Also, internationally, the percentage of students taught Science by teachers who were less than satisfied with their jobs is four times greater than the percentage of students in Lebanon (9% compared to 2% in Lebanon) and twice as much for Math teachers (7% compared to 4% in Lebanon) (Figure 6.10). Additionally, the percentage of students taught by Science teachers who are very satisfied with their jobs is around 3 times the percentage of students taught by teachers who are satisfied with their jobs (75% compared to 23% in Lebanon), compared to only 2% of students taught by teachers who are less than satisfied with their jobs. A similar result is shown for mathematics.

As a result, the highest percentage of Lebanese students are taught by teachers who are very satisfied with their jobs in both Science and Math.

Internationally, there was a positive association between achievement of students who were taught by Science teachers with different levels of job satisfaction (as satisfaction levels increase, average achievements increase). However, in Lebanon, no definite pattern between student achievement and teacher job satisfaction could be deduced due to insufficient data for teachers who were less than satisfied with their jobs (Figure 6.10).

In Math, the difference was 25 scale points higher for teachers who were less than satisfied, whereas it was 6 scale points lower internationally. Unlike the association between levels of job satisfaction and students' average achievement internationally, this relation does not stand in Mathematics where there is no clear link between the level of teacher job satisfaction and student achievement (Figure 6.10).

Figure 6.10. Grade 8 Students' Percentages and Achievement in (A) Science and (B) Math according to Teachers' Level of Job Satisfaction (Lebanon and international comparison)

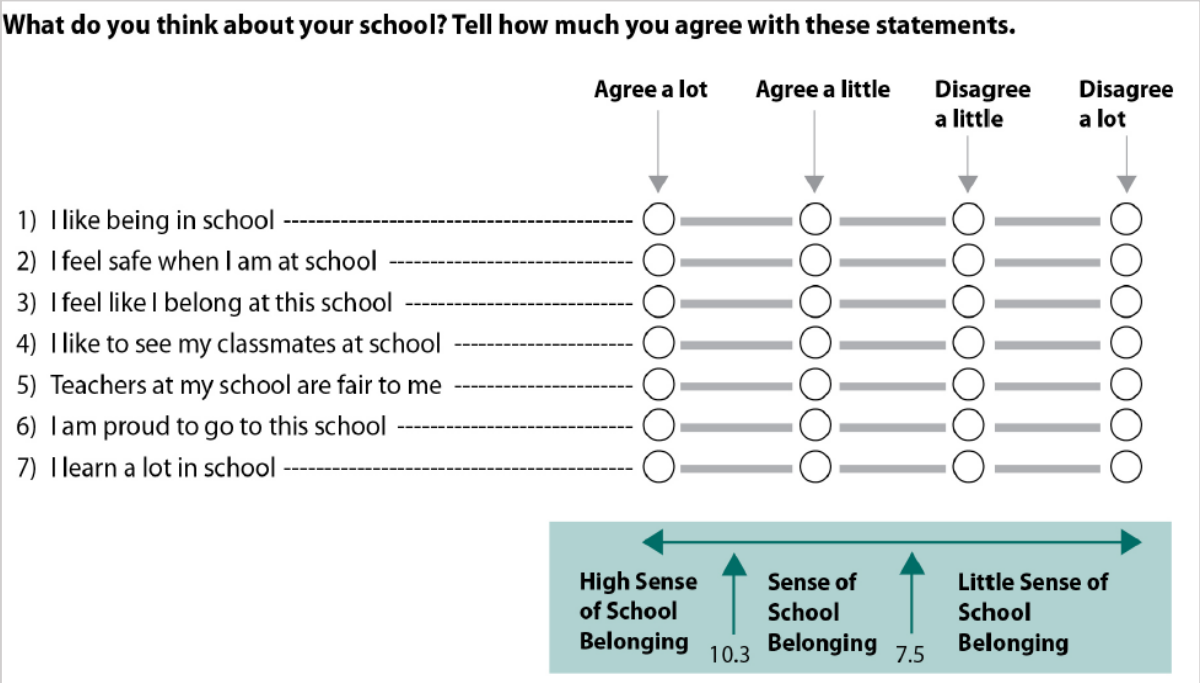


A Tilde (~): insufficient data to report achievement

6.4 – Students' Sense of School Belonging

The 7 items in the student questionnaire below probed for students' sense of belonging to their school. Students were able to answer with one of four responses: agree a lot, agree a little, disagree a little, or disagree a lot (Figure 6.11). The same questionnaire was used in both subjects.

Figure 6.11. Student Questionnaire on Sense of Belonging to Their Schools



Based on how much students agreed with these statements, they were assigned to one of three categories: those who felt A High Sense of Belonging, A Sense of Belonging, and a Little Sense of Belonging to their schools (Table 6.8).

Table 6.8. Category Criteria for Students Taught Science and Math by Their Sense of School Belonging

Category	Scale Score	Category criteria
High Sense of School Belonging	Scale score ≥ 10.3	Students responding 'agreeing a lot' to four of the seven statements and 'agreeing a little' to each of the other three statements, on average
Little Sense of School Belonging	Scale score ≤ 7.5	Teachers responding 'disagreeing a little' to four of the seven statements and 'agreeing a little' to each of the other three statements, on average
Sense of School Belonging	All students with scores >7.5 and <10.3	

Figures 6.12 and 6.13 show that the average achievement of Lebanese Grade 8 students studying Science and who have a high sense of belonging to their schools was 30 scale points higher than students who had a little sense of belonging (compared to a 40-scale point difference internationally). In Mathematics, however, a decrease in performance was documented internationally (34-point decrease) but not exactly in Lebanon where the performance of students with a sense of belonging was only 1-scale point different compared to those with a high sense of school belonging, but both were higher than those with low sense of belonging by 11-12 score points.

There was a positive association across all countries in science between the extent to which students with varying sense of belonging (as the sense of school belonging increases, average achievements increase). As for Mathematics, there was not much variation in the achievement in students when comparing students who have a high sense of school belonging and a sense of school belonging.

Figure 6.12. Grade 8 Student Achievement in Science and Math according to Students' Sense of School Belonging

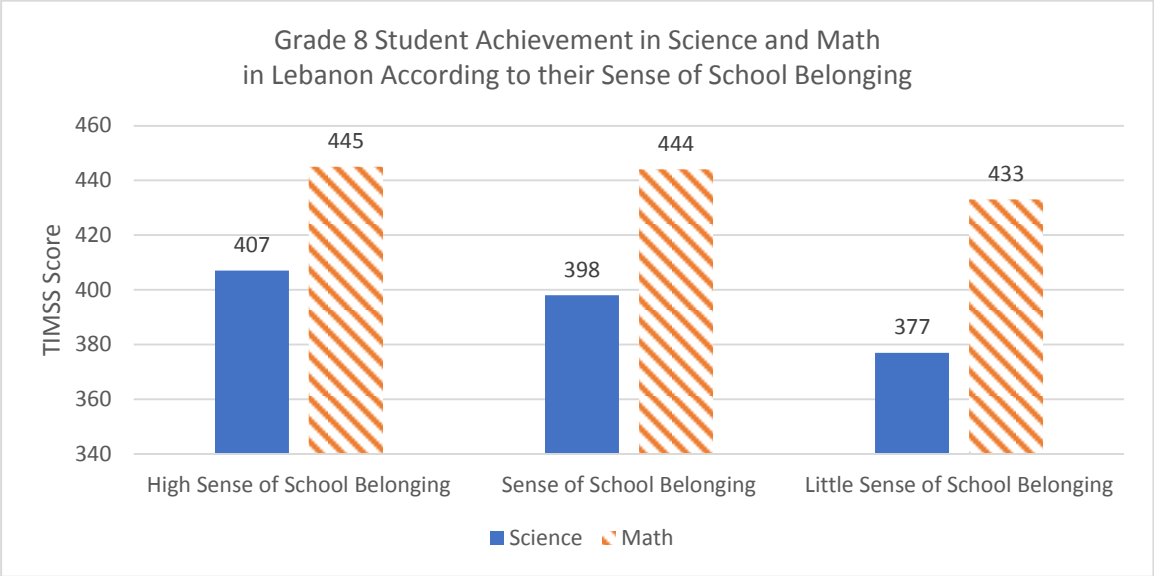
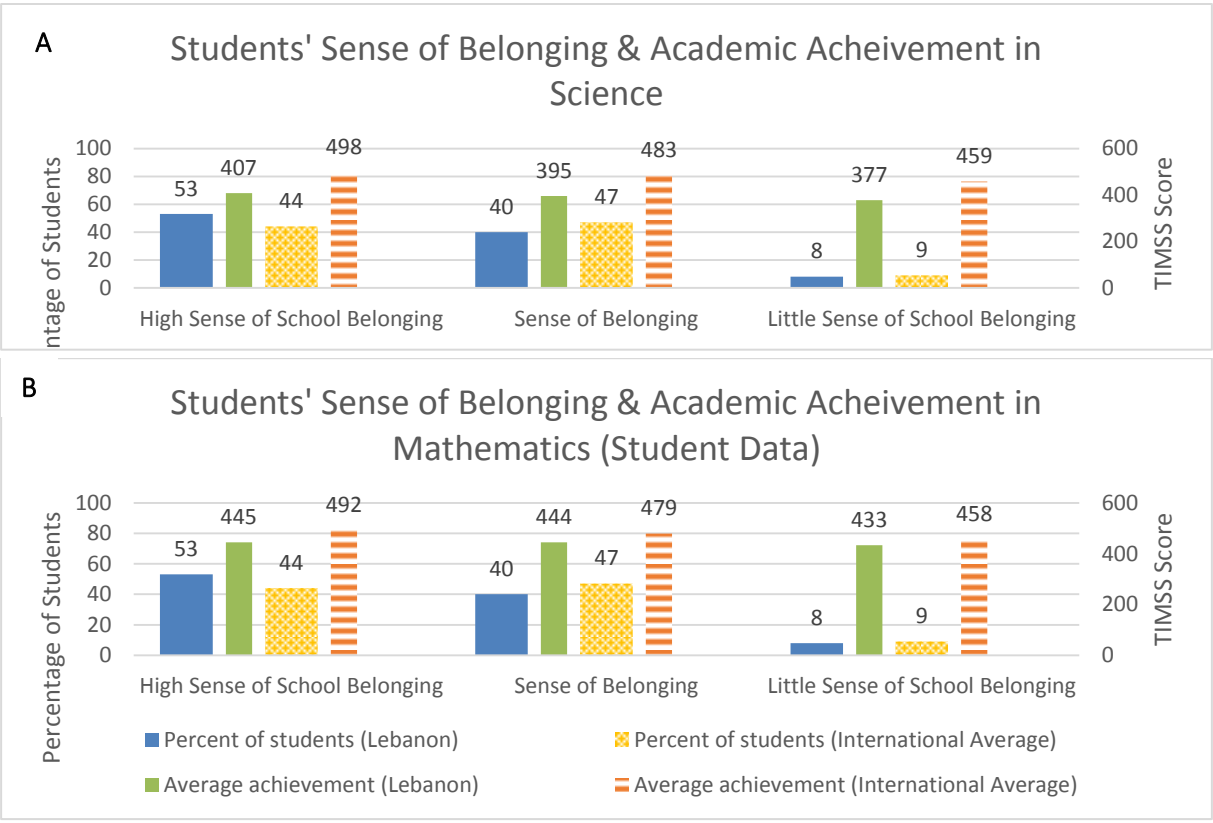


Figure 6.13. Grade 8 Students' Percentages and Achievement in (A) Science and (B) Math according to Their Sense of Belonging (Lebanon and international comparison)



In Lebanon, the percentage of grade 8 students who have a high sense of belonging, a sense of belonging, and little sense of belonging to their school was the same for both Science and Math (53%, 40%, and 8% respectively). The percentage of grade 8 students who have a high sense of belonging to their school is 9% higher than the international counterparts (44%). Interestingly, only a 1% difference between the percentage of students who have a little sense of belonging to their schools was observed between Lebanon and internationally both in Science and Math (Figure 6.13).

6.5 – Conclusion:

In this section, we will provide an overview of school climate and student performance in Lebanon and internationally, by summarizing the results related to school climate.

A – Academic Success

- The percentage of Grade 8 students taught in schools with principal emphasis on academic success was the same in both Science and Math.
- A positive association between school principals' emphasis on academic success and students' average achievement was noted in Lebanon and internationally.
- Lebanese student achievement in Math was consistently higher than their achievement in Science for all levels of principal emphasis on academic success.
- In Lebanon, the average achievement of Grade 8 students taught Math is consistently higher than achievement of students taught Science across all levels of teacher emphasis on academic success.
- Internationally, the average achievement of Grade 8 students taught by Science teacher was higher than achievement of students taught by Math teachers across all levels of emphasis on academic success.
- A positive association between school teachers' emphasis on academic success and students' average achievement internationally may be noted.
- Fewer students were taught in schools with a high emphasis (very high and high) on academic success according to their Science teachers compared to their principals.

B – Teacher Challenges:

- Students in Lebanon who were taught by teachers who face fewer challenges achieved higher compared to their peers internationally.
- There was a negative association between the level of challenges and average achievement in Science both in Lebanon and internationally. This observation was not replicated in math.

C – Teachers' Job Satisfaction:

- The highest percentage of Lebanese students is taught by teachers who are very satisfied with their jobs in both Science and Math.
- Internationally, there was a positive association between achievement of students who were taught by Science teachers with different levels of job satisfaction. This observation was not replicated in Lebanon.

- The association between student achievement and level of teacher job satisfaction was evident in Science but not in Math.
- In Lebanon, student achievement in Math was highest for teachers who were less than satisfied in their teaching.

D – Students' School Belonging:

- In Lebanon, the percentage of grade 8 students who have a high sense of belonging, a sense of belonging, and little sense of belonging to their school was the same for both Science and Math.
- The percentage of grade 8 students who have a high sense of belonging to their school is higher than the international counterparts.
- There was a positive association in Lebanon and across all countries in Science between students with varying sense of belonging and their achievement.
- In Mathematics, a decrease in performance was documented internationally but not in Lebanon, where there is not much variation in student achievement (comparing high sense of school belonging and a sense of school belonging).

Future analysis may indicate which index is the best school climate predictor for student achievement using step-wise regression analysis (to be calculated by analysis of variance).

CHAPTER 7

School safety

7.1. School safety overview

This chapter considers the discipline problems, safety and bullying at the school. Data extracted from the principals' questionnaire from TIMSS 2015 about the school discipline problem concerning 11 potential school problems, from teachers' degree of agreement with eight statements on the Safe and Orderly School scale, and students' responses to how often they experienced bullying behaviors. Principals, teachers and students' responses in Lebanese math and science classes was analyzed and compared internationally. Indices include:

- School Discipline problems
- School safety and orderly
- Students bullying

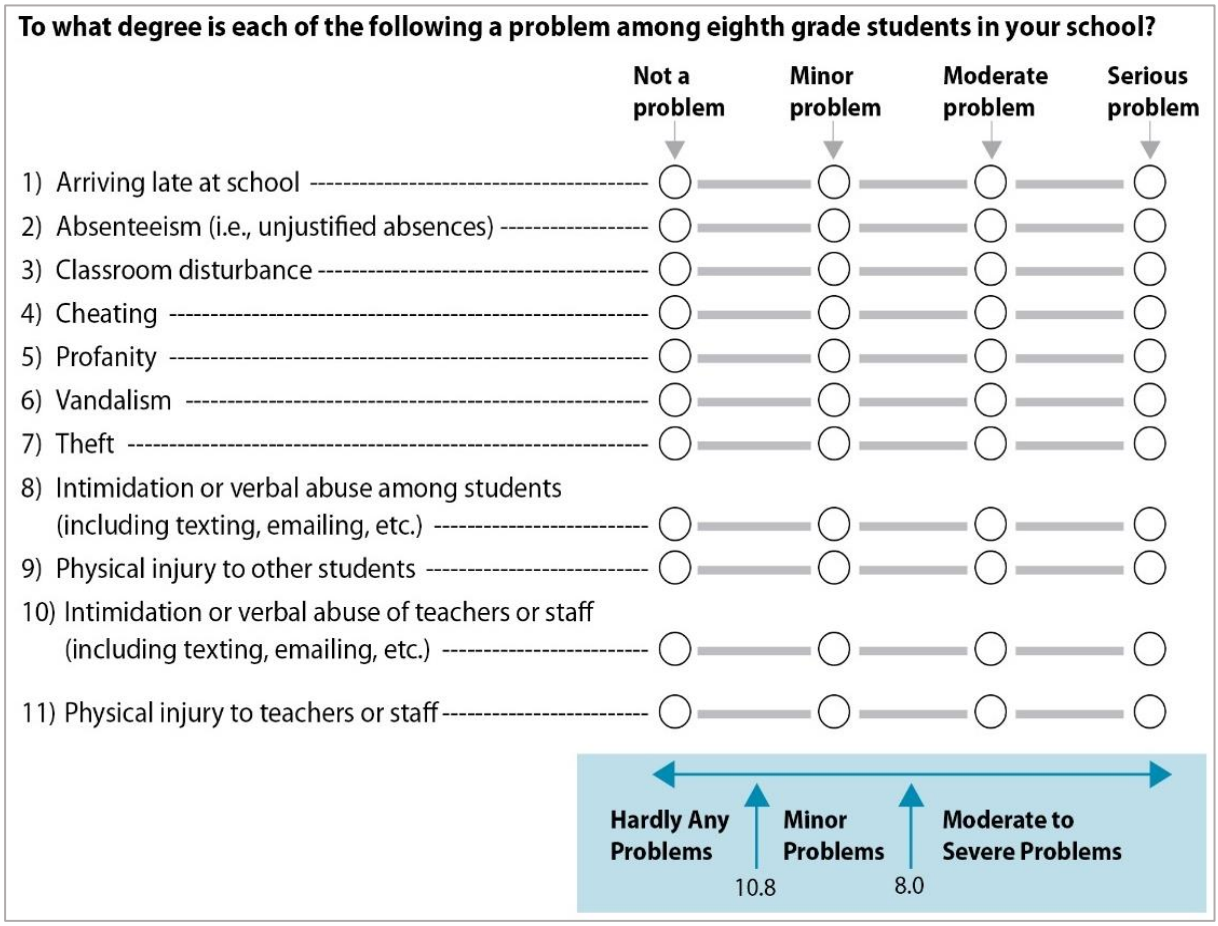
7.2. School discipline problems

The sense of security that comes from attending a school with few behavior problems and having little or no concern about student or teacher safety promotes a stable learning environment. There is increasing research showing that a safe school environment is important for students' academic achievement. On the other hand, a general lack of discipline, especially if students and teachers are afraid for their safety, does not facilitate learning. (TIMSS 2015)

This section presents the TIMSS 2015 results for the eighth-grade school discipline scale on asking the principals about the extent of eleven different discipline problems (Fig 7.1)

Students were scored according to their principals' responses concerning eleven potential school problems on the School Discipline Problems scale (Fig 7.1). Students in schools with Hardly Any Problems had a score on the scale of at least 10.8, which corresponds to their principals reporting "not a problem" for six of the eleven issues and "minor problem" for the other five, on average. Students in schools with Moderate to Severe Problems had a score no higher than 8.0, which corresponds to their principals reporting "moderate problem" for six of the eleven issues and "minor problem" for the other five, on average. All other students attended schools with Minor Problems.

Figure 7.1. TIMSS Questionnaire Assessing Principals' Views on Their School Problems



7.2.1. School Discipline Problems-Mathematics

Figure 7.2 shows that 43 percent of the international students, on average, across the eighth-grade countries were in the Hardly Any Problems category and 49 percent were in the Minor Problems category. Only 11 percent, on average, attended schools where principals reported Moderate Problems with discipline. In summary, 56% of international students reported problems (Moderate and minor).

Students whose principals reported Moderate Problems in their schools had mathematics achievement 439, lower by 34 points (473-439) on average, than students whose principals reported Minor Problem while it is lower by 56 points on average, than students whose principals reported Hardly Any Problems (495-439).

Figure 7.2. Performance of Grade 8 Students in Mathematics by Principals' Views and School Discipline Problems Internationally

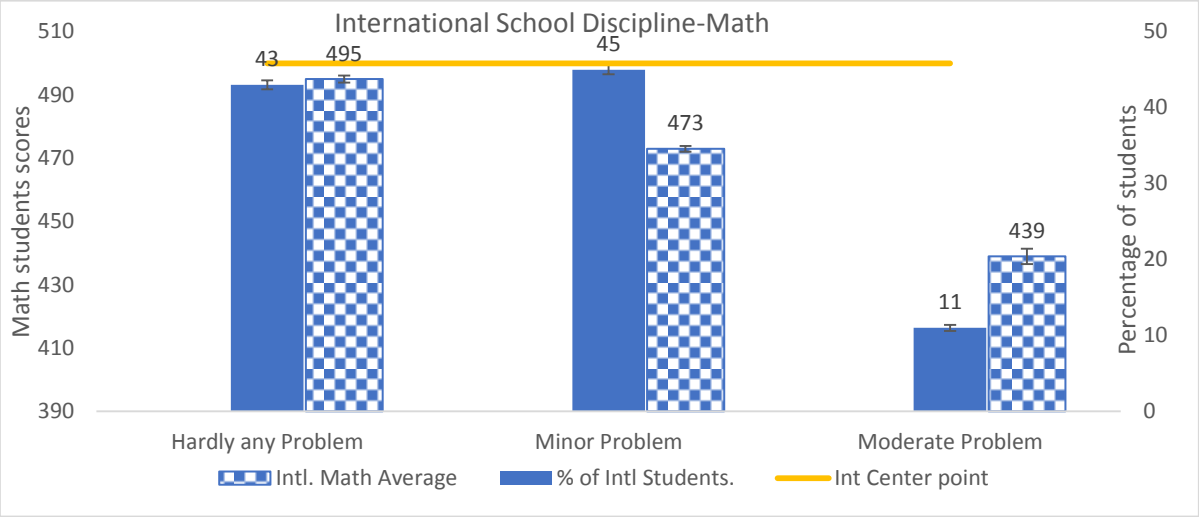
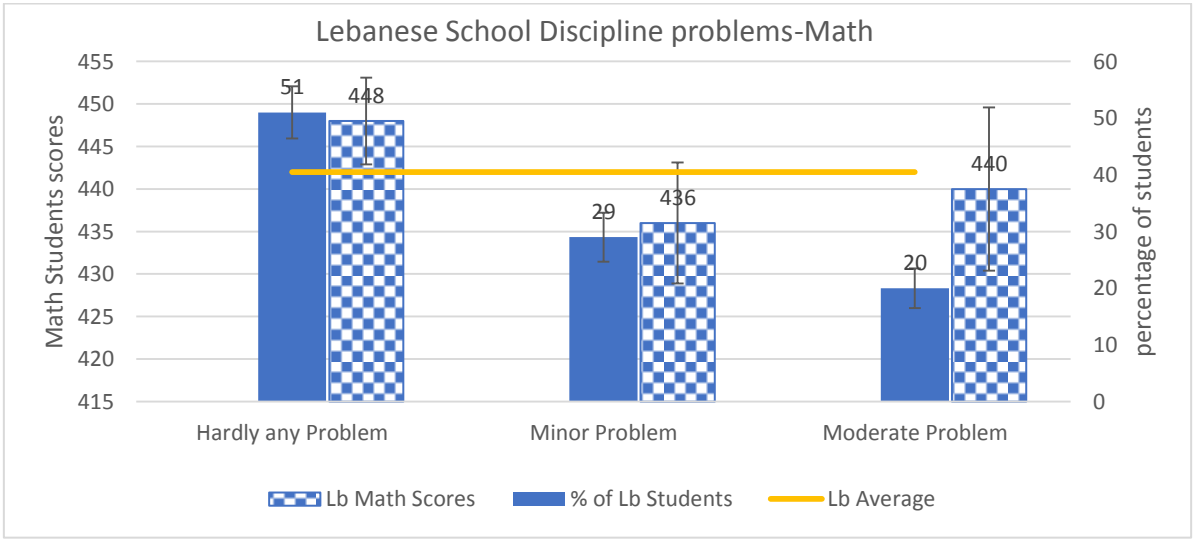


Figure 7.3 shows the results for the eighth-grade Lebanese students 51 percent of students were on Hardly Any Problem, 29 percent were on Minor Problem and 20 percent were on Moderate Problem. In summary, 49% of Lebanese students reported problems (moderate/minor), which is lower than international percentage of 59%.

Compared to the international results, there were similar percentage of eighth grade students in the Hardly Any Problems category (Lb. 51% vs. Intl.49%) and fewer in the Minor Problems category (Lb. 29% vs. Intl. 45%). There were higher percentages of Lebanese students in schools with Moderate Problems (Lb. 20% and Intl. 11%).

Lebanese students whose principals reported Moderate Problems in their schools had mathematics achievement 440 with a high standard error SE (9.6), it is considered close to the students' mathematics achievement 436 whose principals reported Minor Problem and on average, close to the students' mathematics achievement 448 whose principals reported Hardly Any Problems.

Figure 7.3. Performance of Grade 8 Students in Mathematics by Principals' Views and School Discipline Problems in Lebanon



Looking more closely at the Lebanese students' mathematics scores, and by taking into consideration the standard error, we cannot rely on the increase from 440 SE (9.6) to 448 SE (5.1) to deduce a significant relation between the discipline and the mathematics achievement for the Lebanese sample, as results do not show any significant difference in math achievement between those with problems and those without any.

7.2.2. School Discipline Problems-Science

Figure 7.4 shows that 43 percent of the international students, on average, across the eighth-grade countries were in the Hardly Any Problems category and 49 percent were in the Minor Problems category. Only 11 percent, on average, attended schools where principals reported Moderate Problems with discipline. In summary, 56% of international students reported problems (moderate /minor).

Students whose principals reported Moderate Problems in their schools had science achievement 446, lower by 32 points (478-446) on average, than students whose principals reported Minor Problem while it is lower by 55 points on average, than students whose principals reported Hardly Any Problems (501-446).

Figure 7.4. Performance of Grade 8 Students in Science by Principals' Views and School Discipline Problems Internationally

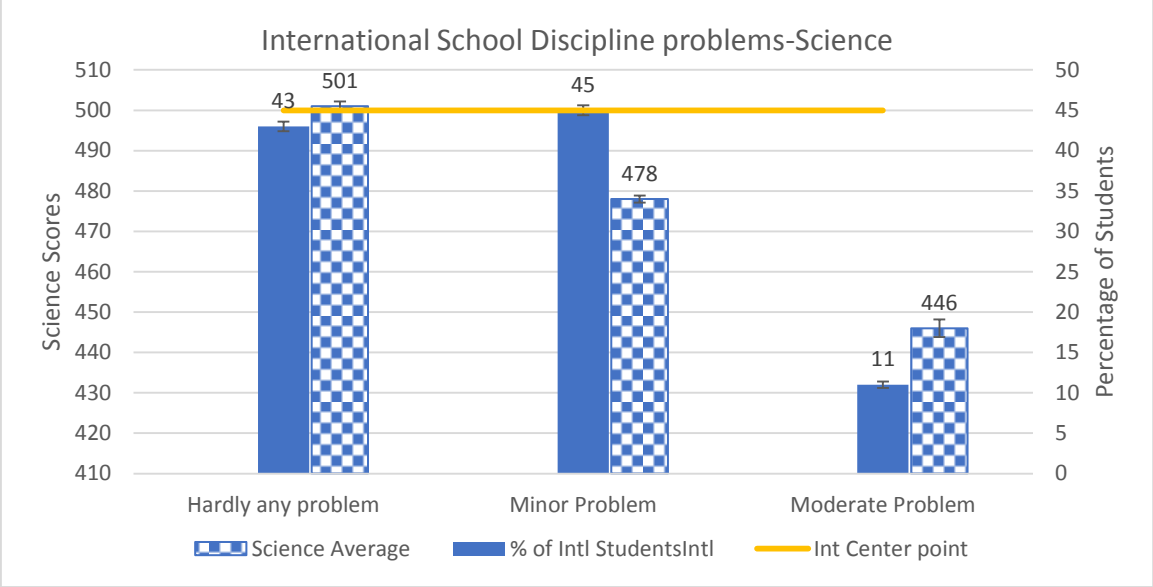
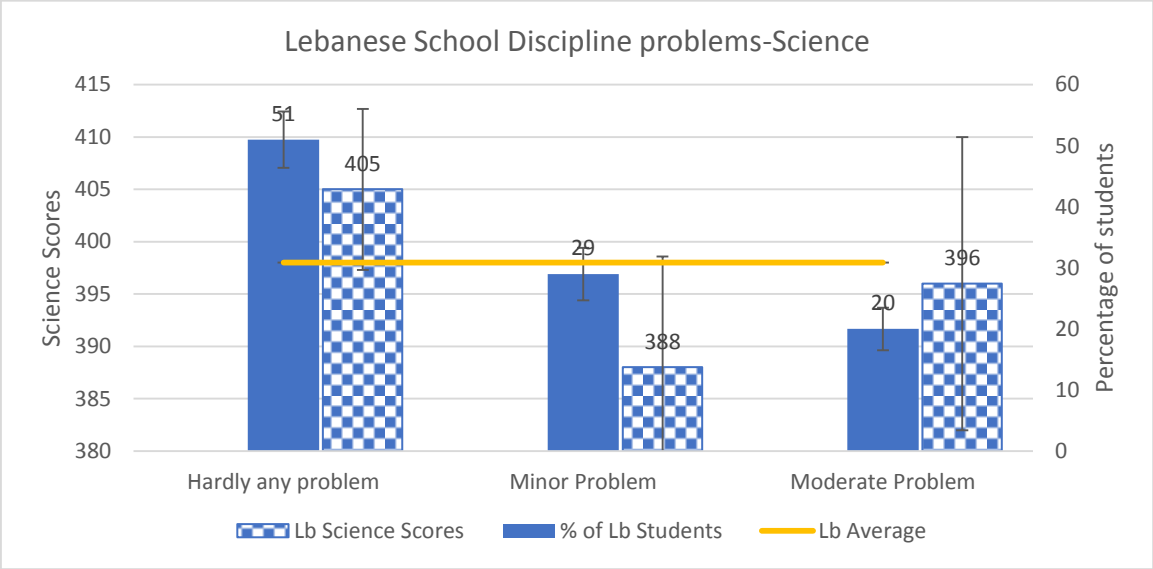


Figure 7.5 shows the results for the eighth-grade Lebanese students 51 percent of students were on Hardly Any Problem, 29 percent were on Minor Problem and 20 percent were on Moderate Problem.

Compared to the international results, there were similar percentage of eighth grade students in the Hardly Any Problems category (Lb. 51% vs. Intl.49%) and fewer in the Minor Problems category (Lb. 29% vs. Intl. 45%). There were higher percentages of Lebanese students in schools with Moderate Problems (Lb. 20% and Intl. 11%). In summary, 49% of Lebanese students reported disciplinary problems (moderate/minor), which is lower than international percentage of 59%.

Lebanese students whose principals reported Moderate Problems in their schools had science achievement 396 with a high standard error (14), it is considered close to the students' achievement 388 SE (10.6) whose principals reported Minor Problem and on average, close to the students' mathematics achievement 405 SE (7.7) whose principals reported Hardly Any Problems.

Figure 7.5. Performance of Grade 8 Students in Science by Principals' Views and School Discipline Problems in Lebanon



Looking more closely at the Lebanese students' science scores, and by taking into consideration the standard error, we cannot rely on the increase from 396 SE (14) to 405 SE (7.7) to deduce a relation or an effect between discipline and the science achievement. In summary, having or not having disciplinary problems had no significant effect on Lebanese students' achievement in science.

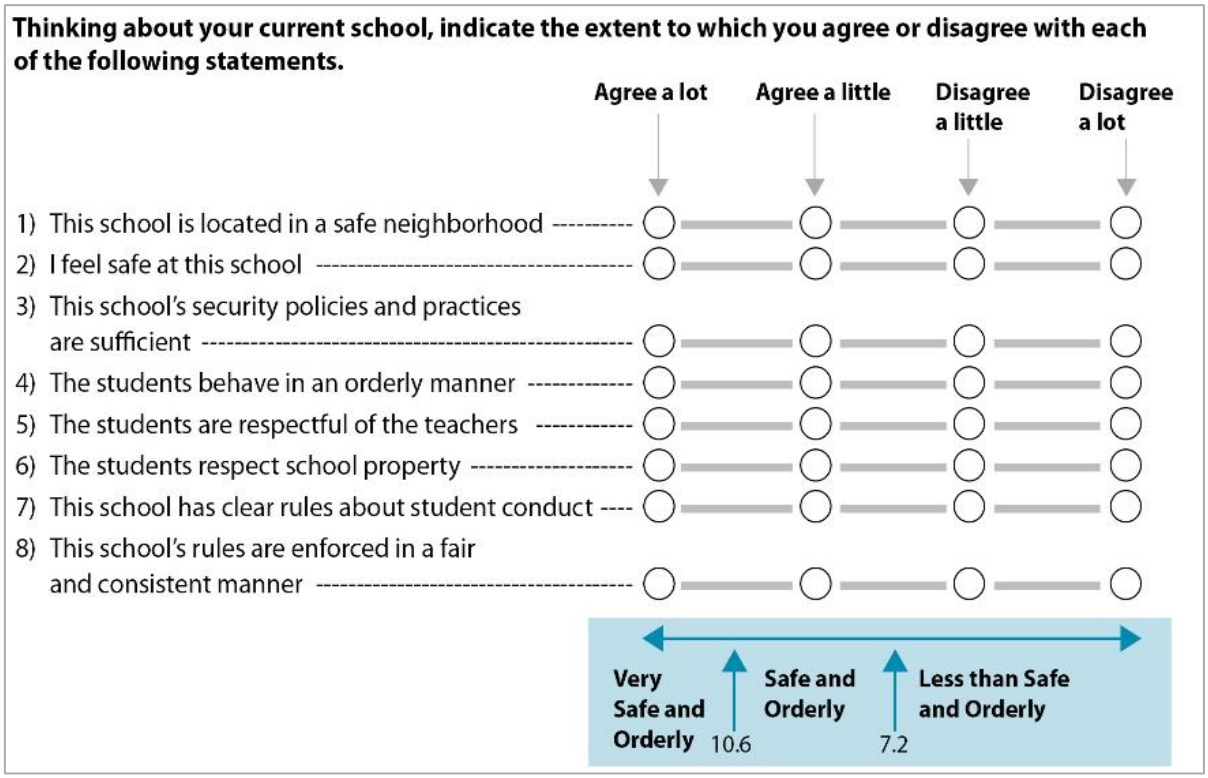
7.3. Safety and orderly school

There is growing evidence that students' perceived school safety adversely affects academic performance (Milam, Furr-Holden, & Leaf, 2010). It seems that safety at school can no longer be taken for granted. To provide information on the extent to which school safety might be affecting mathematics achievement, TIMSS 2015 developed the Safe and Orderly School scale. Teachers in eighth grade assessments were asked the degree to which they agreed or disagreed with eight statements:

- This school is located in a safe neighborhood;
- I feel safe at this school;
- This school's security policies and practices are sufficient;
- The students behave in an orderly manner;
- The students are respectful of the teachers;
- The students respect the school property;
- This school has clear rules about students conduct and
- This school's rules are enforced in a fair and consistent manner.

This section presents the results for the Safe and Orderly School scale (Fig 7.6) for the grade eight students in Lebanon and international. Students were scored according to their teachers' degree of agreement with eight statements on the Safe and Orderly School scale. Students in Very Safe and Orderly schools had a score on the scale of at least 10.6, which corresponds to their teachers "agreeing a lot" with four of the eight qualities of a safe and orderly school and "agreeing a little" with the other four, on average. Students in Less than Safe and Orderly schools had a score no higher than 7.2, which corresponds to their teachers "disagreeing a little" with four of the eight qualities and "agreeing a little" with the other four, on average. All other students attended Safe and Orderly schools.

Figure 7.6. TIMSS Questionnaire Assessing Teachers' Views on Their Schools' Safe and Orderly Scale in Grade 8 Science and Mathematics



7.3.1. Safety and orderly school-Mathematics

Internationally, on average, across the eighth-grade students, 46 percent of math students were attending schools judged by their teachers to be very safe and orderly, and the same percentage of students (46%) also attending school judged by their teachers to be safe and orderly, only 8 percent were in schools judged less than safe and orderly. The safer the school as reported by their teachers, the higher the students' average mathematics achievement. Fig 7.7 shows that the students attending very safe and orderly scored in mathematics 493 with SE (0.9) that is higher than students who were in schools that were safe and orderly with a score 474 SE (0.9) which is also higher than students who were in schools less than safety and orderly with a score 453 SE (2.5).

Figure 7.7. Performance of Grade 8 Students in Mathematics by Teachers' Views and Safe and Orderly School Internationally

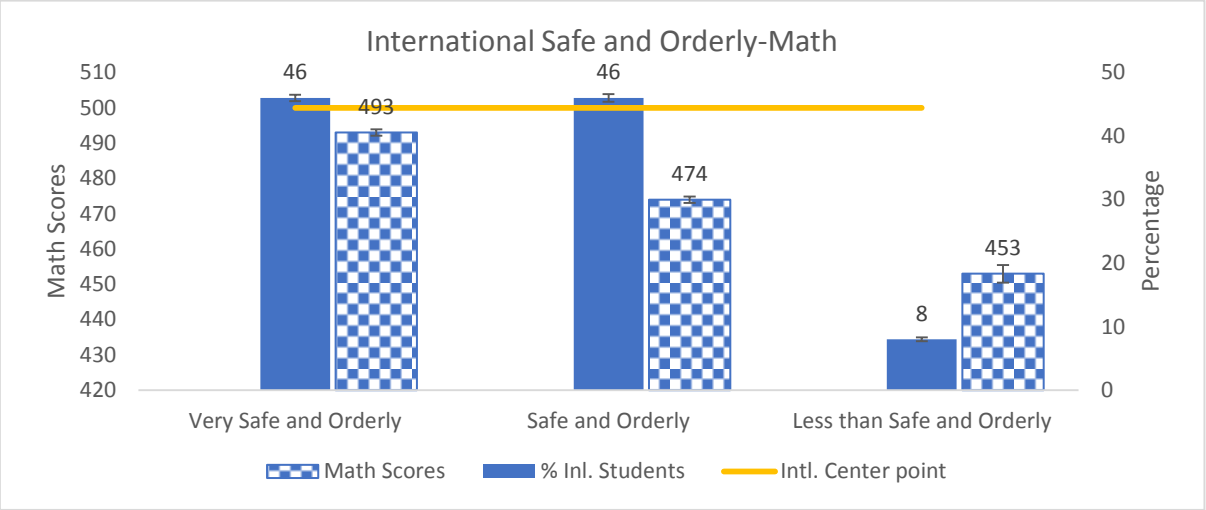
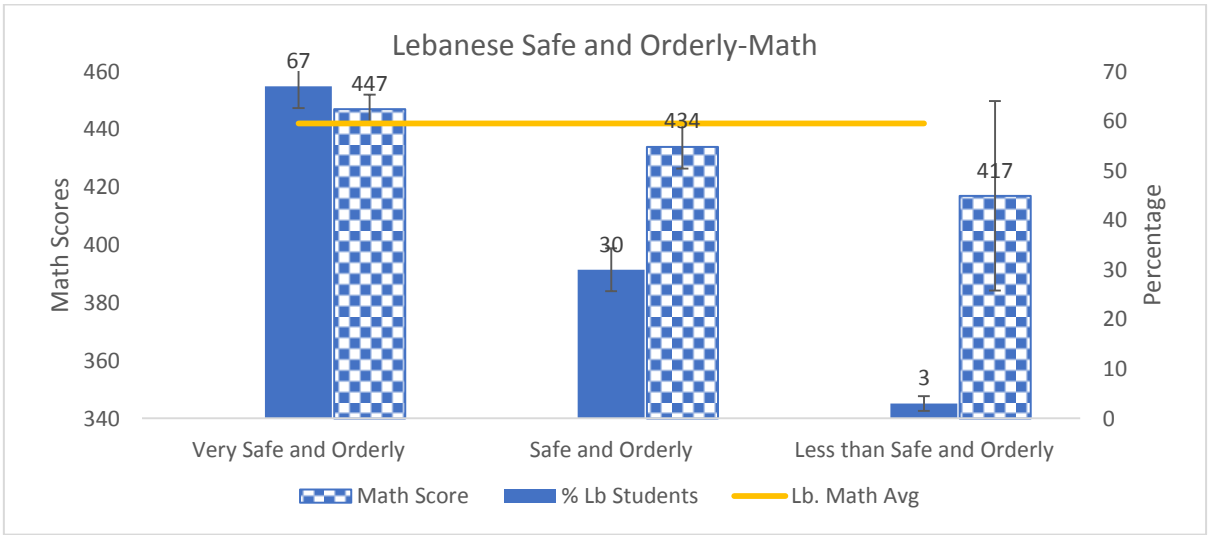


Figure 7.8 shows the results for the eighth-grade Lebanese students where 67 percent of students were attending schools judged by their teachers to be very safe and orderly, 30 percent of students were attending school judged by their teachers to be safe and orderly, only 3 percent of Lebanese students were in schools judged less than safe and orderly. Lebanese students whose teachers judged their school to be very safe and orderly had mathematics achievement 447 with a standard error (4.3), it is considered close to the students' achievement 434 SE (7.6) whose teachers judged their school as safe and orderly finally the students' whose teachers judged their school to be less than safe and orderly had mathematics achievement 417 SE (32.8). The international results show a relative difference between students' achievement according to the safety of the school with a standard error less than one, whereas we cannot draw a similar conclusion form the Lebanese data due to the high standard error. In summary, having or not having safe and orderly school had no significant effect on Lebanese students' achievement in math.

Figure 7.8. Performance of Grade 8 Students in Mathematics by Teachers' Views and Safe and Orderly School in Lebanon



7.3.2. Safety and orderly school-Science

Internationally, on average, across the eighth-grade students, 45 percent of science students were attending schools judged by their teachers to be very safe and orderly, 47% percentage of students attending school judged by their teachers to be safe and orderly, only 8 percent were in schools judged less than safe and orderly. The safer the school as reported by their teachers, the higher the students' average mathematics achievement. Fig7.9 shows that the students attending very safe and orderly scored in mathematics 493 with SE (0.9) that is higher than students who were in schools that were safe and orderly with a score 474 SE (0.9) which is also higher than students who were in schools less than safety and orderly with a score 453 SE (2.5)

Figure 7.9. Performance of Grade 8 Students in Science by Teachers' Views and Safe and Orderly School Internationally

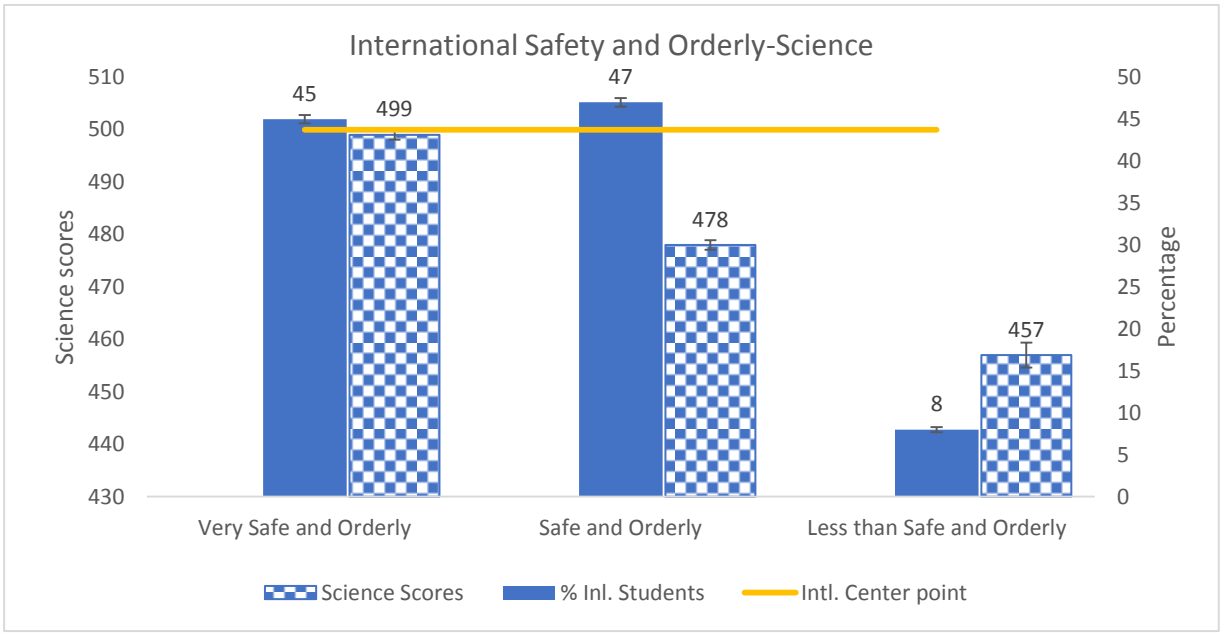
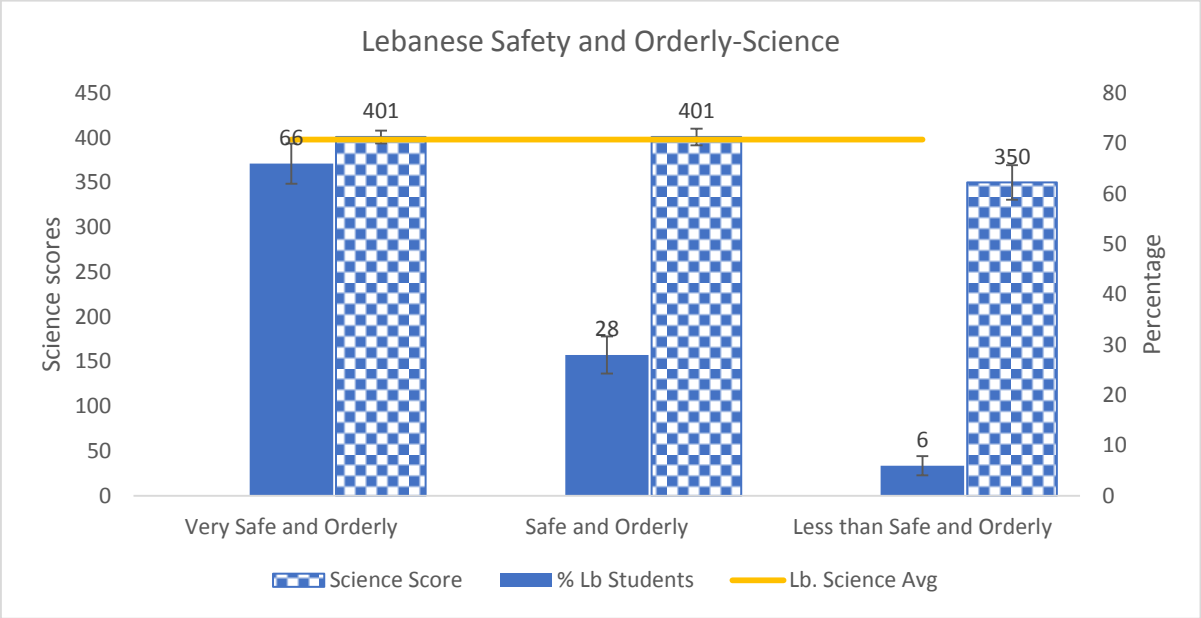


Figure 7.10 shows the results for the eighth-grade Lebanese students where 66 percent of students were attending schools judged by their teachers to be very safe and orderly, 28 percent of students were attending school judged by their teachers to be safe and orderly, only 6 percent of Lebanese students were in schools judged less than safe and orderly. Lebanese students whose teachers judged their school to be very safe and orderly had science achievement 401 with a standard error (7.1), it is equal to the students' achievement 401 SE (9.3) whose teachers judged their school as safe and orderly finally the students' whose teachers judged their school to be less than safe and orderly had science achievement 350 SE (19.3). The international results show a significant difference between students' achievement according to the safety of the school with a standard error less than one, while Lebanese students' science achievement is not affected by this factor, except for the difference between the very safe/safe categories and less than safe and orderly where the difference in achievement is significant from 401 to 350 despite the large standard error of 19.3.

Figure 7.10. Performance of Grade 8 Students in Science by Teachers' Views and Safe and Orderly School in Lebanon

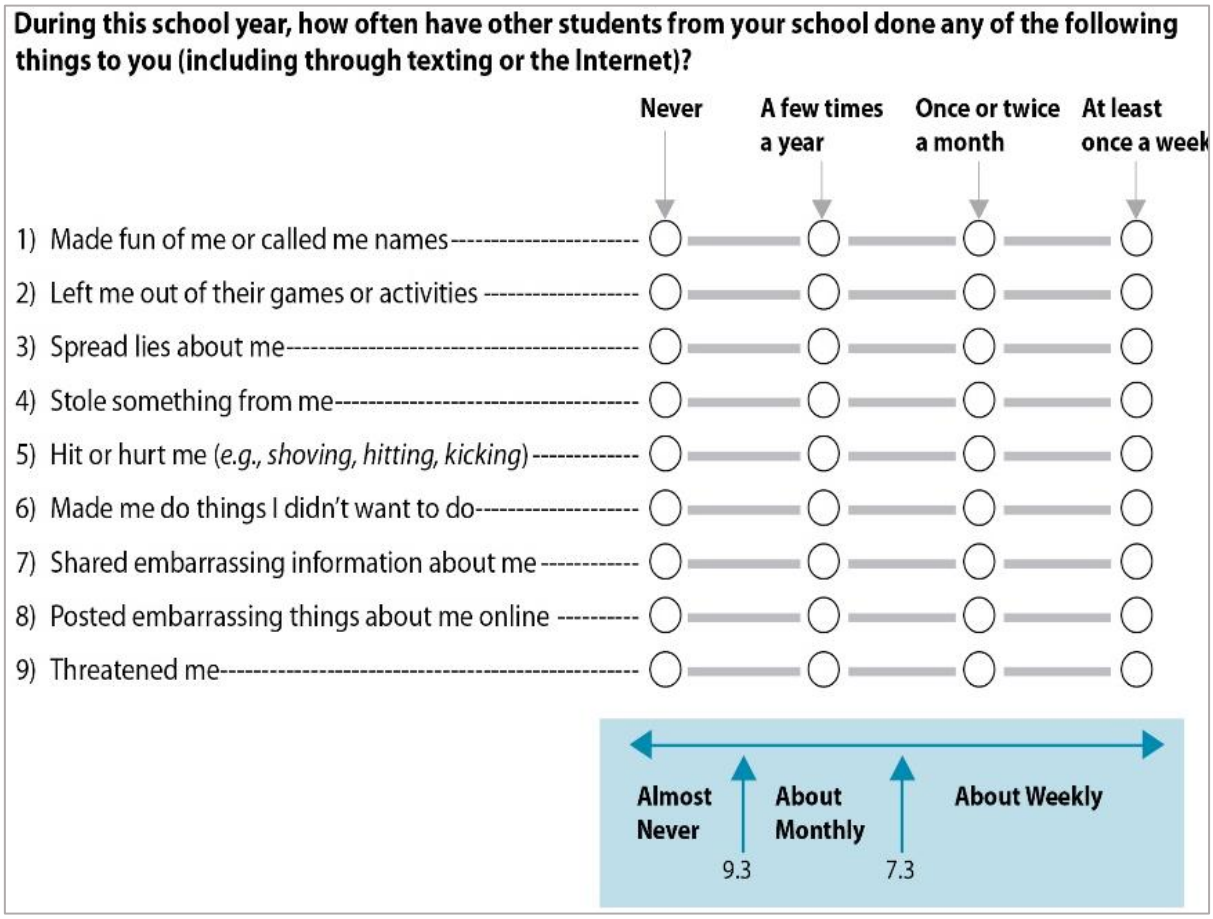


7.4. Student bullying

In general, bullying involves aggression or negative behavior intended to harm or bother less physically or psychologically powerful persons, although a New Zealand review of the literature found a range of definitions and terminology relating bullying to violence and abuse (Carroll-Lind, 2009). There is growing evidence that bullying in schools is on the rise, especially with the emergence of cyber-bullying, and that bullying does have a negative impact on students' educational achievement (TIMSS-2015). To provide data about bullying in the participating countries, TIMSS 2015 developed the Students Bullied at School scale, students were scored according to their responses to how often they experienced nine bullying behaviors on the Student Bullying scale (fig 7.11). Students bullied Almost Never had a score on the scale of at least 9.3, which corresponds to "never" experiencing five of the nine bullying behaviors and experiencing each of the other four behaviors "a few times a year," on average. Students bullied About Weekly had a score no higher than 7.3, which corresponds to their experiencing each of five of the nine behaviors "once or twice a month" and each of the other four "a few times a year," on average. All other students were bullied About Monthly.

- Made fun of or called names;
- Left me out of their games or activities;
- Spread lies about me;
- Stole something from me;
- Hit or hurt me;
- Made me do things I didn't want to do;
- Shared embarrassing information about me;
- Posted embarrassing things about me on line; and
- Threatened me

Figure 7.11. TIMSS Questionnaire Assessing Students' Views on Student Bullying in Grade 8 Science and Mathematics

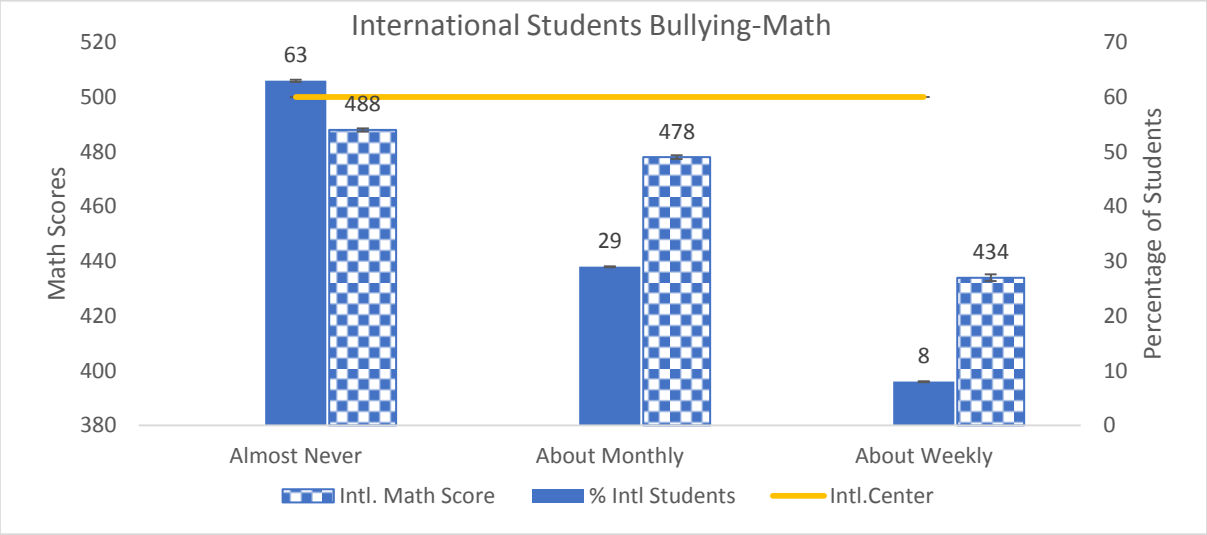


7.4.1. Student bullying-Mathematics

Internationally, on average across the eighth-grade students, the majority of eighth-grade students (63%) Almost Never experienced bullying behaviors, (29%) of students about monthly experienced bullying, whereas only 8 percent of students about weekly experienced bullying, so in summary 37% experienced some degree of bullying internationally.

Figure 7.12 shows that students who were almost never bullied scored 488 with a SE (0.9) which is 10 points higher than students who were bullied about monthly, and students who were bullied about monthly scored 478 which is 34 points higher than students who were bullied about weekly (434), so there is a strong significant relationship between bullying and achievement, the more frequent bullying the lower the achievement.

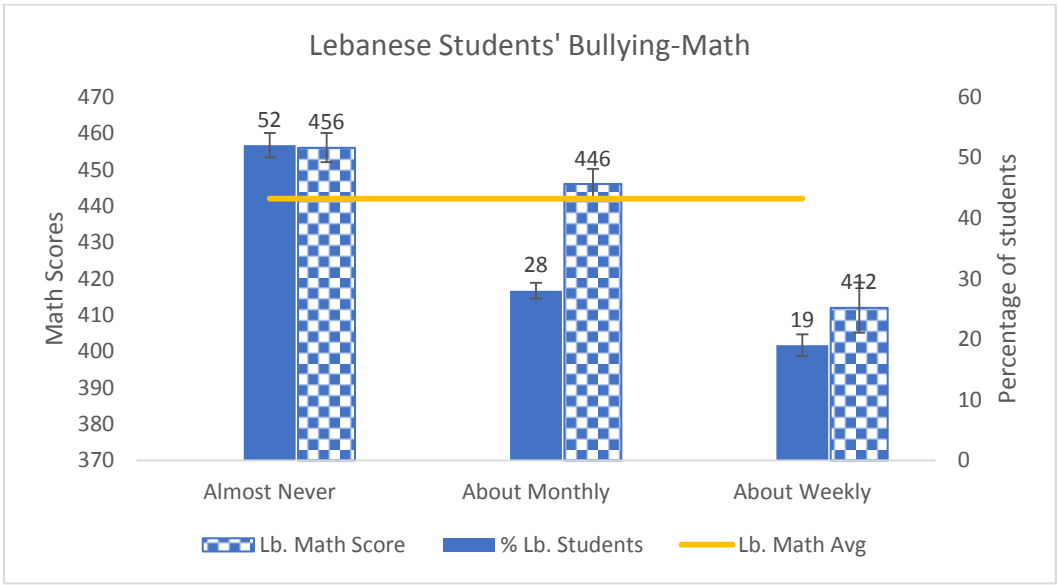
Figure 7.12. Performance of Grade 8 Students in Mathematics by Students' Views and Student Bullying Internationally



On average across the Lebanese eighth-grade students, half of eighth-grade students (52%) Almost Never experienced bullying behaviors, (28%) of students about monthly experienced bullying, whereas 19 percent of students about weekly experienced bullying, so in summary 47% experienced some degree of bullying in Lebanon higher than international results of 37%.

Figure 7.13 shows that students who were almost never bullied scored 456 with a SE (4) which is 10 points higher than students who were bullied about monthly with a score 446 and SE (4.2), and students who were bullied about monthly scored 34 points higher than students who were bullied about weekly 412 with a SE (6.9). The increase of bullying from almost never to about monthly and about weekly shows a significant decrease in the mathematics achievement of Lebanese students as standard errors are not overlapping.

Figure 7.13. Performance of Grade 8 Students in Mathematics by Students' Views and Student Bullying in Lebanon

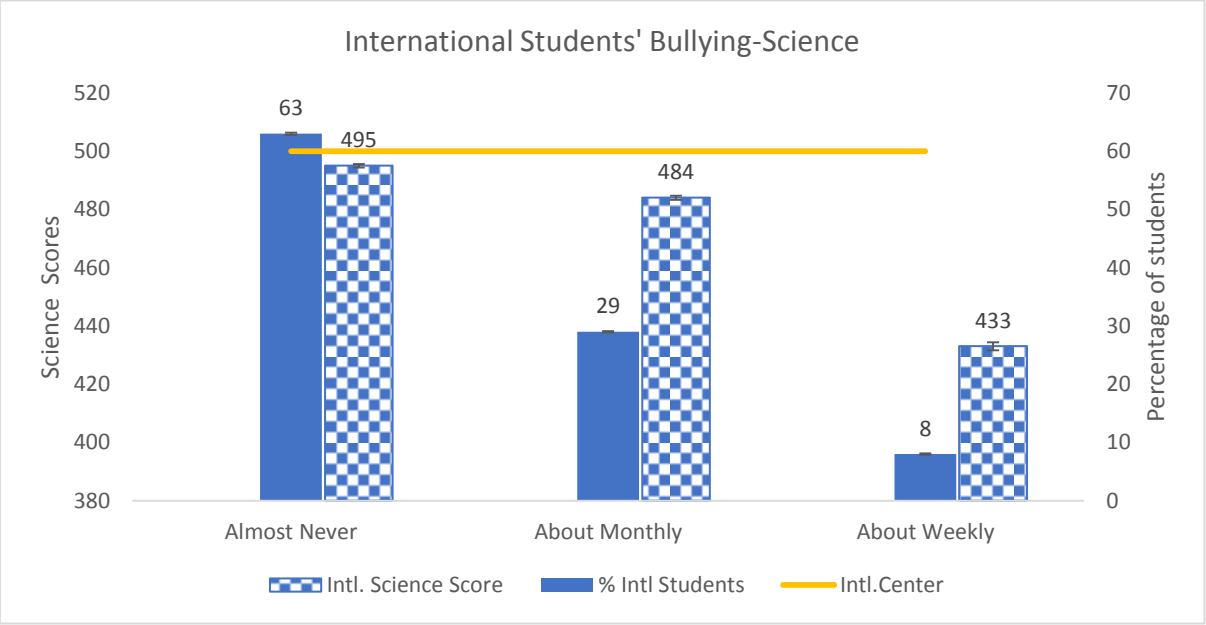


7.4.2. Student bullying-Science

Internationally, on average across the eighth-grade students, the majority of eighth-grade students (63%) Almost Never experienced bullying behaviors, (29%) of students about monthly experienced bullying, whereas only 8 percent of students about weekly experienced bullying.

Figure 7.14 shows that students who were almost never bullied scored 495 with a SE (0.6) which is only 11 points higher than students who were bullied about monthly and scored 484 with a standard error SE (0.7), and students who were bullied about monthly scored 51 points higher than students who were bullied about weekly (433) with a SE (1.4). this shows that the increase of bullying between the last two categories produces a decreasing in the science achievement.

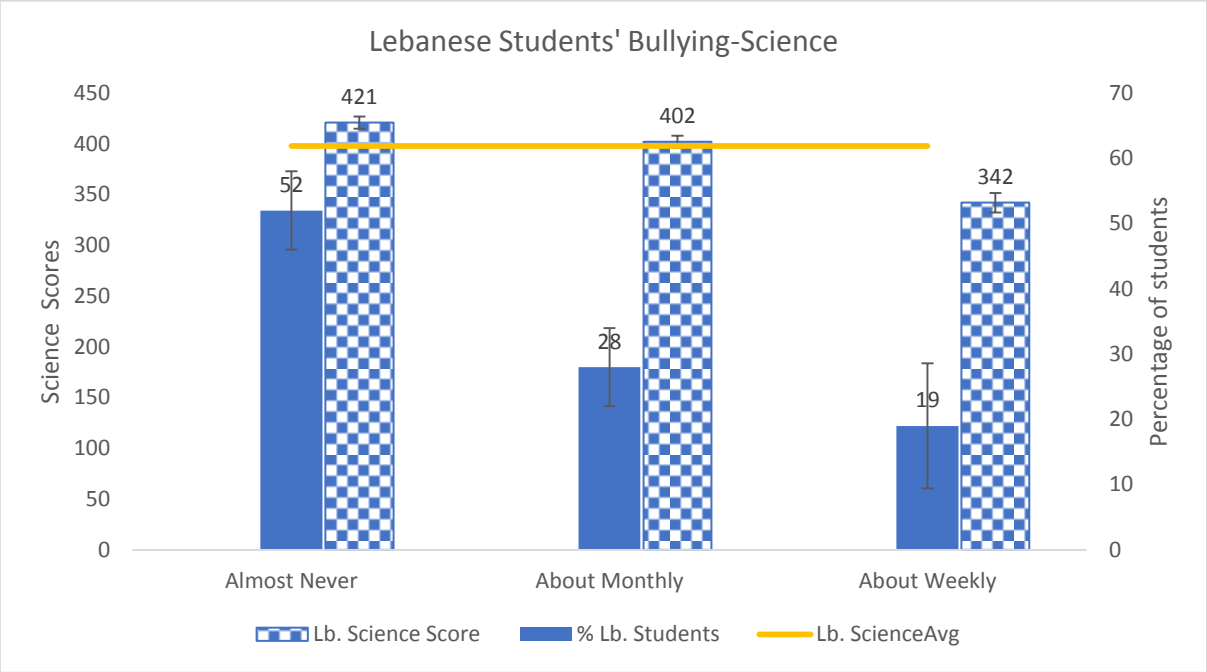
Figure 7.14. Performance of Grade 8 Students in Sciences by Students' Views and Safe and Student Bullying Internationally



On average across the Lebanese eighth-grade students, half of eighth-grade students (52%) Almost Never experienced bullying behaviors, (28%) of students about monthly experienced bullying, whereas 19 percent of students about weekly experienced bullying.

Figure 7.15 shows that students who were almost never bullied scored 421 with a SE (6) which is 20 points higher than students who were bullied about monthly with a score 402 and SE (6), and students who were bullied about monthly scored 60 points higher than students who were bullied about weekly 342 with a SE (9.6). The increase of bullying from almost never to about monthly and to about weekly shows a strong relation between bullying and the science achievement that significantly dropped with the increase in frequency of bullying and this similar to the result in mathematics.

Figure 7.15. Performance of Grade 8 Students in Sciences by Students' Views and Student Bullying in Lebanon



Increase in frequency of bullying led to a significant decrease in achievement in both math and science, both internationally and in Lebanon. However, the decrease in achievement in Lebanon was more noticeable when we moved from about monthly exposure to bullying to about weekly exposure. Higher decreases were noted then.

In summary, having or not having disciplinary problems had no significant effect on Lebanese students' achievement in both math and science. Similarly, having or not having safe and orderly school had no significant effect on Lebanese students' achievement in both math and science. While students in Lebanon, and internationally, who experience bullying behaviors perform lower than peers who do not, so there is an association between the extent to which year 8 Lebanese students experienced bullying and their average achievement: the lesser the extent to which students experience bullying, the higher their average achievement in both math and science.

CHAPTER 8

Student Engagement and Attitudes

This chapter considers the learning environment of the classroom itself. Evidence from successive TIMSS assessments between students' attitudes towards mathematics and their mathematics achievement (Mullis et.al., 2012,p.326) showed a strong positive relationship. Similar results were also drawn from TIMSS in science (Martin et.al.,2012, p.331). Data extracted from the student questionnaire from TIMSS 2015 about the engagement and attitude of students in Lebanese math and science classes was analyzed and compared internationally. Indices include:

I- Students' engagement in mathematics and science classes.

II- Students' attitude towards math and science

II-A. Students like math and/ or science

II-B. Confidence of students in their math and science abilities

II-C. Students value math and science

The student questionnaire included 21 items, and the students in the study sample answered them in about 40 minutes. The students' answers provided information on their family and academic background, and their attitudes and aspirations and classroom practices for math and science teachers from the students' perspectives.

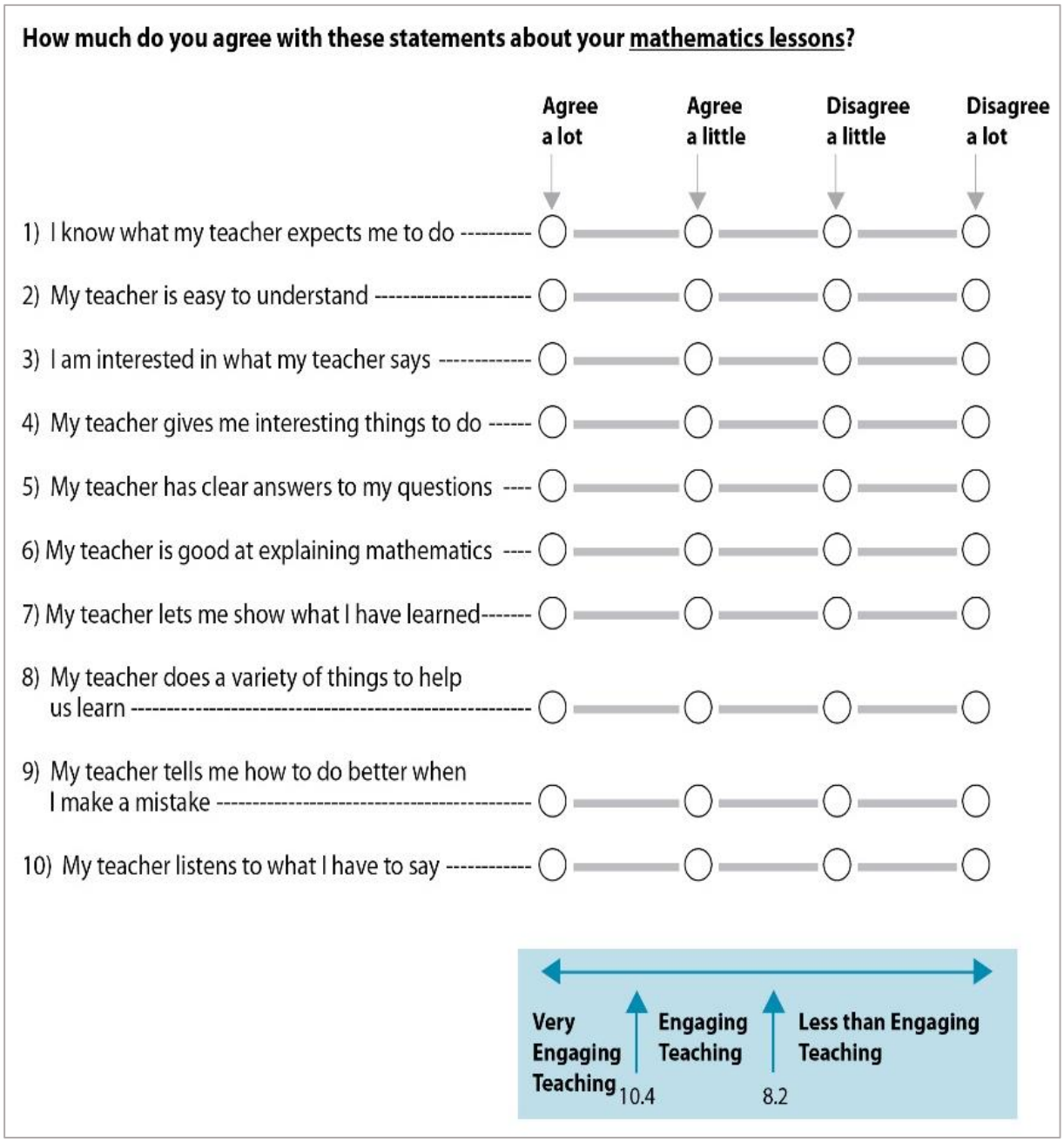
8.1. Students' engagement in mathematics and science classes.

This section uses responses from the student questionnaires to set out the extent to which students in Lebanon say they find mathematics and science lessons engaging. Students reported though answering the questionnaire the extent to which they find the math and science teaching to be engaging and how positive they were about the math and science instruction. This chapter also describes whether or not these attitudinal factors are associated with higher or lower performance in the TIMSS assessments.

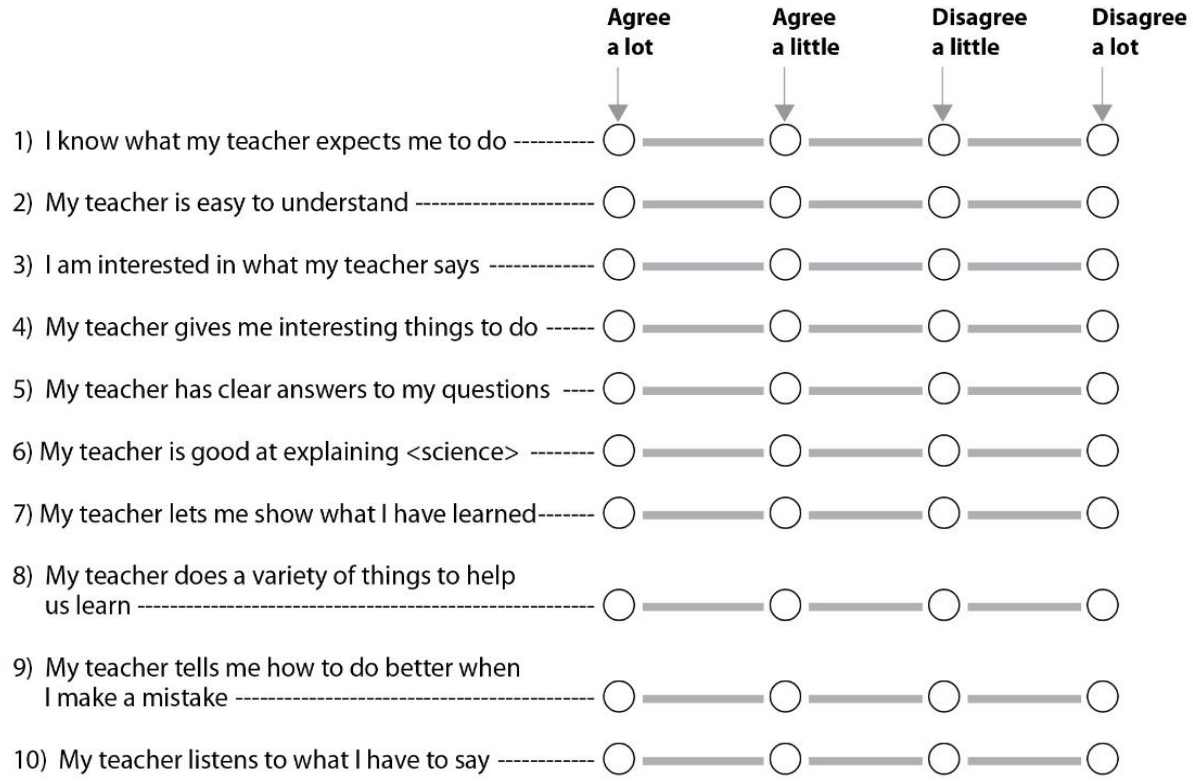
International results showed that 43% of students in grade 8 reported that math instruction is very engaging and 41% stated that it was engaging with 17% only who considered it to be less engaging. Their average achievements were 494, 478 and 464 respectively (Mullis et.al. 2016). On the other hand, 69% of grade 8 students who participated in TIMSS 2015 reported that science instruction is very engaging and had an average achievement of 510 and 25% considered science instruction to be engaging and got an average achievement of 500 while 6% only who considered science to be less engaging got 489 as an average achievement (Martin et. al., 2016). In general, for both math and science, students who reported that teaching is more engaging had a higher average achievement. Figure 1 shows the questionnaire consisting of 10 statements. This was the same for both subjects but with question six adjusted according to the subject.

Based on their degree of agreement with these statements, pupils were assigned to one of three categories: very engaging; engaging and less than engaging.

Figure 1. Engagement in Mathematics and Science Lessons



How much do you agree with these statements about your <science/biology/chemistry/physics/ earth science> lessons?



	Very Engaging Teaching	Engaging Teaching	Less than Engaging Teaching
For General/ Integrated Science	10.2		8.1
For Biology	10.0		7.7
For Chemistry	10.2		8.1
For Physics	10.3		8.1
For Earth Science	10.2		8.0

Based on how much students agreed with the statements in figure 2, students were assigned to one of three categories: very much engaging, engaging, or not engaging math or science (Table 4).

Table 4. Category criteria for students taught Science and Math by level of engagement

Category	Subject	Scale Score	Category criteria
Very much engaging teaching	Mathematics	Score of at least 10.4	Students "agreeing a lot" with 5 of the 10 statements and "agreeing a little' with the other 5.
	Biology, Chemistry and Physics	Scale score of at least 10.2	which corresponds to their "agreeing a lot" with five of the ten statements and "agreeing a little" with the other five
Not engaging teaching	Mathematics	Scale score no higher than 8.2	Students "disagreeing a little" with 5 of the 910 statements and "agreeing a little" with the other 5.
	Biology, Chemistry and Physics	Scale score no higher than 8.1	Students "disagreeing a little" with five of the ten statements and "agreeing a little" with the other five
Engaging teaching		All other students in schools	

The study built the scale of the students' attitudes towards mathematics based on his/her responses on a Likert scale, the students were divided into three categories: ***very engaging teaching, engaging teaching and less engaging teaching***. Table 5 shows the distribution of students' percentages by the categories of this variable and their achievement in mathematics and sciences. Lebanon's percentages for the three categories were as follows: 64%, 65%, 66% and 64% responded to find mathematics, biology, chemistry and physics instruction respectively to be very engaging. Students who found teaching to be very engaging in all the 4 subjects performed better than those who considered it to be engaged or less engaged.

Table 5. Distribution of Students according to Their Engagement and performance in Mathematics and Sciences

	Very Engaging Teaching		Engaging Teaching		Less than Engaging Teaching	
Subject	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Mathematics	64	450	25	436	11	426
Biology	65	417	25	389	10	371
Chemistry	66	415	22	380	12	377
Physics	64	416	23	384	13	386

Source: TIMSS 2015 Results

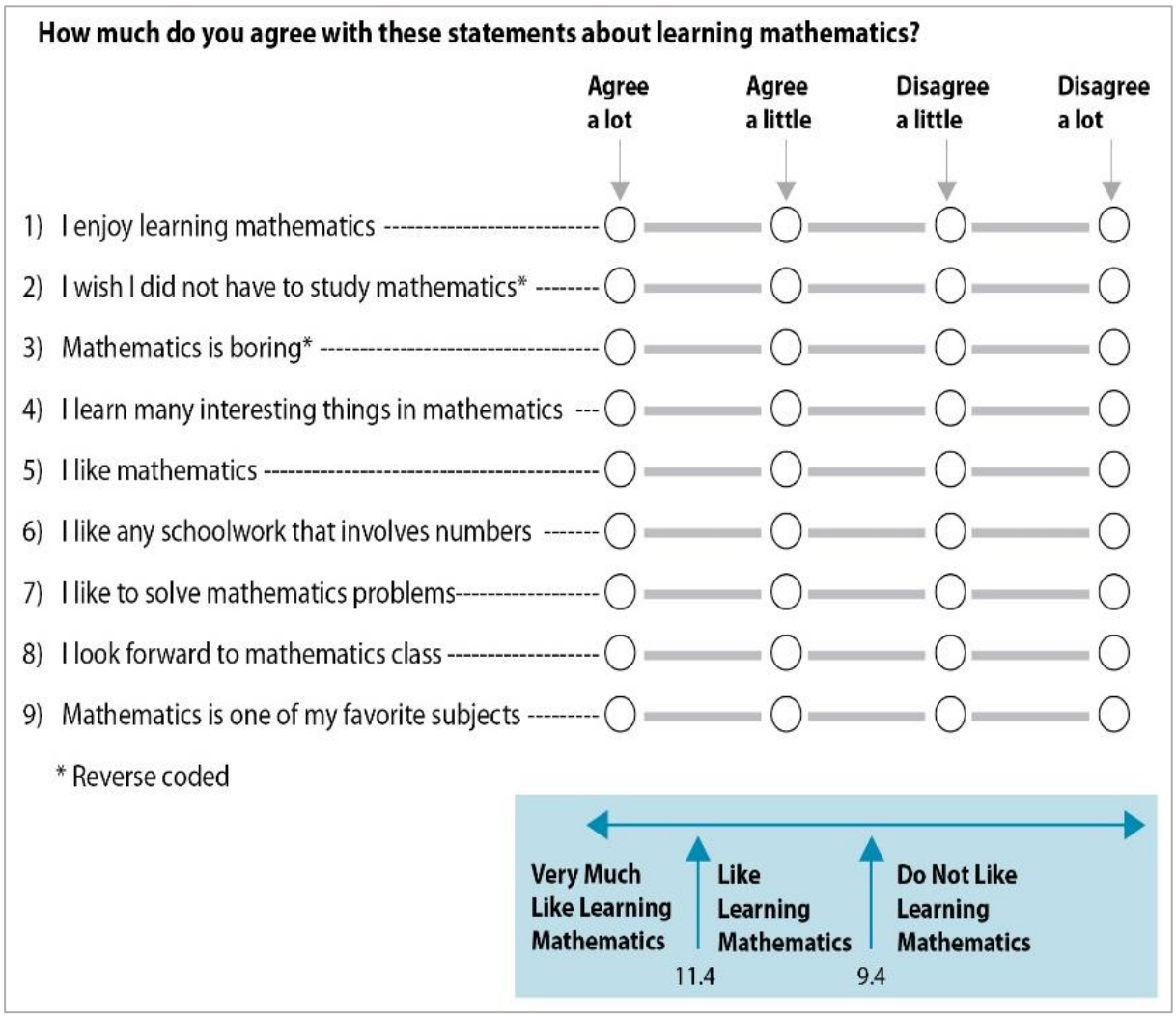
As shown in Table 5 above, 89 percent of grade 8 students in Lebanon viewed teaching to be either engaging or very engaging in mathematics. The proportion of students perceiving it to be very engaging (64%) had an average achievement (450) below the international mean (500) and international average for similar category of 494. 65% of grade 8 Lebanese students viewed biology as very engaging with an average achievement (417), 66% viewed chemistry as very engaging with an average achievement (415). Students' perception of physics instruction was close to those on biology and chemistry with a percentage of 64% who considered physics teaching to be very engaging with an average of 416. These are close to international percentages of 69% who found science to be very engaging but with lower achievement averages.

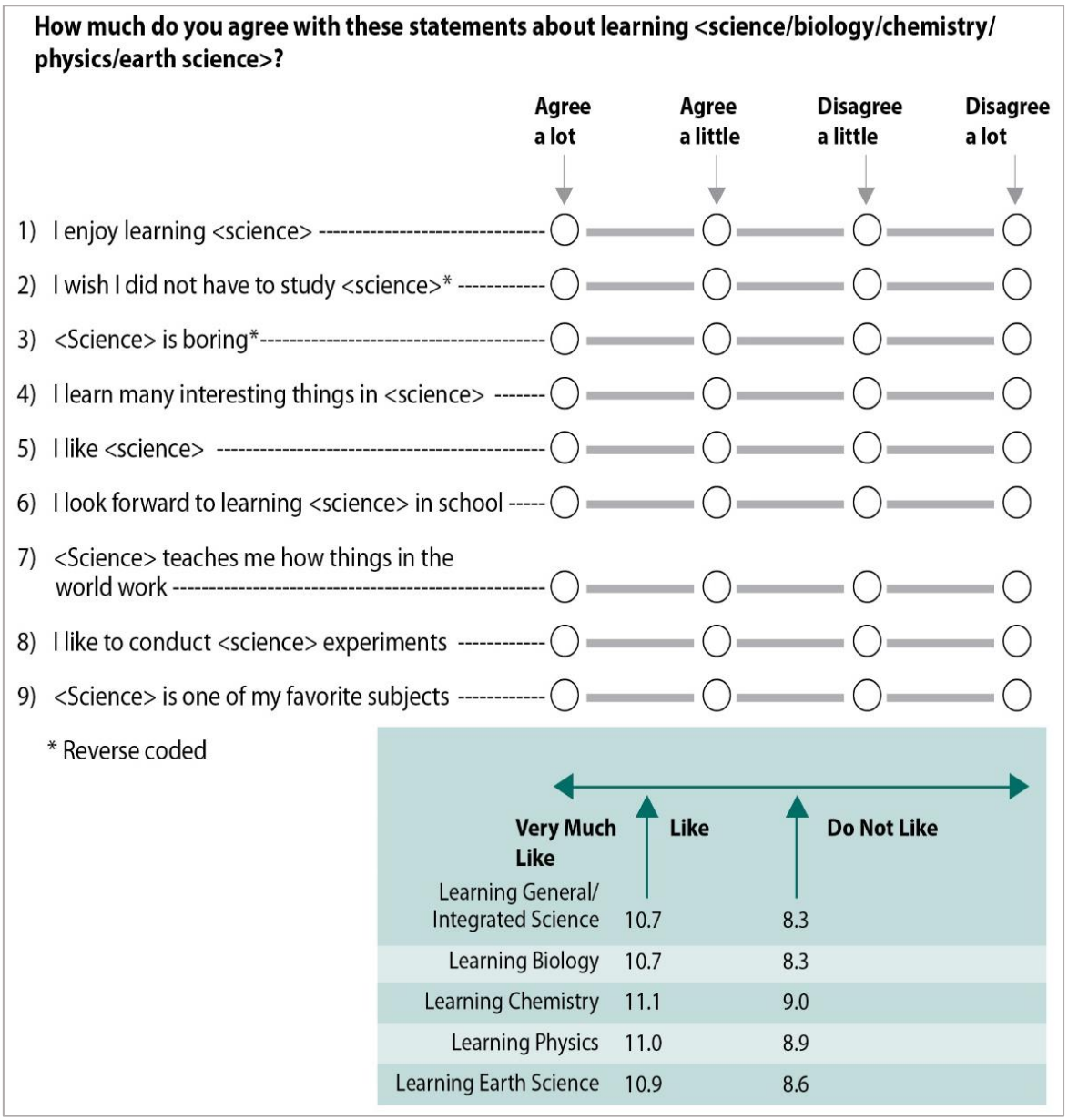
8.2 Students' like learning math and science

8.2.1. Students like math and/ or science

In 2015, the extent to which pupils liked mathematics and science was assessed through a questionnaire comprising nine statements. There were minor variations in the way statements were phrased between subjects. For example, in science, the statement 'Science teaches me how things in the world work' was used in place of the statement 'I like any schoolwork that involves numbers in mathematics' in math test. Figure 2 below shows the questionnaire related to mathematics.

Figure 2 .Students like learning mathematics and Science Lessons





Based on how much students agreed with the statements in figure 2, students were assigned to one of three categories: very much like, like, or do not like learning math or science (Table 6).

Table 6. Category criteria for students taught Science and Math by level of confidence

Category	Subject	Scale Score	Category criteria
Very much like	Mathematics	Score of at least11.4	Students "agreeing a lot" with 5 of the 9 statements and "agreeing a little' with the other 4.
	Biology, Chemistry and Physics	Scale score of at least 10.7	which corresponds to their "agreeing a lot" with four of the eight statements and "agreeing a little" with the other four
Do not like learning	Mathematics	Scale score no higher than 9.4	Students "disagreeing a little" with 5 of the 9 statements and "agreeing a little" with the other 4.

Category	Subject	Scale Score	Category criteria
	Biology, Chemistry and Physics	Scale score no higher than 8.3	Students "disagreeing a little" with four of the eight statements and "agreeing a little" with the other four
Like learning		All other students in schools	

Students were distributed according to the degree of the extent they like learning mathematics or sciences. Three rubrics were considered: very much like learning, like learning or do not like learning. Table 7 shows the percentage of students in each subject according to this scale associated with the average achievement.

Table 7. Distribution of Students according to the extent they Like Mathematics and Science Associated with Average Achievement.

Country	Very Much Like Learning		Like Learning		Do Not like Learning	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Mathematics	31	466	45	434	23	430
Biology	42	438	44	383	14	365
Chemistry	38	431	48	384	14	389
Physics	33	445	49	386	17	391

As shown in Table 7, among the students who reported that they very much like mathematics or science, the highest percentage (42%) was for biology followed by chemistry (38%), then physics (33%) and mathematics (31%). It is noticed that, in general, the more the students like mathematics or science, the higher their achievement average. For chemistry and physics, students who do not like learning chemistry (14%) or physics (17%) had a slightly higher achievement (389) and (391), respectively than the 48% and 49% students who do (384, 386). However, these differences may not be significant and tests of significance need to check for that. So in general, the more students like a subject the higher the achievement which is in line with international findings.

8.3. Confidence in Mathematics or Science

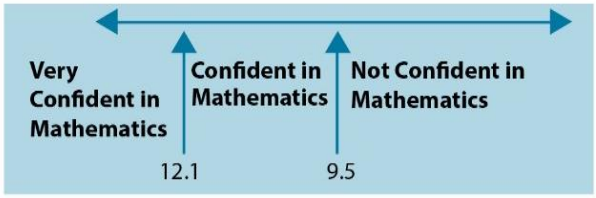
Confidence in mathematics was assessed through a questionnaire comprising nine statements (see Figure 3 below). In science, the same statements were used with the subject name changed, but with the exclusion of statement 5 and with minor variations. For example, the statement 'I am just not good at mathematics' was replaced with 'Science is not one of my strengths'.

Figure 3 .Students confident in math or science Lessons

How much do you agree with these statements about mathematics?

	Agree a lot	Agree a little	Disagree a little	Disagree a lot
1) I usually do well in mathematics	○	○	○	○
2) Mathematics is more difficult for me than for many of my classmates*	○	○	○	○
3) Mathematics is not one of my strengths*	○	○	○	○
4) I learn things quickly in mathematics	○	○	○	○
5) Mathematics makes me nervous*	○	○	○	○
6) I am good at working out difficult mathematics problems	○	○	○	○
7) My teacher tells me I am good at mathematics	○	○	○	○
8) Mathematics is harder for me than any other subject*	○	○	○	○
9) Mathematics makes me confused*	○	○	○	○

* Reverse coded



How much do you agree with these statements about <science /biology/chemistry/physics/ earth science >?

	Agree a lot	Agree a little	Disagree a little	Disagree a lot
1) I usually do well in <science>	○	○	○	○
2) <Science> is more difficult for me than for many of my classmates*	○	○	○	○
3) <Science> is not one of my strengths*	○	○	○	○
4) I learn things quickly in <science>	○	○	○	○
5) I am good at working out difficult <science> problems	○	○	○	○
6) My teacher tells me I am good at <science>	○	○	○	○
7) <Science> is harder for me than any other subject*	○	○	○	○
8) <Science> makes me confused*	○	○	○	○

* Reverse coded

	Very Confident	Confident	Not Confident
For General/ Integrated Science	11.5		9.2
For Biology	11.1		8.6
For Chemistry	11.6		9.5
For Physics	11.6		9.4
For Earth Science	11.2		8.7

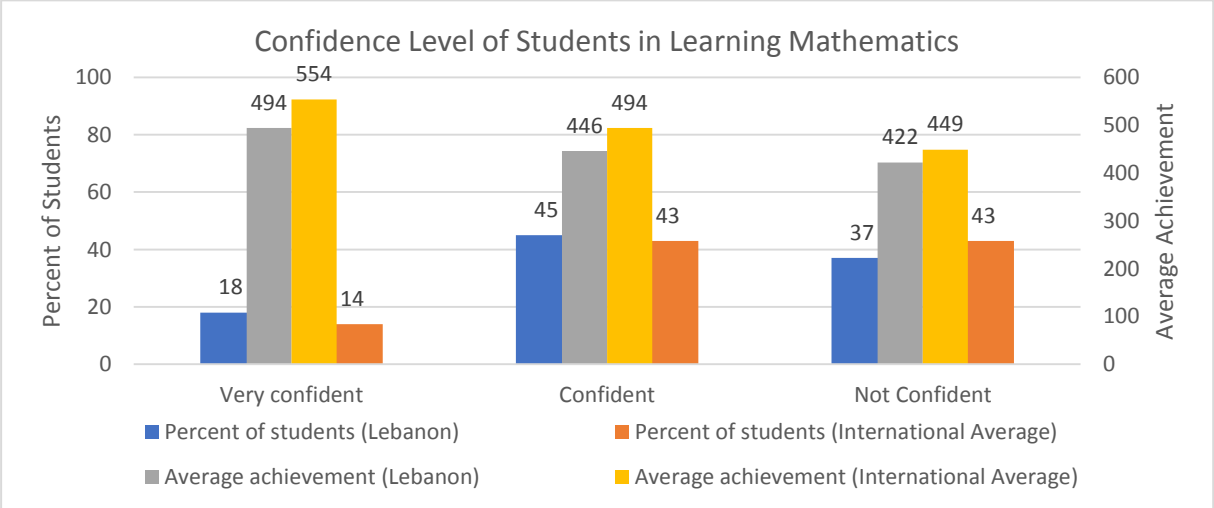
Based on how much students agreed with the statements in figure 2, students were assigned to one of three categories: very confident, confident, or not confident (Table 8).

Table 8. Category criteria for students taught Science and Math by level of confidence

Category	Subject	Scale Score	Category criteria
Very confident	Mathematics	Scale score of at least 12.1	Students "agreeing a lot" with 5 of the 9 statements and "agreeing a little' with the other 4.
	Biology, Chemistry and Physics	Scale score of at least 11.5	which corresponds to their "agreeing a lot" with four of the eight statements and "agreeing a little" with the other four
Not Confident	Mathematics	Scale score no higher than 9.5	Students "disagreeing a little" with 5 of the 9 statements and "agreeing a little" with the other 4.
	Biology, Chemistry and Physics	Scale score no higher than 9.2	Students "disagreeing a little" with four of the eight statements and "agreeing a little" with the other four
Confident		All other students in schools	

Figure 4 presents the eighth grade results for the Students Confident in Mathematics scale. It is clear that the average achievement increases with the confidence level. Majority of Lebanese students (63%) and international students (67%) were classified as very confident and confident".

Figure 4. Average Achievement of Students in Mathematics by Confidence Level



Figures 5, 6 and 7 reveal that, for all sciences, a decline in average achievement was noticed when the scale of confidence dropped from "very confident" to "not confident". Results are similar for those in mathematics in the sense that most of the Lebanese students were reported to be very confident and confident in biology (67%) as compared internationally (73%). In physics, 63% of the Lebanese eighth grade students were classified to be very confident and confident while 59% of international students were considered to be confident or not confident. Similarly, 66% of Lebanese eighth grade students and 61 % of international students considered themselves to be very confident and confident in chemistry. The highest percentage of Lebanese and international students very confident was in biology and chemistry and the least percentage for both was in mathematics. Among the sciences, physics had highest level of 'not confident' both locally and internationally. For each subject, there was a decrease in achievement with decreasing confidence level.

Figure 5. Average Achievement of Students in Biology by Confidence Level

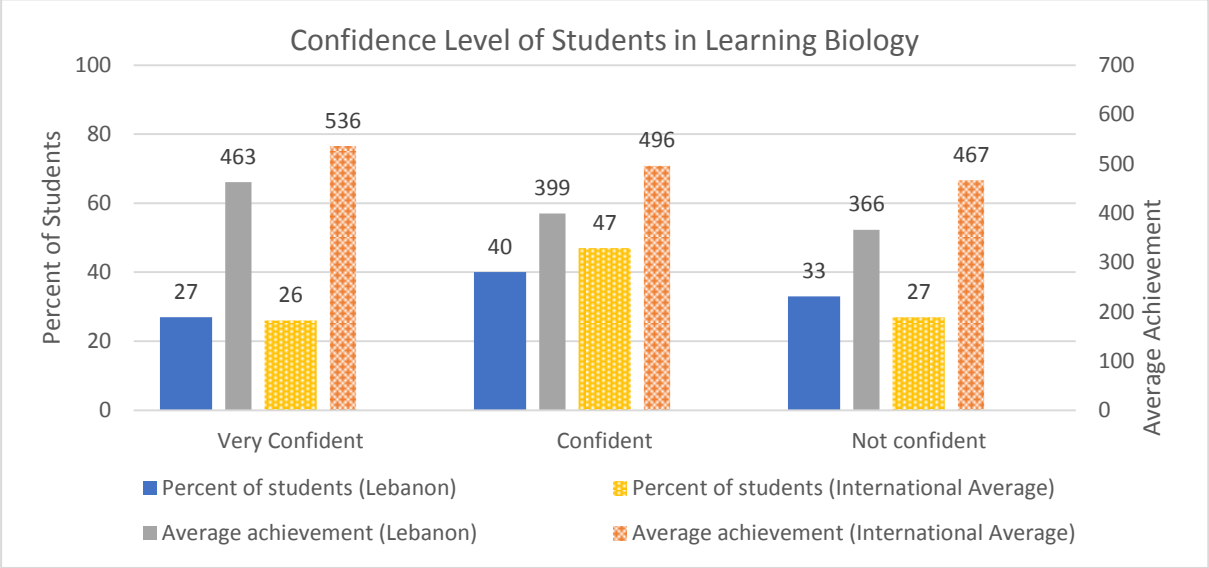


Figure 6. Average Achievement of Students in Physics by Confidence Level

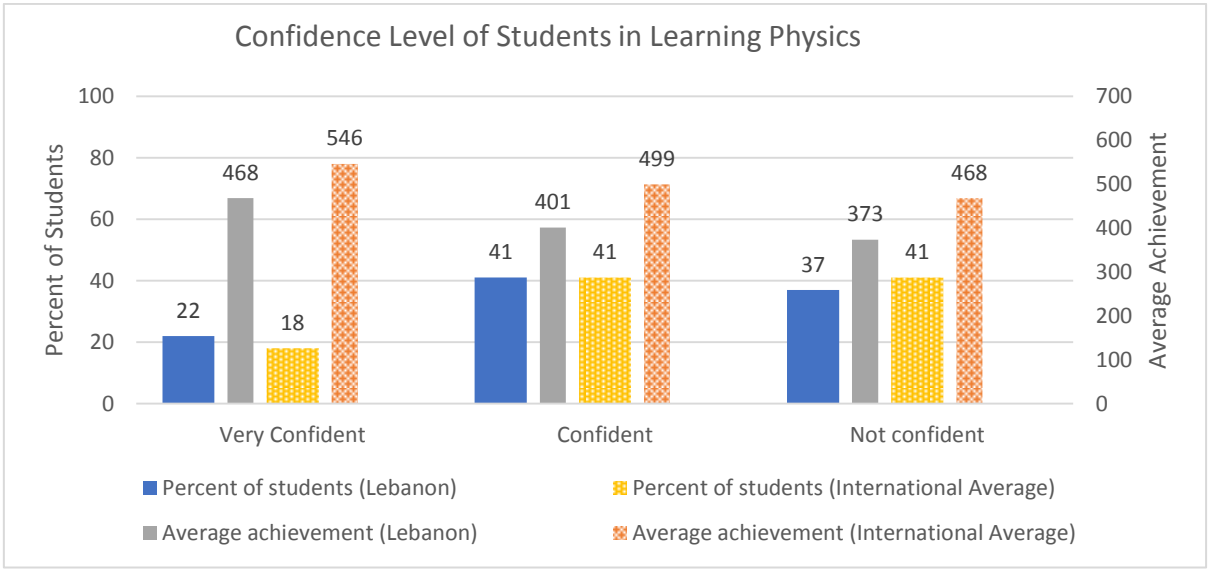
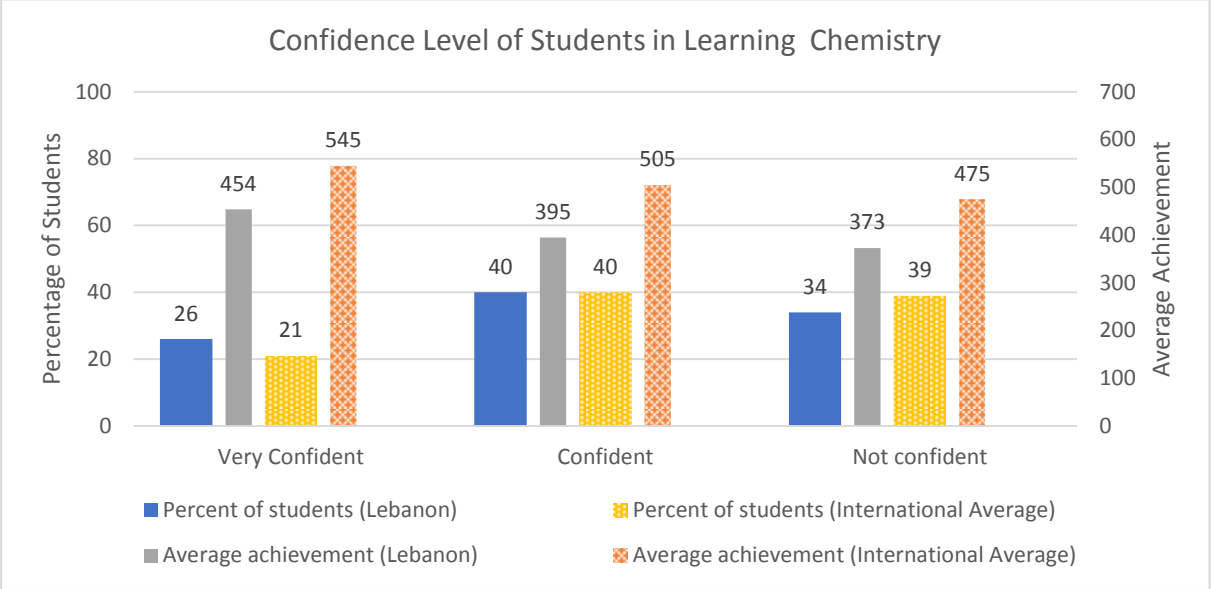


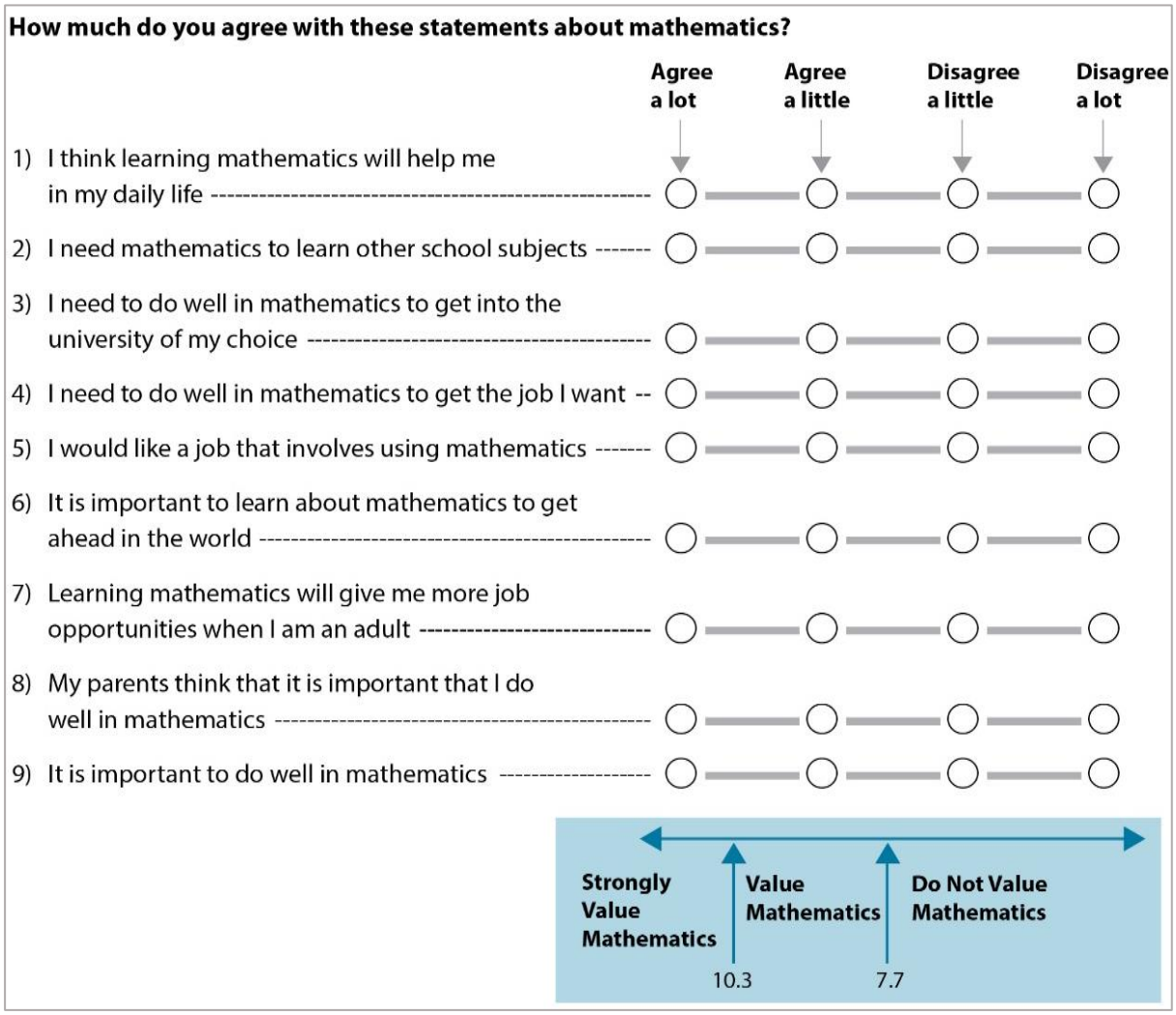
Figure 7. Average Achievement of Students in Chemistry by Confidence Level

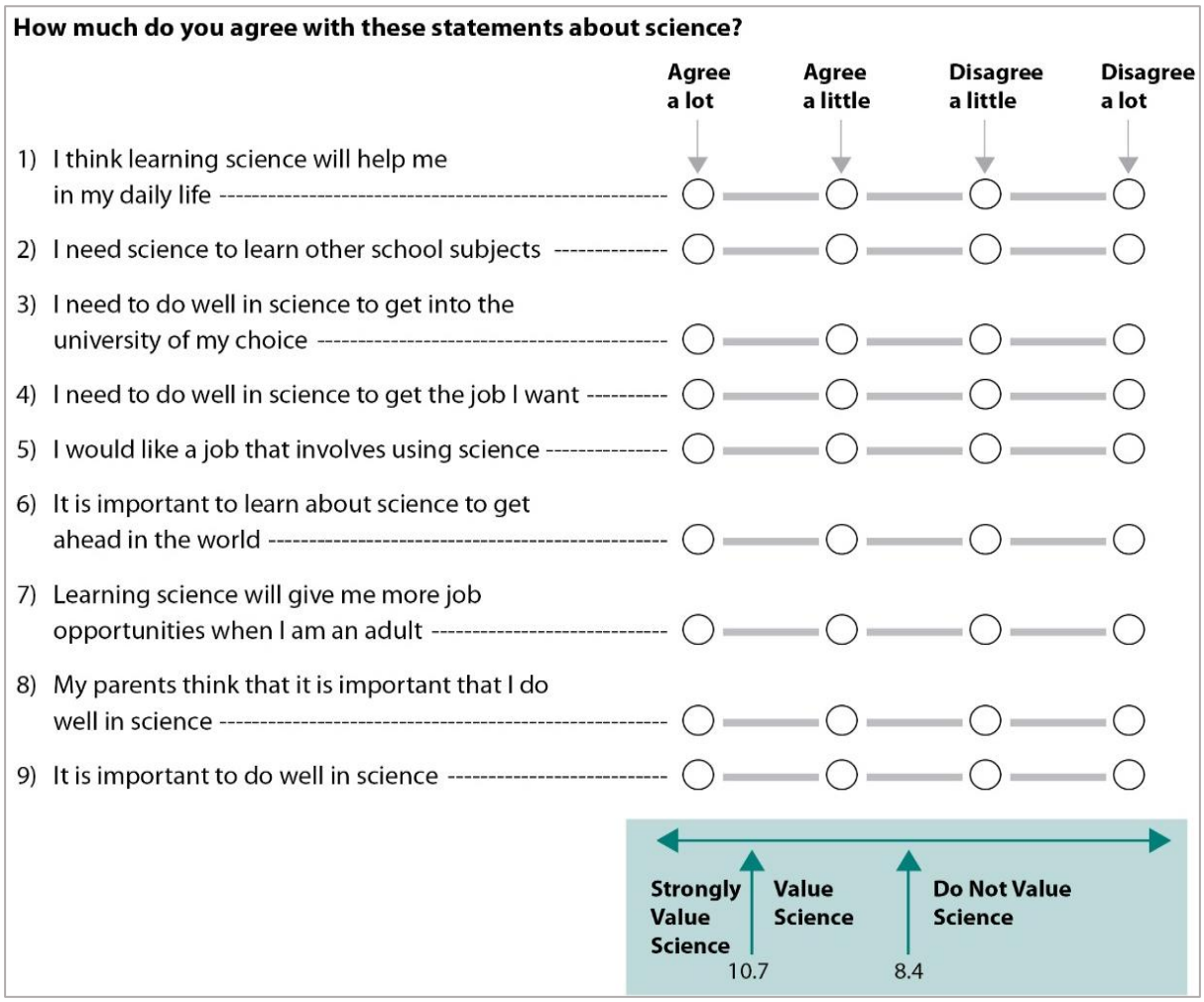


8.4 Students Value Mathematics or Science

In 2015, the extent to which eighth grade students value mathematics and science was assessed through a questionnaire comprising nine statements. These were the same in both subjects with just the subject title changed (figure 8). Based on how much pupils agreed with these statements, they were given a scale score and included within one of three categories: strongly value, value or do not value. The average achievement in the assessments of pupils in each of these categories was then calculated so that any association between valuing the subject and achievement could be identified.

Figure 8 .Students value mathematics or science





Based on how much students agreed with the statements in figure 2, students were assigned to one of three categories: very confident, confident, or not confident (Table 10).

Table 10. Category criteria for students taught Science and Math by value of math and science

Category	Subject	Scale Score	Category criteria
Strongly value	Mathematics	Scale score of at least 10.3	Students "agreeing a lot" with 5 of the 9 statements and "agreeing a little' with the other 4.
	Biology, Chemistry and Physics	Scale score of at least 10.7	which corresponds to their "agreeing a lot" with five of the nine statements and "agreeing a little" with the other four
Do not value	Mathematics	Scale score no higher than 7.7	Students "disagreeing a little" with 5 of the 9 statements and "agreeing a little" with the other 4.
	Biology, Chemistry and Physics	Scale score no higher than 8.4	Students "disagreeing a little" with five of the nine statements and "agreeing a little" with the other four
Value		All other students in schools	

Table 11 presents the percentage of students who strongly value, value or do not value mathematics and science together with their corresponding average achievement in each case. A positive association is noticed between average achievement and the degree students value mathematics and science. The math average achievement is higher than

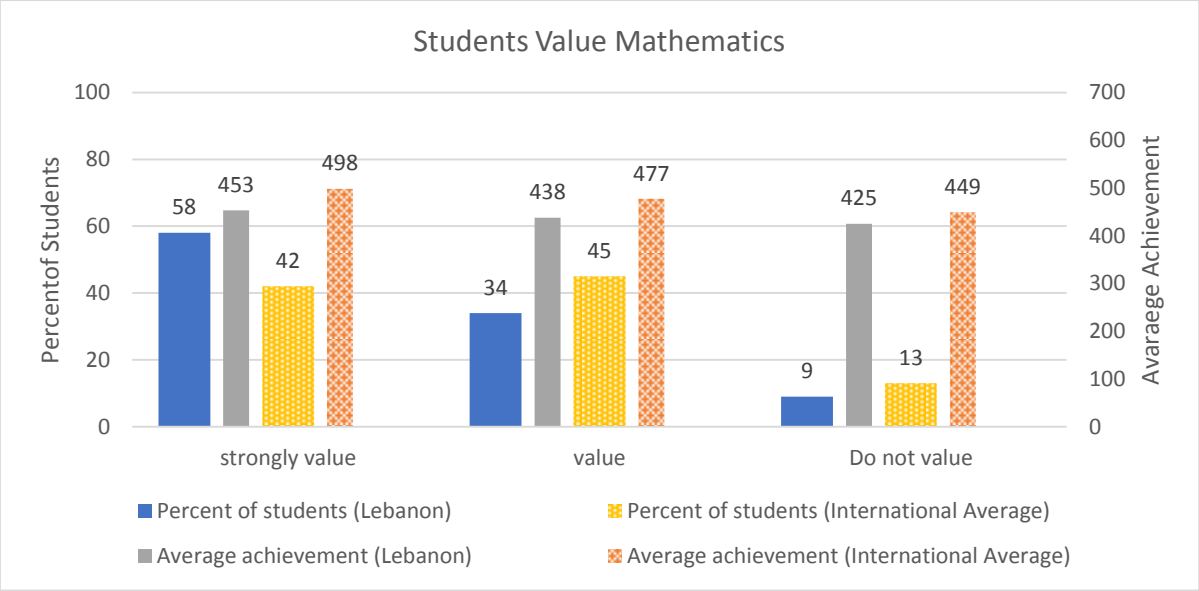
that of science in the three cases under study. It is also noticed that 10 percent or less only do not value math and science.

Table 11. Students' Achievement by the degree Students Value Mathematics and Science

	Strongly Value		Value		Do Not Value	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Mathematics	58	453	34	438	9	425
Science	58	420	32	381	10	359

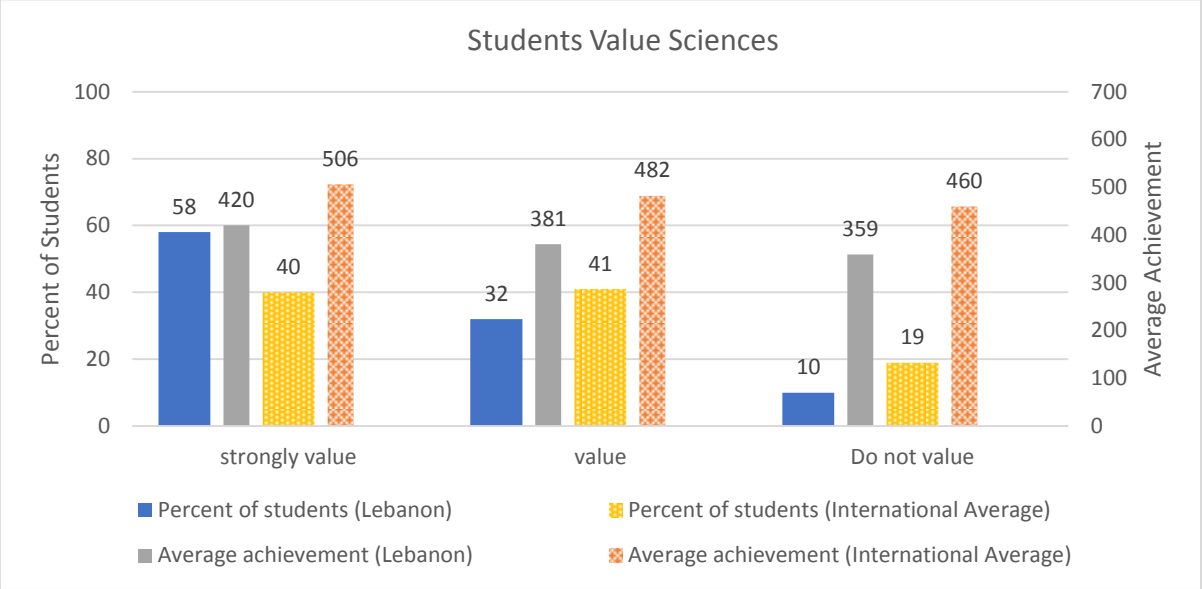
A comparison of Lebanese students' achievement and International students with respect to the degree students value mathematics is presented in figure 9. The extent to which Lebanese students strongly valued (58%) mathematics was higher than the international mean (42%).

Figure 9. Students value mathematics



A comparison of Lebanese students' achievement and International students with respect to the degree students value science is presented in figure 9. The extent to which Lebanese students strongly valued (58%) science was higher than the international mean (40%).

Figure 10. Students value science



As a conclusion, it is noted that Lebanese students were likely to be very engaged in mathematics and science. These students tended to have higher averages than those who are engaged or not engaged. On the other hand, majority of Lebanese students tended to like math and sciences while others who very much liked learning math and sciences were less but got the highest averages. Similar results were found also with respect to confidence in their abilities to learn mathematics and sciences. Majority of the Lebanese students were confident and less were those who were very confident or not confident and the higher the confidence, the higher the achievement. Lebanese students who strongly valued mathematics and science were the majority and got the highest averages.

As a result, Lebanese students should learn in a rich environment where they engage in activities so that they build self-confidence and like learning the material and correspondingly value the subjects taught by feeling their importance and applicability in real life situations.

CHAPTER 9

Classroom instruction

This chapter is based on several types of questionnaire addressed to principals, students and teachers.
The collected data is related to the classroom instruction in the Lebanese schools and includes the following indices:

1- Instructional Time Spent on Science

2- Teachers Emphasize Science Investigation (Science Only)

3- Resources for Conducting Science Experiments (Science Only).

4- Computer Activities During Science Lessons and using internet in schoolwork

5- Weekly Time Students Spend on Assigned Science Homework

6- Teaching Limited by Student Needs

7- Frequency of Student Absences

9.1 Instructional Time Spent on Science

These exhibits present principals' and teachers' reports about the instructional hours per year that were spent on math and science instruction. The principals provided the number of school days per year and the number of instructional hours per day, and the teachers provided the weekly amount of instruction in science. As explained in figure9.1 for science and similar for Math, the data were combined to estimate yearly amounts of instructional time in Math and science for each country.

In science, for countries teaching science as separate subjects at the eighth grade (included Lebanon), the total included the amount of time spent on each individual science subject. As might be anticipated, these estimates vary somewhat from the levels of instructional time set as a matter of policy.

Figure 9.1: Instructional time spent on science

Total Instructional Hours per Year = Principal Reports of School Days per Year X Principal Reports of Instructional Hours per Day

Hours per Year for Science Instruction = $\frac{\text{Teacher Reports of Weekly Science Instructional Hours}}{\text{Principal Reports of School Days per Week}}$ X Principal Reports of School Days per Year

Figure9.2: Instructional Time Spent on Science in Hour Per Year for Some Selected Participant Countries

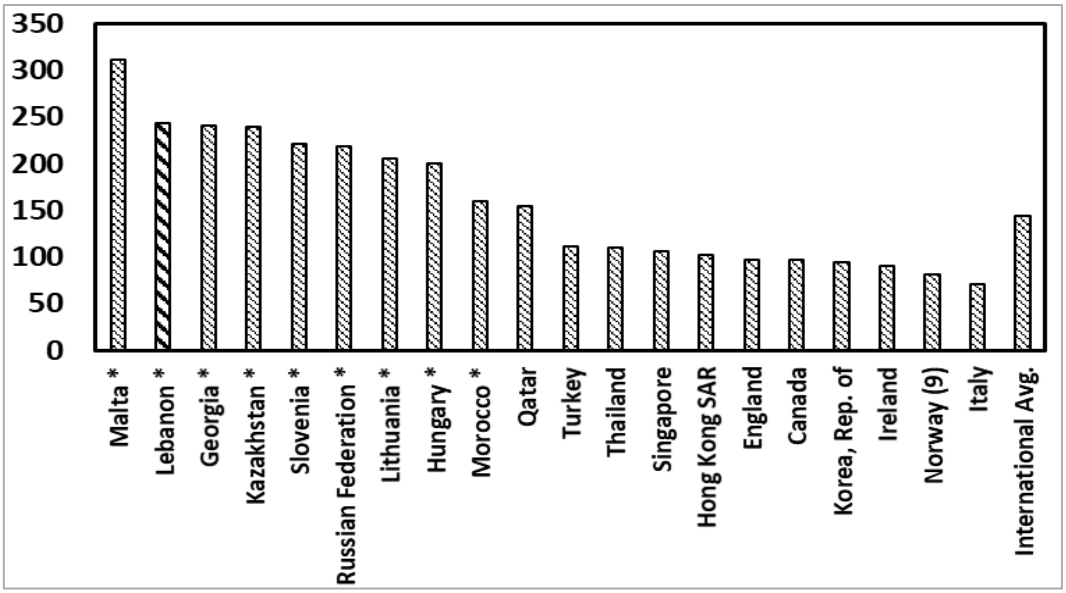


Figure 9.2 represents the instructional time spent on science teaching in hour per year for a group of participating countries, which were selected according to the number of hours of science instruction, representing the top ten and the last ten according to the number of hours of science instruction in the 8th class

Figure 9.2 shows that Lebanon spent about 240h per year for science instruction which is higher than international average and represents one of the top ten countries, in fact the second country that allocates the largest number of teaching hours for science instruction after Malta (310h/year). This may be due to the fact that the teaching of science instruction is done separately for several subjects (Chemistry, Physics, Biology). However, we did not see any positive reflection of the number of teaching hours on the general result of students in TIMSS exam.

On the other hand, the instructional time spent on math teaching in hour per year for a group of participating countries is represented in figure 9.3. The presented countries were selected according to the number of hours of math instruction, representing the top ten and the last ten according to the number of hours of math instruction in the 8th class.

Figure9.3: Instructional Time Spent on Science in Hour Per Year for Some Selected Participant Countries.

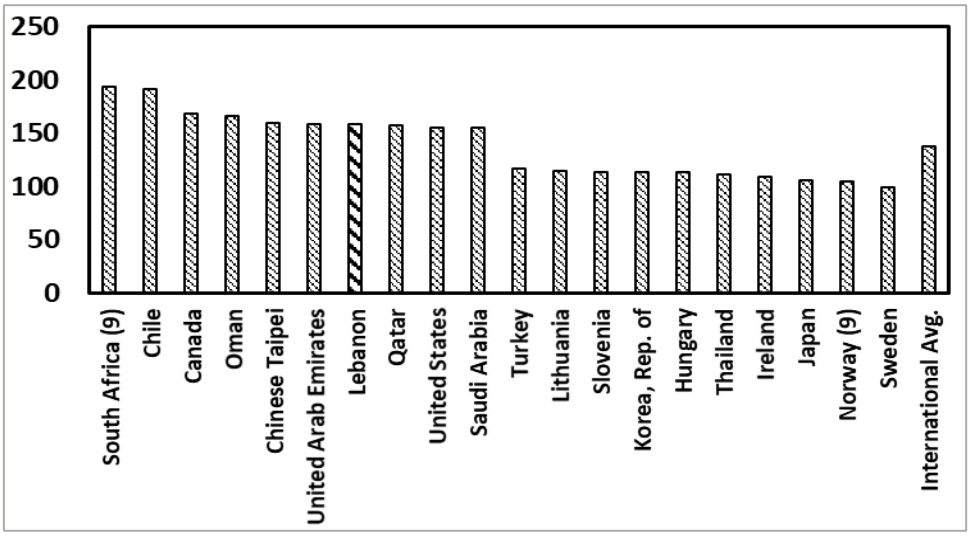
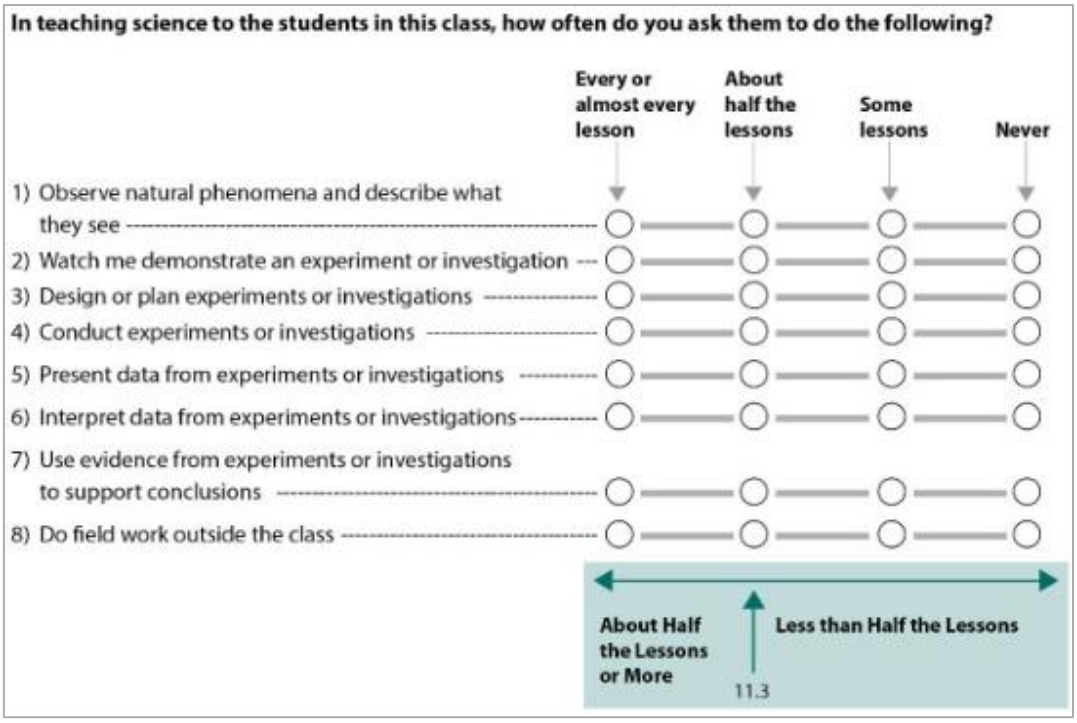


Figure 9.3 shows that the instructional time spent on math is lower than that spent on science, however, it is still considered among the highest worldwide and it is close to the international average.. In addition, this figure does not present a high variability between countries, as the range is between 198 h in South Africa and 100 in Sweden. Same as science, the instructional time spent on math does not reflect positively on the Lebanese student's achievement in TIMSS.

9.2 Teachers Emphasize Science Investigation (Science Only)

Students were scored according to their teachers' responses to how often they used each of eight instructional activities on the Emphasize Science Investigation scale (Figure 9.4). Students with teachers who emphasized science investigation in About Half the Lessons or More had a score on the scale of at least 11.3, which corresponds to their teachers using all eight activities in "about half the lessons," on average. All other students had teachers who emphasized science investigation in Less than Half the Lessons.

Figure9.4:Teachers Emphasize Science Investigation questionnaire.



The result of this questionnaire are collected in table 9.1

Table 9.1: The Emphasis on Science Investigation Scale and Student Achievement in Science, Lebanon and the International average

Country	About Half the Lessons or More				Less than Half the Lessons				Average Scale Score	
	Percent of Students	SE of %	Average Achievement	SE	Percent of Students	SE of %	Average Achievement			
Lebanon	52	(3.9)	403	(6.2)	48	(3.9)	392	(9.2)	11.3	(0.11)
International Avg.	27	(0.5)	490	(1.3)	73	(0.5)	485	(0.7)		

According to their teachers' responses, around 50% of the Lebanese Grade 8 students had teachers who emphasized scientific investigations in half or more of their science lessons. This was much higher than the international average, which was 27%. However, among Lebanese students there were no significant differences (See SE of %) in the science assessment scores of those students whose teachers emphasized scientific investigations in about half the lessons or more and those who did so less often, a significant relationship was found across participating countries on average internationally. Those students whose teachers emphasized scientific investigation in at least half of their lessons tended to outperform those students whose teachers emphasized this aspect less often.

These results raise an important question as to why 'emphasize science investigation' has not had a significant impact on science achievement in Lebanon although more than 50% of the teachers claimed that they emphasized science investigation in About Half of their Lessons or More.?!

9.3 Resources for Conducting Science Experiments (science Only).

In this part, students were scored according to their principles' responses about the presence of science laboratory in the school and if the teachers have an available assistance in the laboratory during conducting experiments.

Table 9.2 represent The laboratory resources scale and student achievement in science, Lebanon and the international average.

Table9.2: Performance of Grade 8 Students in Science in Lebanon and Internationally by Laboratory resources.

Country	Schools Have a Science Laboratory								Teachers Have Assistance Available when Students are Conducting Experiments							
	Yes				No				Yes				No			
	Percent of Students		Average Achievement		Percent of Students		Average Achievement		Percent of Students		Average Achievement		Percent of Students		Average Achievement	
Lebanon	89	(2.8)	406	(5.5)	11	(2.8)	339	(16.4)	75	(4.0)	402	(7.2)	25	(4.0)	388	(13.0)
International Avg.	85	(0.4)	489	(0.7)	15	(0.4)	450	(2.0)	58	(0.5)	489	(1.1)	42	(0.5)	481	(1.5)

Table 9.2 shows that 89% of Lebanese student are conducting experiments in a scientific laboratory and about 11% have no scientific laboratory in their schools. The difference in the Lebanese student's achievement is significant, and show the importance of scientific resources in the performance of Lebanese students. On the other hand, the international results were similar to those of Lebanon, a significant difference was observed in the international student achievement in terms of the presence of scientific laboratory in the schools. The presence of a laboratory assistant was not an effective factor on the

improvement of students' results in Lebanon but not internationally, as availability of assistance contributed significantly to achievement internationally.

9.4 Computer Activities During Science Lessons and using internet in schoolwork

TIMSS teachers reported considerable variation in computer availability for use in science and math lessons.

Figure 9.5 represents a part of participating countries and the percentage of students that have access to computers during science lesson. About 12 % of Lebanese students have available computers to use in Science Lessons which is somehow far from the international average of Computers Available for Students to Use in Science Lessons.

Figure9.5: Percentage of Students That Have Access to Computers during Science Lesson.

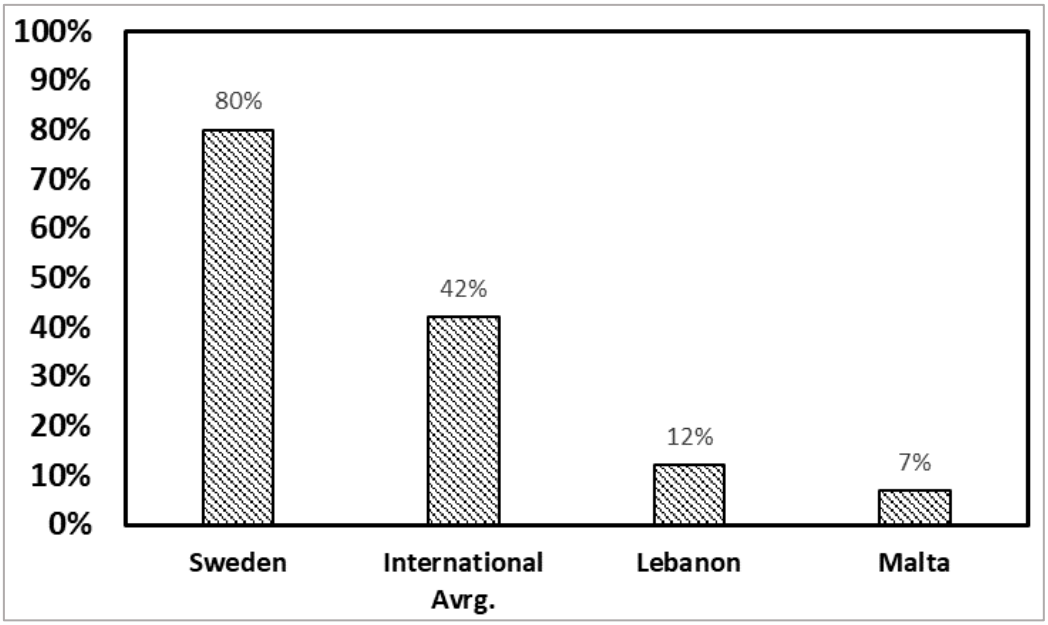


Table 9.3 represents the Percentage of Lebanese and international students with computer availability during science lessons and their average achievement

Table9.3: Percentage of Lebanese and International Students with Computer Availability during Science Lessons and their Average Achievement

Country	Computers Available for Students to Use in Science Lessons					
	Percent of Students		Average Achievement			
	Yes		Yes		No	
Lebanon	12	(2.6)	427	(13.9)	393	(5.7)
International Avg.	42	(0.5)	493	(1.0)	483	(0.8)

By comparing the results of students' achievement in science we note that the international Average science achievement for student with computer availability compared to those without availability are significantly different, 493 (1) and 483 (0.8) respectively. In Lebanon, the results are also significant, the average science achievement

for Lebanese students with and without computer availability are significantly different 427 (14) and 393 (6) respectively, as standard errors do not overlap.

These results give the impression that the use of computers in science lessons improve the performance of students in grade 8 both in Lebanon and internationally.

On the other hand, Table 9.4 represent the percent of students who use the internet to do different tasks related to science in comparison with the international average of using internet for the same purpose.

Lebanese students reported that they use internet in many different tasks related to science in a percentages rate higher than the global average of students' Internet use in science education.

Table9.4: Percentage of Students Who Use of Internet for Science Schoolwork in Lebanon and internationally

Country	Percent of Students Who Use the Internet to Do the Following Tasks				
	Access the Textbook or Other Course Materials	Access Assignments Posted Online by the Teacher	Collaborate with Classmates on Assignments or Projects	Communicate with the Teacher	Find Information, Articles, or Tutorials to Aid in Understanding Science
Lebanon	57%	43%	77%	42%	62%
International Avg.	56%	53%	69%	36%	61%

The same discussion was dealt with in mathematics.

Figure 9.6 represents a part of participating countries and the percentage of students that have access to computers during **Math** lesson.

Figure9.6: Percentage of Students That Have Access to Computers during Math Lesson.

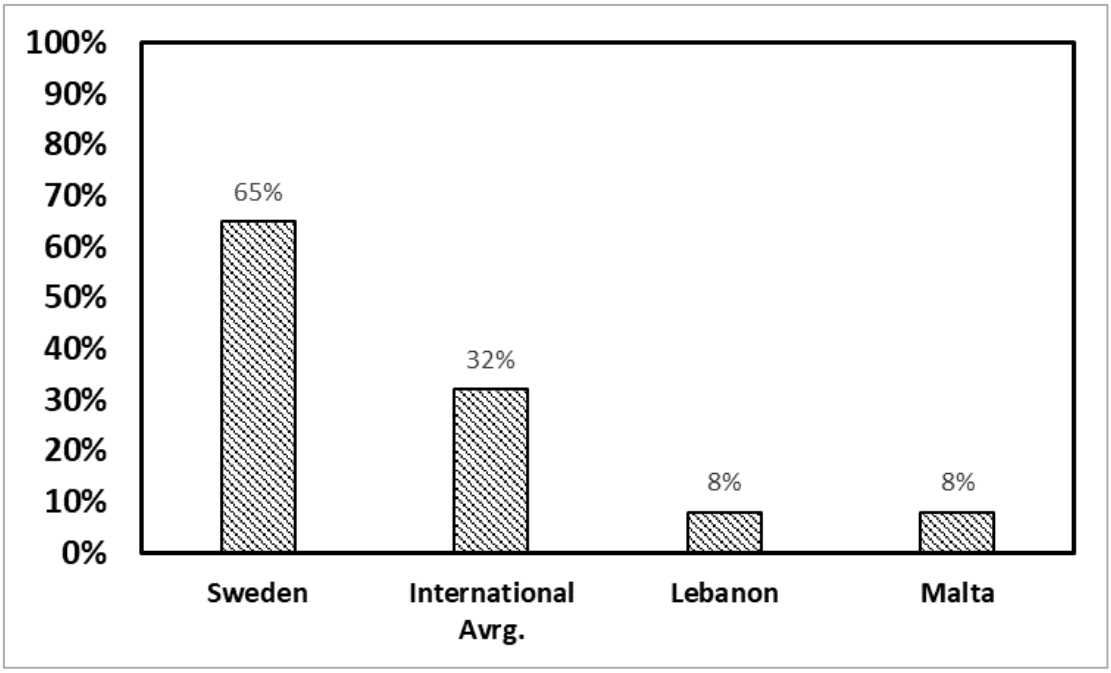


Figure 9.6 shows that only about 8 % of Lebanese students have available computers to use in math Lessons which is different from the international average and consider from the lowest between the participating countries.

Table 5 represents the Percentage of Lebanese and international students with computer availability during science lessons and their average achievement

Table9.5: Performance of Grade 8 Lebanese and International Students with Computer Availability during Math lessons

Country	Computers Available for Students to Use in Mathematics Lessons					
	Percent of Students		Average Achievement			
	Yes		Yes		No	
Lebanon	8	(2.3)	451	(11.8)	442	(3.9)
International Avg.	32	(0.5)	485	(1.3)	481	(0.7)

Contrary to what is stated in science, Table 9.5 shows that no significant difference between the international average math achievement for students with computer availability compared to those without availability in Lebanon but not internationally. These facts put as in a continuing debate about the role of technology in education in science and math classes.

Finally, Table 9.6 represent the percent of students who use the internet to do different tasks related to math in comparison with the international average of using internet for the same purpose.

Table9.6: Percentage of Students Who Use The Internet for Math Schoolwork in Lebanon and Internationally

Country	Percent of Students Who Use the Internet to Do the Following Tasks														
	Access the Textbook or Other Course Materials			Access Assignments Posted Online by the Teacher			Collaborate with Classmates on Assignments or Projects			Communicate with the Teacher			Find Information, Articles, or Tutorials to Aid in Understanding Mathematics		
Lebanon		57	(1.3)		43	(1.7)		77	(1.5)		42	(1.7)		58	(1.3)
International Avg.		56	(0.2)		53	(0.2)		69	(0.2)		36	(0.2)		57	(0.2)

9.5 Weekly Time Students Spend on Assigned Science Homework

Students in Grade 8 were asked how often their teacher gives them mathematics and sciences homework and how much time they usually spend on it when it is given.

The time spend by Lebanese students on assigned science and mathematics homework is represented in Table 9.7.

This table presents the percentage of student related to each interval of time spend on assigned science and mathematics homework and their corresponding average achievement, as well as the international averages for the same parameters. This international average summarizes responses for countries where students are taught science as separated subjects.

Table9.7: Performance of Students by Time Spent on Mathematics and Science Homework per week in Lebanon and Internationally.

Subject Country	3 Hours or More				More than 45 Minutes but Less than 3 Hours				45 Minutes or Less			
	Percent of Students		Average Achievement		Percent of Students		Average Achievement		Percent of Students		Average Achievement	
Biology												
Lebanon	3	(0.3)	385	(11.4)	16	(0.9)	394	(8.1)	81	(1.0)	405	(5.3)
International Avg.	6	(0.2)	465	(3.4)	22	(0.3)	490	(1.8)	72	(0.3)	497	(1.2)
Chemistry												
Lebanon	3	(0.4)	370	(12.2)	20	(0.9)	399	(7.0)	77	(1.0)	404	(5.4)
International Avg.	9	(0.2)	473	(2.8)	25	(0.3)	498	(1.6)	66	(0.4)	496	(1.2)
Physics												
Lebanon	4	(0.4)	369	(15.3)	20	(1.0)	397	(6.9)	76	(1.1)	405	(5.4)
International Avg.	9	(0.2)	471	(2.8)	27	(0.3)	491	(1.6)	64	(0.4)	495	(1.2)
Math												
Lebanon	14	(1.0)	436	(5.4)	32	(1.3)	456	(4.8)	54	(1.5)	442	(4.0)
International Avg.	15	(0.1)	481	(1.1)	36	(0.2)	491	(0.7)	49	(0.2)	474	(0.7)

Table 9.7 shows that the vast majority of Lebanese students reported spending less than 45 minutes per week on science and math homework, which was significantly greater than the proportion of students across participating countries who spent this amount of time on science and math homework. By comparing the average science and math score of those who spent less than 45 minutes with those who spent between 45 minutes and three hours per week on homework, we found that there is no significant difference except in math in Lebanon. On the other hand, the proportion that did three or more hours per week was too small to allow estimation of their average performance in science and math. In fact, the relationship between time spent on homework and student performance can be difficult to interpret, because of different approaches and policies regarding assigning homework. At least we can assume that there is no direct correlation between time spent on homework and score average of 8th grade students in science and mathematics.

9.6 Teaching Limited by Student Needs

Students were scored according to their teachers' responses concerning six needs on the Teaching Limited by Student Needs scale (Figure 9.7). Students with teachers who felt Not Limited by student needs had a score on the scale of at least 11.4, which corresponds to their teachers feeling “not at all” limited by three of the six needs and to “some” extent

limited by the other three needs, on average. Students with teachers who felt Very Limited by student needs had a score no higher than 7.4, which corresponds to their teachers reporting feeling limited "a lot" by three of the six needs and to "some" extent limited by the other three needs, on average. All other students had teachers who felt Somewhat Limited by student needs.

Figure9.7: Teaching limited by student needs questionnaire

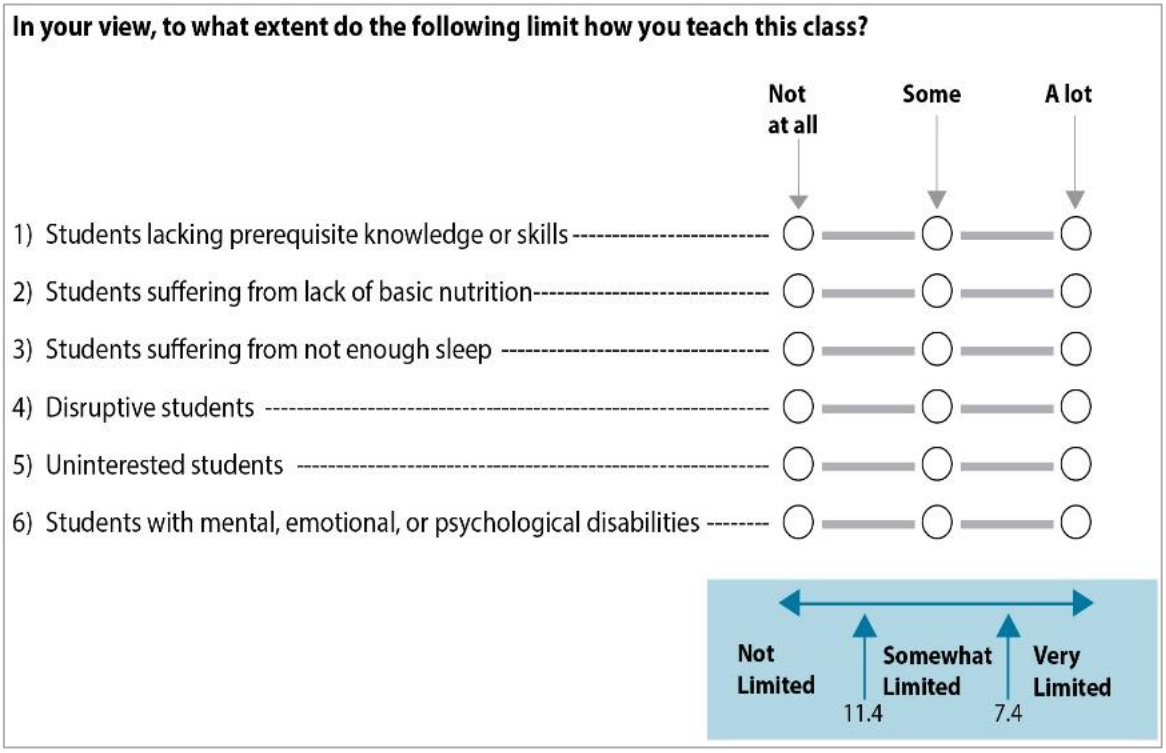


Table 9.8 Performance of Grade 8 Students in Math and Science by Students' Needs in Lebanon and Internationally.

Subject	Country	Not Limited				Somewhat Limited				Very Limited				Average Scale Score	
		Percent of Students		Average Achievement		Percent of Students		Average Achievement		Percent of Students		Average Achievement			
Math	Lebanon	27	(3.6)	436	(7.0)	68	(3.7)	442	(5.1)	5	(1.7)	466	(17.0)	10.2	(0.17)
	International Avg.	27	(0.5)	510	(1.5)	62	(0.6)	475	(0.7)	11	(0.4)	446	(2.4)		
Science	Lebanon	29	(3.9)	393	(8.3)	67	(4.0)	399	(6.8)	4	(1.1)	415	(25.6)	10.1	(0.12)
	International Avg.	28	(0.5)	511	(1.4)	62	(0.5)	480	(0.7)	10	(0.3)	454	(2.2)		

The results indicated in table 9.8 shows that the international results in both Subjects (Math and science) are directly and significantly affected by the students' needs. In other words, using teaching method not limited to the students' needs has reflected positively on the educational achievement of the students. In Lebanon, the results are quite different and confusing. In math, there was a significant but inverse relation between achievement and students' needs .As teaching methods were more limited, achievement significantly went up which is contrary to expectations. As for science, the same trend prevails however the results are not statistically significant between the 'not limited' of 393 and the 'very limited' of 415 because of the large standard errors reaching to almost 26. The reason could be that the questions were not well understood. It is difficult to interpret the Lebanon behavior according to this factor.

9.7 Frequency of Student Absences

in order to evaluate the effect of Absenteeism on the performance of 8th grade student in science and Math, students were scored according to frequency of absences.

Table 9.9 shows the distribution of Lebanese and international student according to their frequency of absences and their corresponding average achievement.

Table9.9: Performance of Grade 8 Students in Math and Science by Absence frequency (0.1<%SE<0.6)

Subject	Country	Never or Almost Never			Once a Month			Once Every Two Weeks			Once a Week or More		
		Percent of Students	Average Achievement		Percent of Students	Average Achievement		Percent of Students	Average Achievement		Percent of Students	Average Achievement	
Science	Lebanon	66	418	(5.2)	18	386	(6.9)	6	354	(10.5)	10	333	(7.4)
	International Avg.	61	502	(0.6)	23	477	(0.7)	8	447	(1.1)	8	407	(1.3)
Math	Lebanon	66	455	(3.7)	18	436	(4.9)	6	413	(6.2)	10	401	(5.7)
	International Avg.	61	496	(0.6)	23	471	(0.7)	8	442	(1.0)	8	404	(1.2)

Table 9.9 shows that the frequency of absence of Lebanese student is slightly higher than that of international students in grade 8. On the other hand, and as expected, the high frequency of absence has a negative effect on the average achievement of the Lebanese and international students and on both subjects (science and math).

9.8 Conclusion:

In summary, despite the fact that the instructional time for math and science in Lebanon is one of the highest in the world and higher than the international average, students' achievement in Lebanon is not affected positively in TIMSS. As for the time spent for investigation in science, 50% of Lebanese students whose teachers claimed that they trigger their students for science investigation, but this had no positive impact on students' performance. However, results showed that the availability of computers had a significant positive impact on Lebanese students in science TIMSS achievement but not in math. As for time spent on homework, it didn't have a direct impact on students' performance in TIMSS in science and mathematics. Contrary to the international results, as teaching methods were more limited, achievement significantly went up in math and science which is contrary to expectations. While as expected, the high frequency of absentees had a negative effect on the average achievement of the Lebanese and international students and on both subjects (science and math).

CHAPTER 10

TEACHERS' AND PRINCIPALS' PREPARATION

10. Teachers' and principals' preparation

10.1. Teachers and principals overview

This chapter considers teachers and principals background due to the importance of a well-prepared teaching force and its effectiveness on students' achievements, TIMSS 2015 collected a range of information about teacher education, this chapter provides information about teachers' education, experience, professional development, and principals background and a comparison between the international and Lebanese results related to the following 6 indices:

1- Teachers' formal education
2- Teachers' Majored "education and Mathematics/ Science"
3- Teachers' years of experience
4- Teachers professional development
5- Principals formal education
6- Principals years of education

There is growing evidence that teacher preparation is a powerful predictor of students' achievement, perhaps even overcoming socioeconomic and language background factors (Darling-Hammond, 2000). Internationally, teachers of eighth grade students reported high levels of education and considerable experience. The following table10.1 shows the Lebanese results and the international results concerning the teachers' major and the years of experience. These criteria will be studied in details together with students' achievements in the following sections of this chapter.

Table 10.1 Percentage of Grade 8 Students in Lebanon and Internationally by Teachers' Background

Teachers' back ground	Mathematics		Science	
	International	Lebanon	International	Lebanon
At least Bachelor's degree	91%	80%	92%	67%
Advanced degree	25%	41%	28%	40%
At least 20 years of experience	34%	25%	32%	16%
TTs Major in subject	36%	46%	47%	56%
TTs subject Education	13%	3%	11%	0%
Major in subject and education	36%	20%	32%	22%

10.2. Teachers' Formal Education

This section shows the percentage of students according to their teachers' educational level, the educational levels based on countries' categorizations according to UNESCO's International standard classification of education and the levels are:

- Completed Postgraduate University Degree "Doctorate, Master's degree"
- Completed Bachelor's Degree or Equivalent but Not a Postgraduate Degree
- Completed Post-Secondary Education but Not a Bachelor's Degree
- No Further than Upper-Secondary Education

10.2.1. Percentage of grade 8 students according to their Mathematics teachers' education level.

Figure 10.1 and table 10.2 present mathematics teachers' reports about their highest level of formal education for the TIMSS 2015 eighth grade assessments. On average, locally, across the eighth-grade students in Lebanon, 41 percent of the students had mathematics teachers with a postgraduate university degree vs 25 percent international average, 39 percent had teachers with a bachelor's degree vs 66 percent international average, 1 percent had teachers who had completed post-secondary education (usually a 3-year teacher education program) less than the international average which is 7 percent , and 20 percent had teachers with an upper secondary degree vs 2 percent international average

Figure 10.1 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Teachers' Educational Level

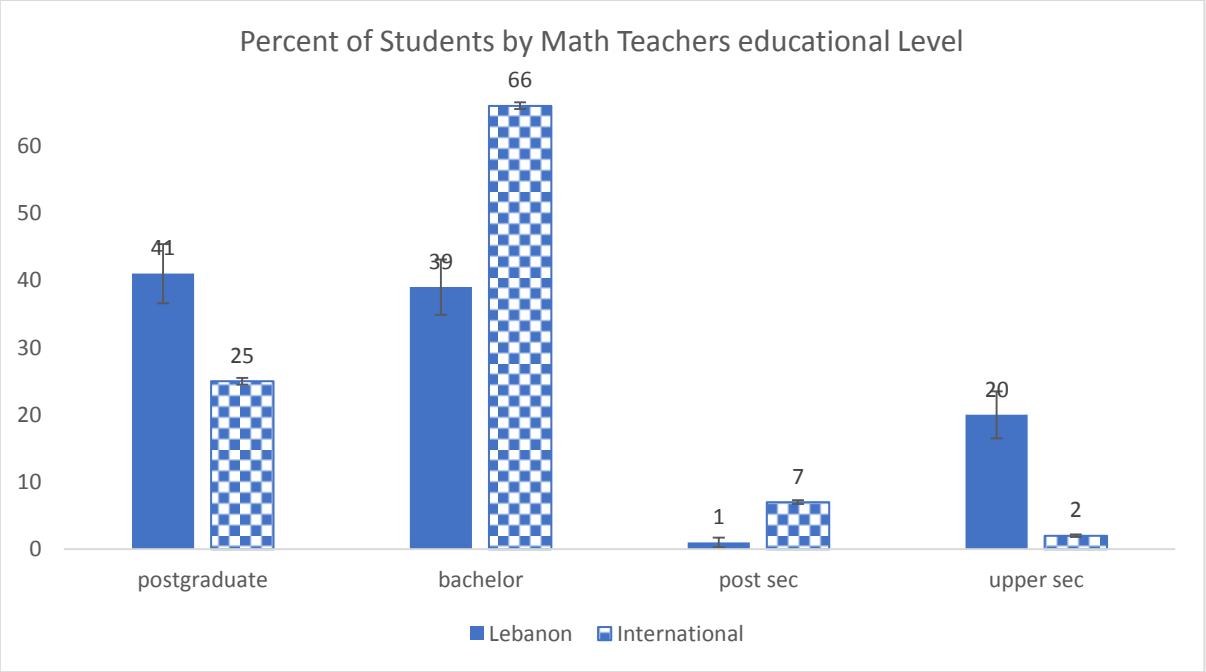


Table 10.2 Percentage of Grade 8 Students in Lebanon and Internationally by Teachers' Educational Level

Mathematics	Lebanon		International	
	%of students	Standard error	%of students	Standard error
postgraduate	41	(4.4)	25	(0.5)
bachelor	39	(4.1)	66	(0.5)
post sec	1	(0.7)	7	(0.3)
upper sec	20	(3.5)	2	(0.2)

10.2.2. Percentage of grade 8 students according to their science teachers' education level.

Figure 10.2 present science teachers' reports about their highest level of formal education for the TIMSS 2015 eighth grade assessments. On average, across the eighth-grade students in Lebanon 40 percent of the students had Science teachers with a postgraduate university degree vs 28 percent international average, 27 percent had teachers with a bachelor's degree vs 64 percent international average, 19 percent had teachers who had completed post-secondary education (usually a 3-year teacher education program) greater than the international average which is 7 percent , and 15 percent had teachers with an upper secondary degree vs 2 percent international average.

Figure 10.2 Performance of Grade 8 Students in Lebanon and Internationally in Science by Teachers' Educational Level

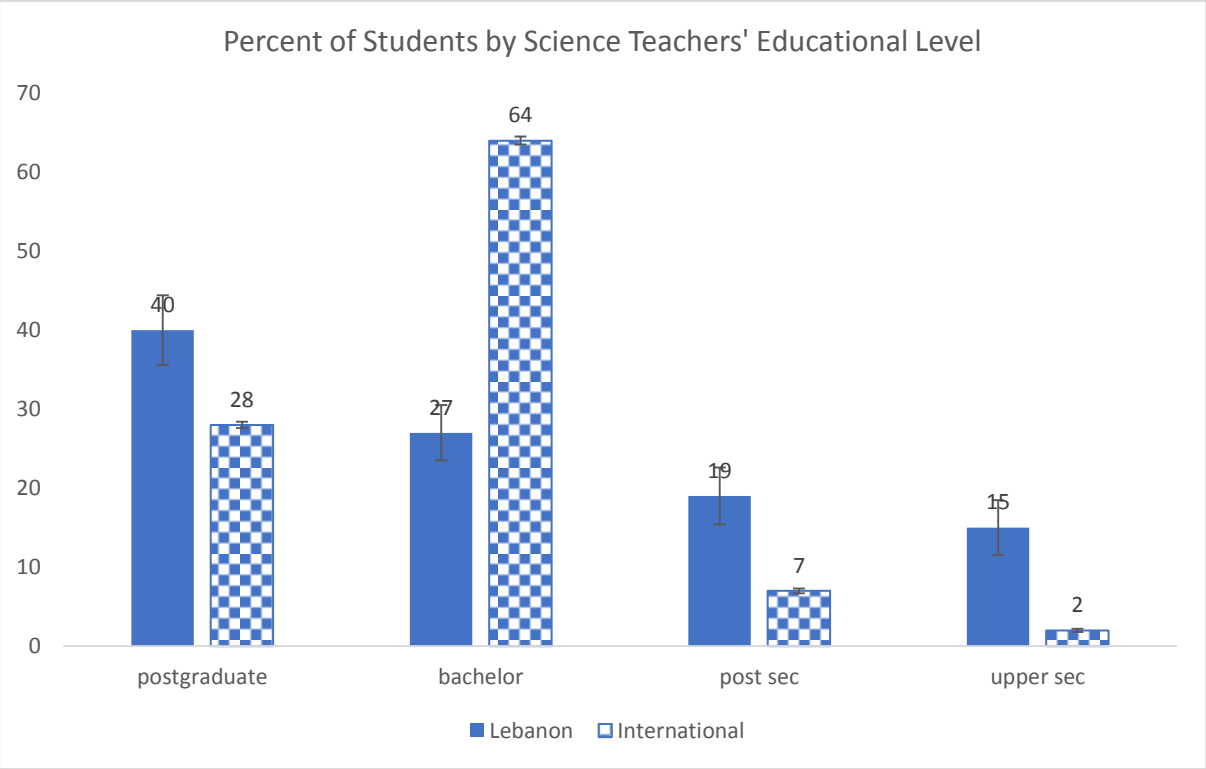


Table 10.3 Prcentage of Grade 8 Students in Lebanon and Internationally by Teachers' Educational Level

Science	Lebanon		International	
	%of students	Standard error	%of students	Standard error
postgraduate	40	(4.4)	28	(0.4)
bachelor	27	(3.5)	64	(0.5)
post sec	19	(3.6)	7	(0.3)
upper sec	15	(3.5)	2	(0.2)

10.3. Teachers Majoring in Education and subject

In addition to the importance of a college or university degree or advanced degree, the literature reports widespread agreement that teachers should have solid mastery of the content in the subject to be taught. For example, a meta-analysis of studies in the United States examining various teacher characteristics and student achievement found that, at least in high school, students learn more mathematics when their mathematics teachers have additional degrees or coursework in mathematics (Wayne & Youngs, 2003). This section will study the relation between the teachers' major in math or education and the students' achievement.

10.3.1. Teachers Majoring in Education and Mathematics

Figure 10.3 shows the mathematics international results of students according to their teachers major and it is clear that the mathematics achievement was the highest (483) for students taught by teachers with both education and mathematics major with a slight difference from students taught by teacher with math major only (482), students taught by teachers with education major (481) followed by students taught by teachers with other major (477) and the lowest for students taught by teachers with no formal major (396).

Figure 10.3 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Teachers' Majors

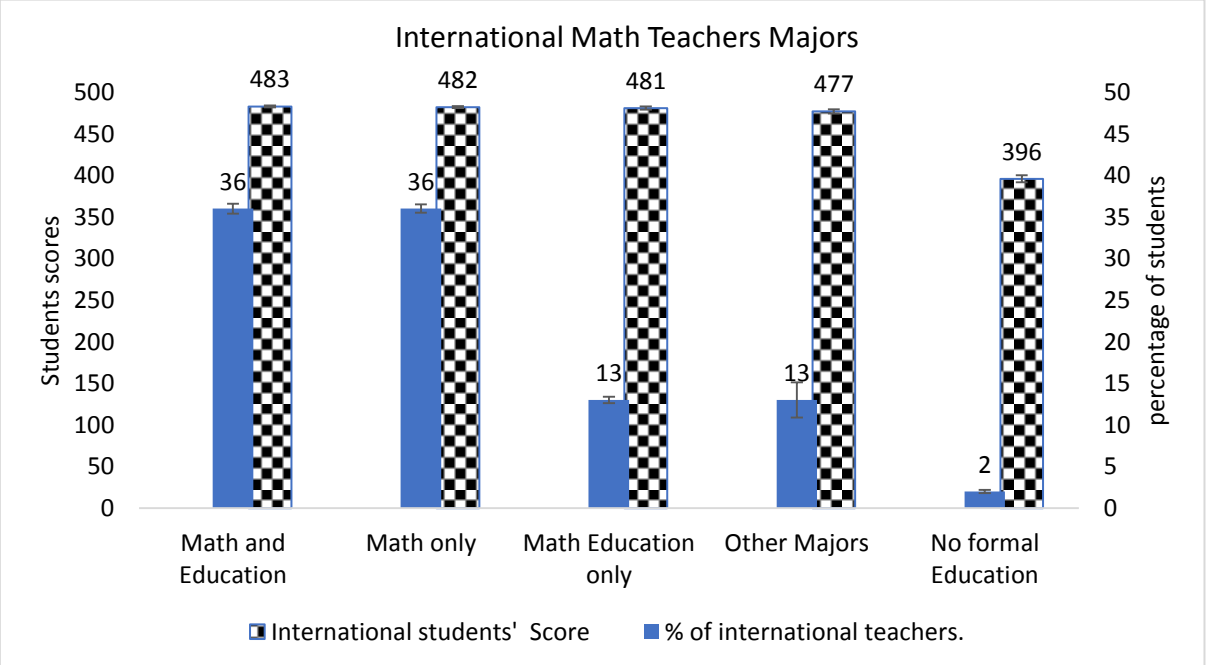


Figure 10.4 shows the percentages of Lebanese students in the TIMSS 2015 eighth grade mathematics assessment whose teachers had a major in education and if they also had a major or specialization in mathematics. 20 percent of the students were taught mathematics by a teacher with a major in both math education and mathematics, and the majority "almost half (46%)" of teachers with major in mathematics only. Just 3 percent of eighth grade students were taught mathematics by a teacher with a major in mathematics education but not in math, and another 11 percent by a teacher with some other major and 20 percent were taught mathematics by teachers with no formal education.

Figure 10.4 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Teachers' Major

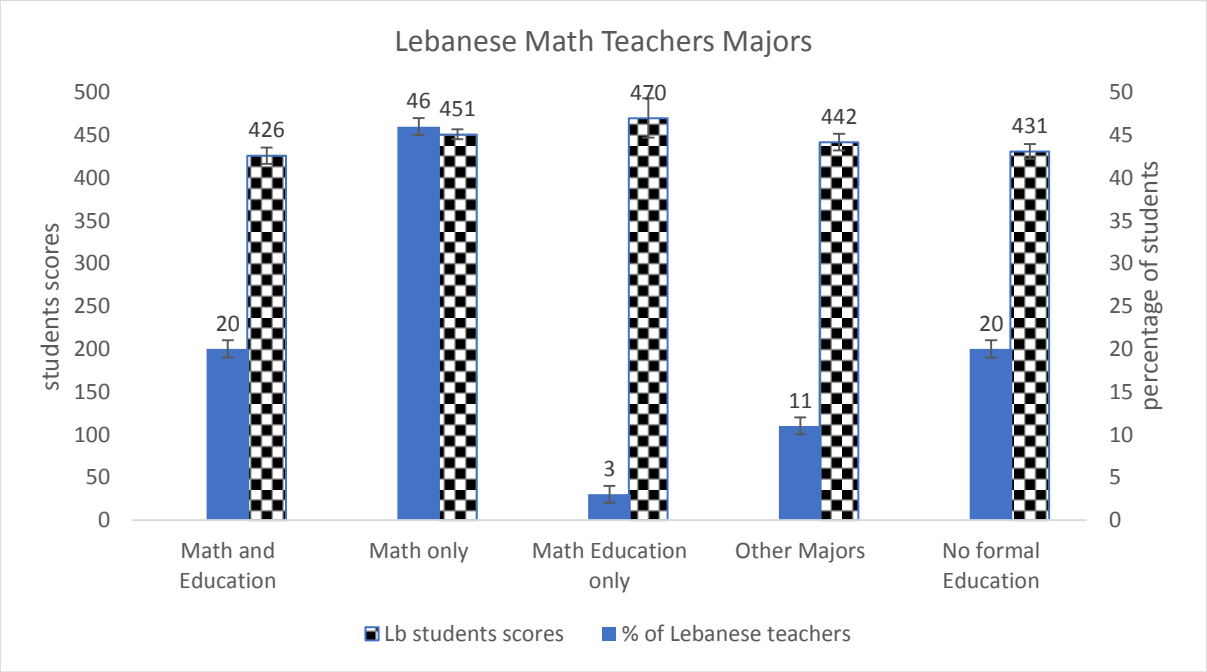


Figure 10.4 shows that mathematics achievement was the highest, on average, among students taught by teachers with a major in math education (470) but not a mathematics major which is higher than the Lebanese average (442), followed by students taught by a teacher with math major (451) and students taught by a teacher with other major (442), students taught by teachers with no formal education score (431) was better than those taught by teachers with both mathematics and education (426)which was the lowest. So based on the results, students of holders of math education and math degrees obtained best results and they were higher than the Lebanese average.

Among the eighth-grade students whose teachers had college degrees in both mathematics and education, average achievement was lower than students taught by a teacher with a no formal major.

10.3.2. Teachers Majoring in Education and Science

Figure 10.5 shows the international science results of students according to their teachers' major and it is clear that the science achievement was the highest (493) for students taught by teachers with both education and science major followed by students taught by teacher with science major only (488), however, students taught by teachers with any other major had a score (485) greater than the students taught by teachers with science education major (480) finally the lowest score for students taught by teachers with no formal major (404).

Figure 10.5 Performance of Grade 8 Students Internationally in Science by Teachers' Major

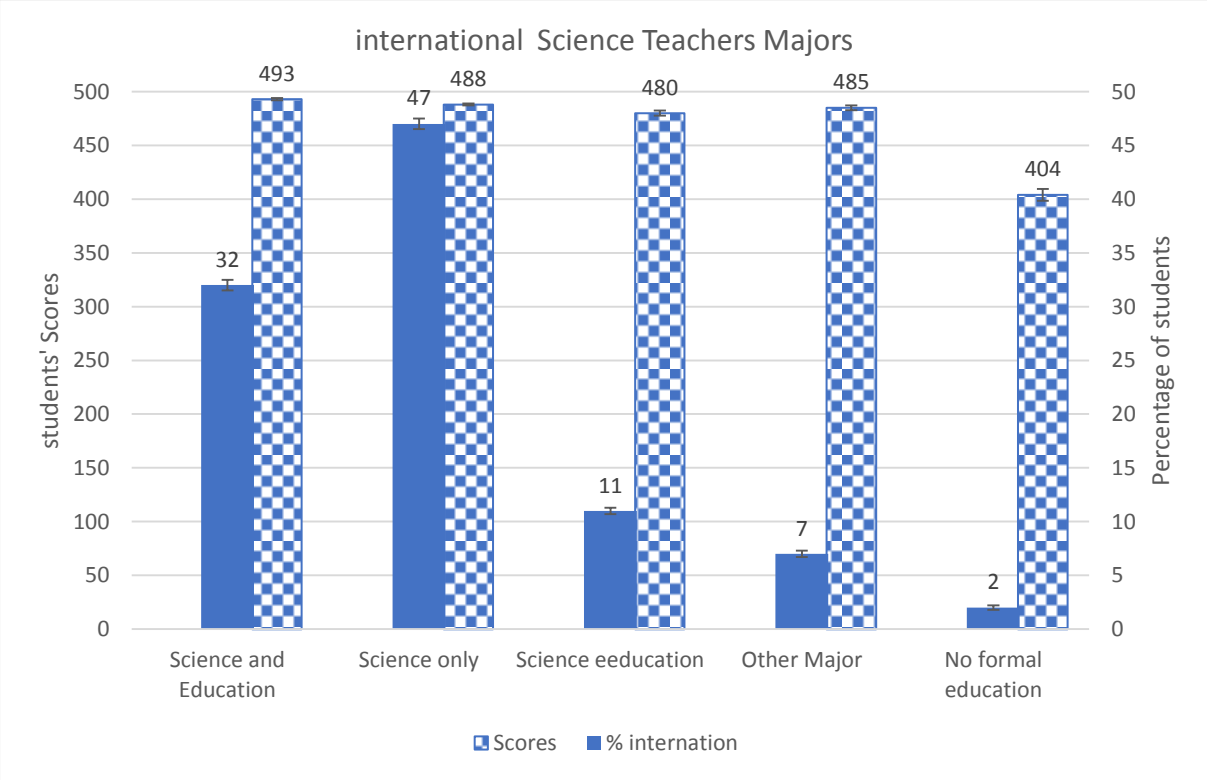


Figure 10.6 shows the percentages of students in the TIMSS 2015 eighth grade science assessment whose teachers had a major in education and if they also had a major or specialization in science. 22 percent of the students were taught science by a teacher with a major in both science education and science, and the majority "almost half (56%)" of teachers with major in science only, none of the students (0.0%) were taught by teachers with science education and only 7 percent of eighth grade students were taught science by a teacher with a major in other subject, and another 15 percent by a teacher with no formal education.

Figure 10.6 Performance of Grade 8 Students in Lebanon in Science by Teachers' Major

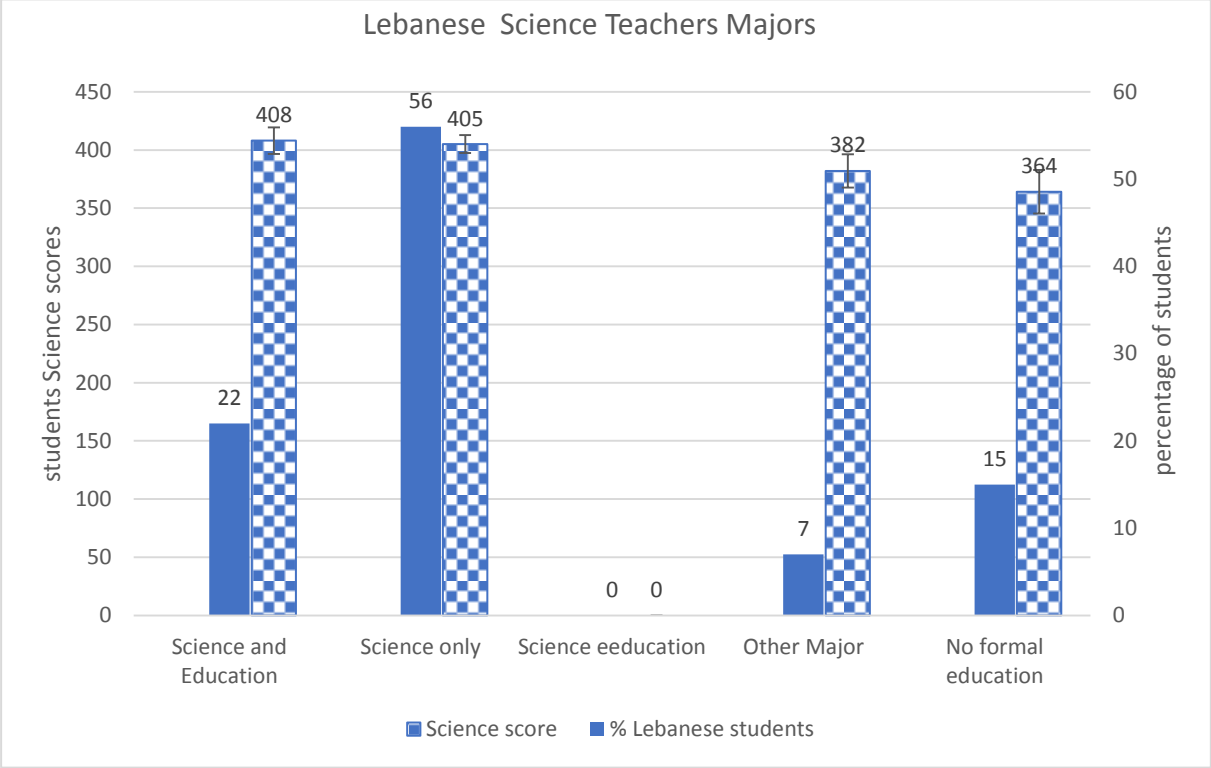


Figure 10.6 shows that science achievement was the highest, on average, among students taught by teachers with science and education major (408) which is higher than the Lebanese average (398), followed by students taught by a teacher with science major (405) which is also higher than Lebanese science average (398), while students taught by a teacher with other major (382) greater than score of students taught by teachers with no formal education score (364). The data in figure 10.6 shows that there weren't any students taught by teachers with science education only. The above table shows a relationship between teacher preparation and major and achievement in science, as students studying with teachers having science and science education degrees did better than other groups. This relationship in science is clearer than in math.

10.4.Teachers' Years of Experience

It is difficult to examine the effects of teacher experience on student achievement, because sometimes more experienced teachers are assigned to students of higher ability and fewer discipline problems, and other times the more experienced teachers are assigned to the lower-achieving students in need of more help. However, some research has addressed this selection bias problem; and experience can have a large positive impact primarily in the first few years of teaching, although the benefits can continue beyond the first five years of a teacher's career (Harris & Sass, 2011; Leigh, 2010).

This section presents teachers' report about their years of experience for participants in the TIMSS eighth grade assessment. Lebanese teachers of mathematics had been teaching for an average of 13 years and Lebanese teachers of science had been teaching for 10 years. In what follows a comparison between international and Lebanese results will be shown.

10.4.1. Mathematics Teachers Years of Experience

Figure 10.7 shows the mathematics international results of students according to their teachers' years of experience, 34 percent of students had very experienced teachers with 20 years or more of experience their score was (484) and another 30 percent had teachers with 10 to 20 years of experience their score was (483) which is slightly less than the previous, the students achievement decreases to (480) for those who had teachers with 5 to 10 years of experience and the lowest achievement score was (477) for those who had teachers experience less than 5 years.

Figure 10.7 Performance of Grade 8 Students Internationally in Mathematics by Teachers' Years of Experience

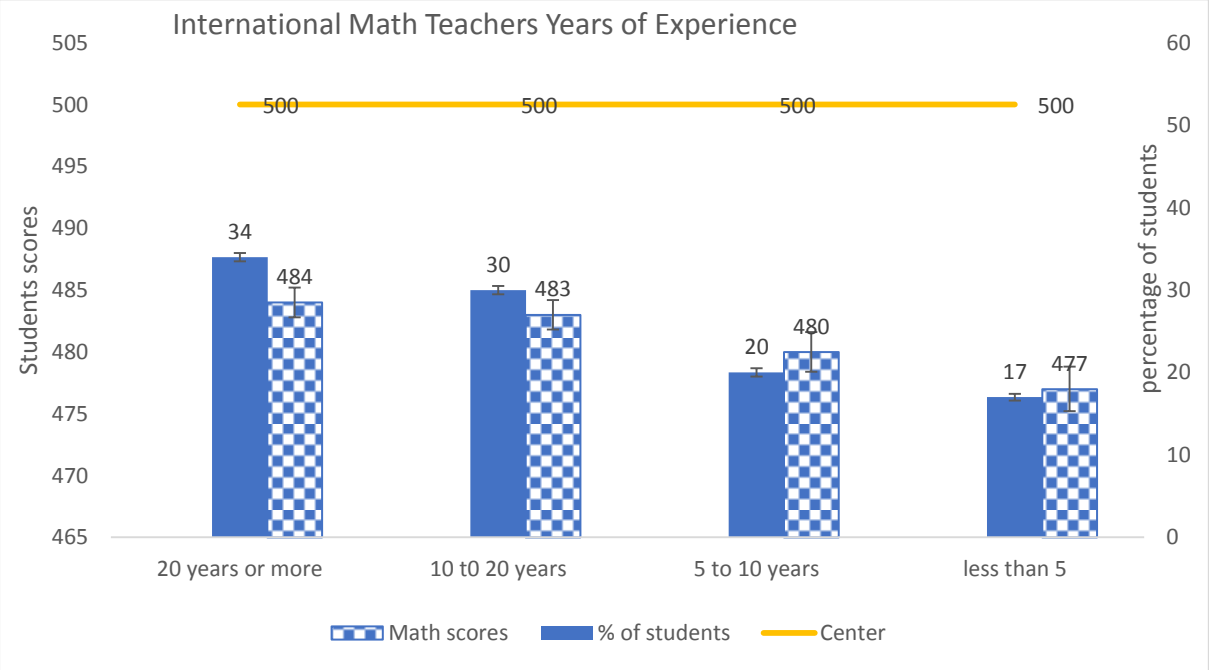
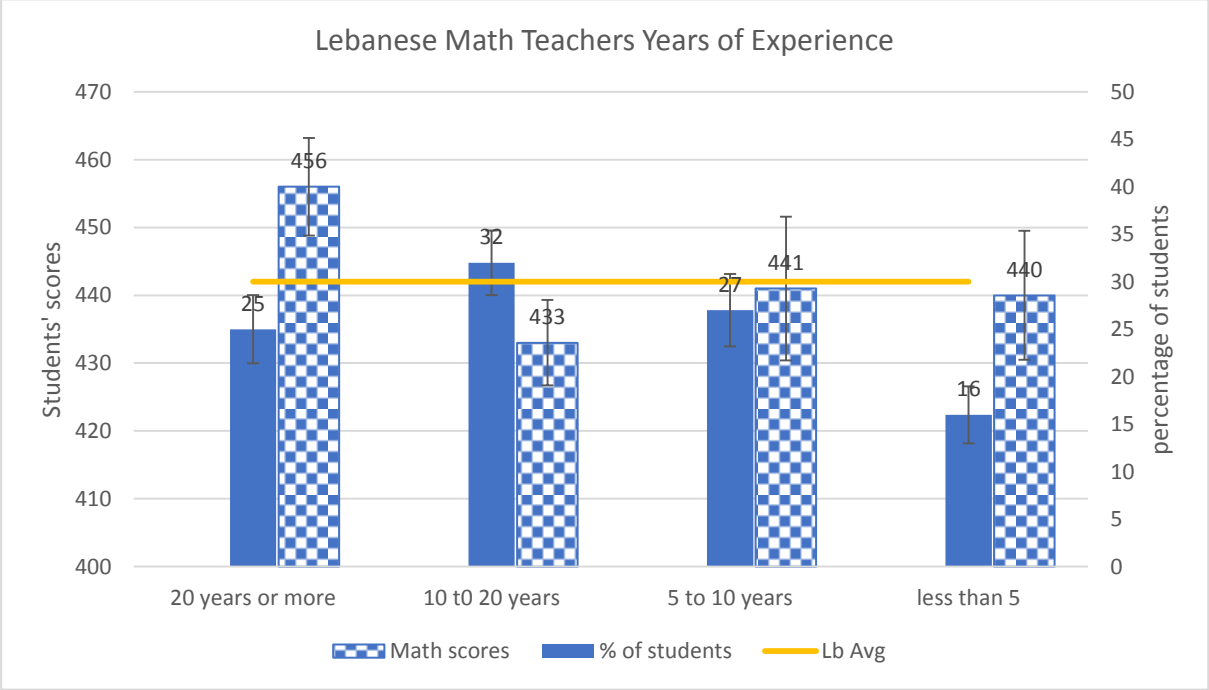


Figure 10.8 shows the mathematics Lebanese results of students according to their teachers' years of experience. 25 percent of students had very experienced teachers with 20 years or more of experience their score was the highest (456) and it is greater than the Lebanese average (442), 32 percent had teachers with 10 to 20 years of experience their score was (433) which is less than (441) the achievement score of those who had teachers with 5 to 10 years of experience, and less than (440) the students achievement for those who had teachers with less than 5 years of experience. This achievement gap could reflect the fact that the newer teachers still are learning the most effective instructional approaches. Highest achievement was noted with teachers with most experience (≥ 20 years), it is significantly higher than other categories, and then it started to decrease with other groups. The differences among the lower experienced teachers are not significant.

Figure 10.8 Performance of Grade 8 Students in Lebanon in Mathematics by Teachers' Years of Experience



10.4.2. Science Teachers Years of Experience

Figure 10.9 shows the science international results of students according to their teachers' years of experience, 32 percent of students had very experienced teachers with 20 years or more or more of experience their score was (487) and another 30 percent had teachers with 10 to 20 years of experience their score was (487) which is the same as the previous, the students achievement for those who had teachers with 5 to 10 years of experience and those who had teachers experience less than 5 years is the same (486), the students' scores are the same whatever the teachers years of experience are.

Figure 10.9 Performance of Grade 8 Students Internationally in Science by Teachers' Years of Experience

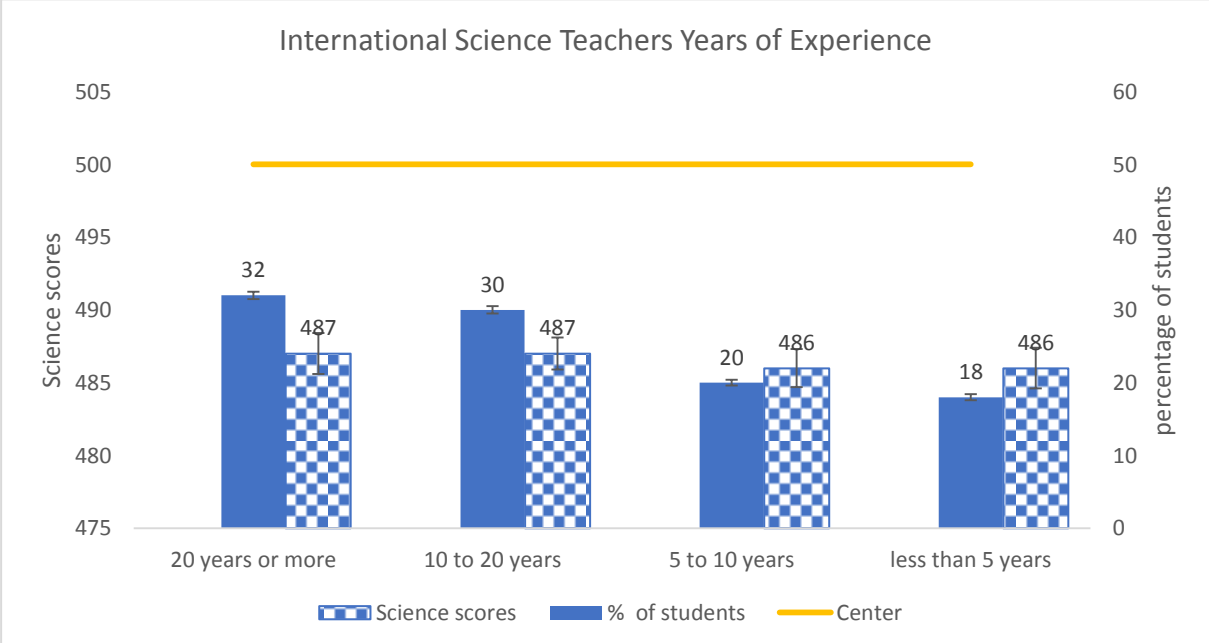
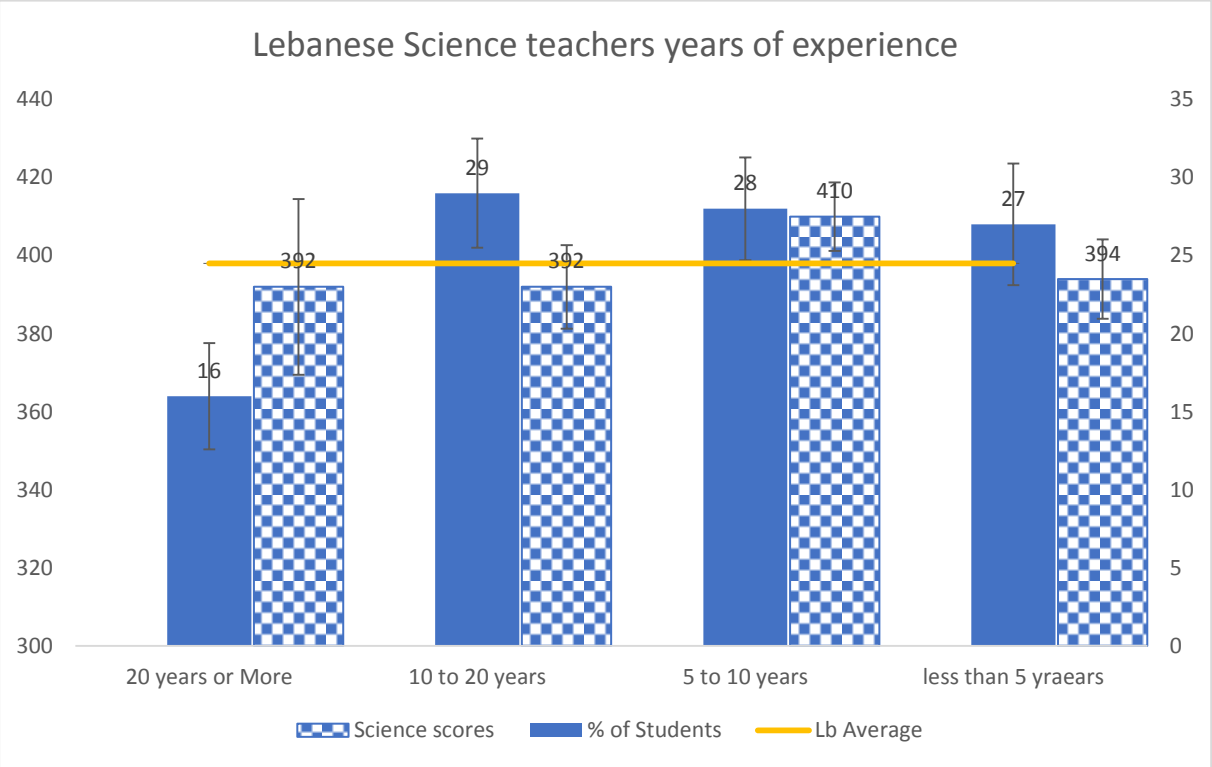


Figure 10.10 shows the science results of Lebanese students according to their teachers' years of experience. 16 percent of students had very experienced teachers with 20 years or more of experience their score was the lowest (392) and it is lower than the Lebanese average 398, 29 percent had teachers with 10 to 20 years of experience their score was also (392) which is less than the Lebanese average (398) the achievement score of those who had teachers with 5 to 10 years of experience was the greatest (410) and higher than the Lebanese average (398), and the students achievement for those who had teachers with less than 5 years of experience was (394) even if it is slightly lower than the Lebanese average but it is higher than the average of students who had more than 10 years of experience. Years of experience had a negative effect on science achievement in Lebanon, with the highest achievement demonstrated by the 5-10 years of experience group, while all the others are at the same lower level of 392.

Figure 10.10 Performance of Grade 8 Students in Lebanon in Science by Teachers' Years of Experience



10.5. Teacher Participation in Professional Development in the Past 2Years.

Evidence from recent research shows that teacher professional development in mathematics has a significant positive effect on student achievement (Blank & de las Alas, 2009) and that the amount of professional development (more than 14 hours) was an important factor (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

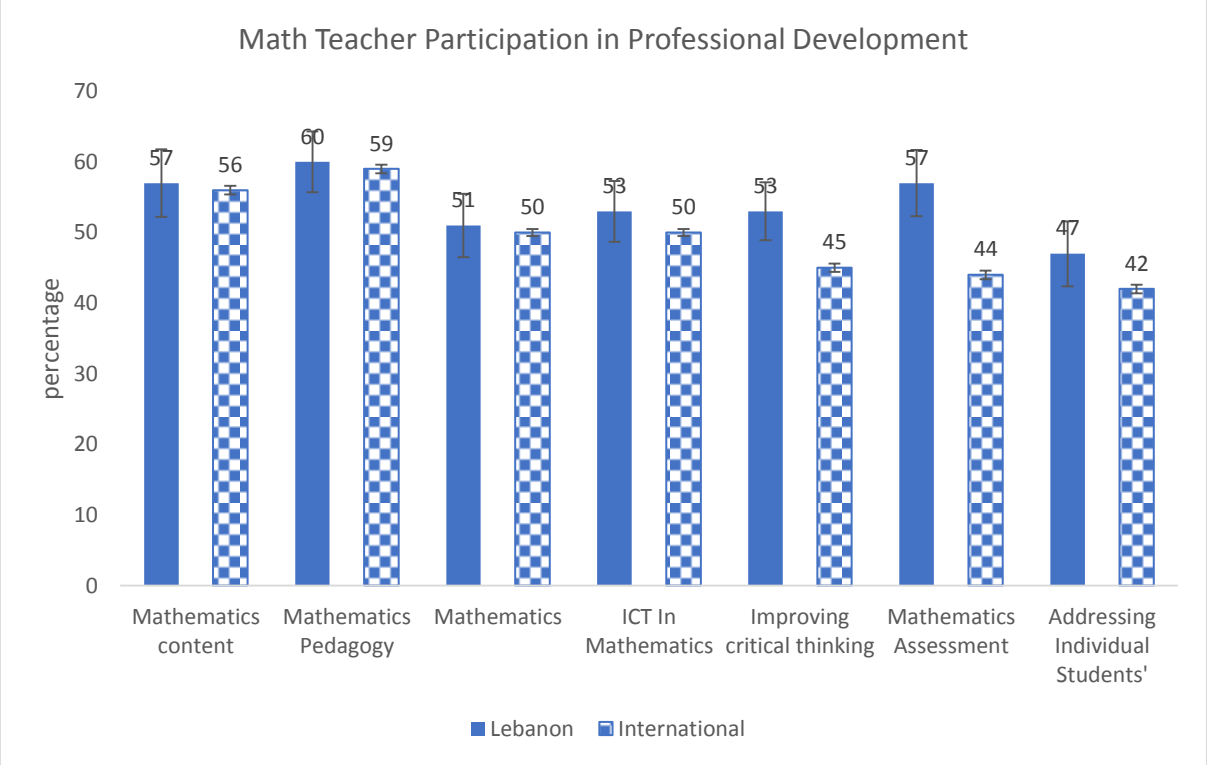
In this chapter we will study the participation of Lebanese teachers in the professional development, unfortunately the existing data from TIMSS 2015 international results shows information about the professional development but not linked to the students' achievement, so we will limit our study to the comparison between Lebanese and International participation in professional development for both mathematics and science teachers. The professional development domains are:

- Mathematics content
- Mathematics Pedagogy Instruction
- Mathematics Curriculum
- Integration Information Technology into Mathematics
- Improving Students' Critical Thinking or Problem-Solving Skills
- Mathematics Assessment
- Addressing Individual Students' needs

10.5.1. Teacher Participation in Professional Development in Mathematics in the Past 2 Years

Figure 10.11 reports about areas of professional development in mathematics in which teachers had participated in the past two years. On average, 57 percent of Lebanese students had teachers taking mathematics content which is very close to the international average (56%), 60 percent of Lebanese students had teachers who had professional development in mathematics instruction or pedagogy and is also close to the international average (59%). From 51 percent to 53 percent of students had teachers who had professional development in mathematics curriculum, Mathematics assessment and integrating information technology into mathematics that are also very close to the international percentage, 47 percent of Lebanese students had teachers taking development in addressing individual students' needs which is greater than the international average (42%). Lebanese teachers had higher professional development than international teachers in math assessment and improving critical thinking,

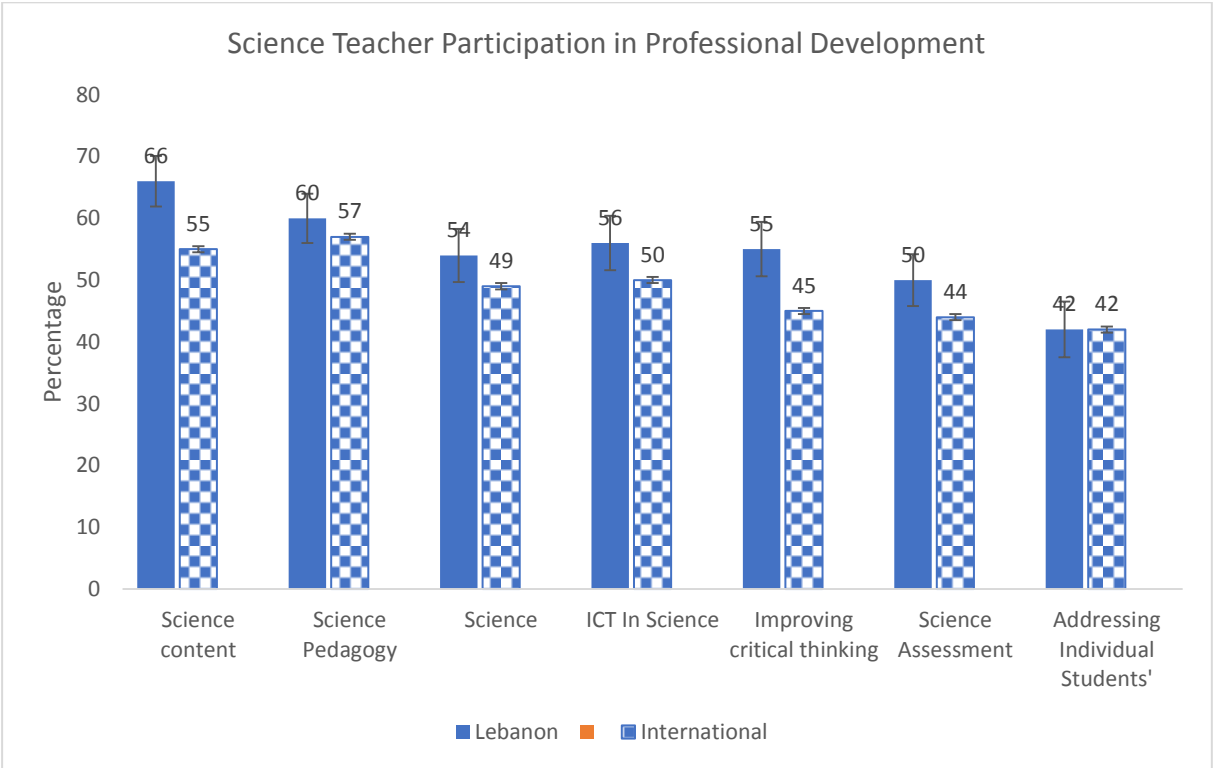
Table 10.11 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Teachers' Professional Development



10.5.2. Teacher Participation in Professional Development in Science in the past 2 years

As shown in figure 10.12, science teachers of students in the TIMSS eighth grade assessment reported somewhat higher levels of participation in sciences professional development in comparison to both international Science results and Lebanese mathematics results. On average, across the eighth-grade students, the majority of Lebanese students were taught by science teachers who had participated in professional development in science content (66%) which is significantly greater than the international percentage (55), instruction or pedagogy (60%) close to the international percentage (57) , almost half of the students had teachers with professional development in science curriculum (54%), integrating information technology into science (56%), improving students' critical thinking or problem-solving skills (55%), science assessment (50%). The last three domains were higher than international percentages. Despite of the high percentage of Lebanese teachers who are participating in professional development, the Lebanese science average was (398) is lower than the international center point (500), though Lebanese teachers had higher participation rates of engagement in professional development in most of the domains.

Table 10.12 Performance of Grade 8 Students in Lebanon and Internationally in Science by Teachers' Professional Development

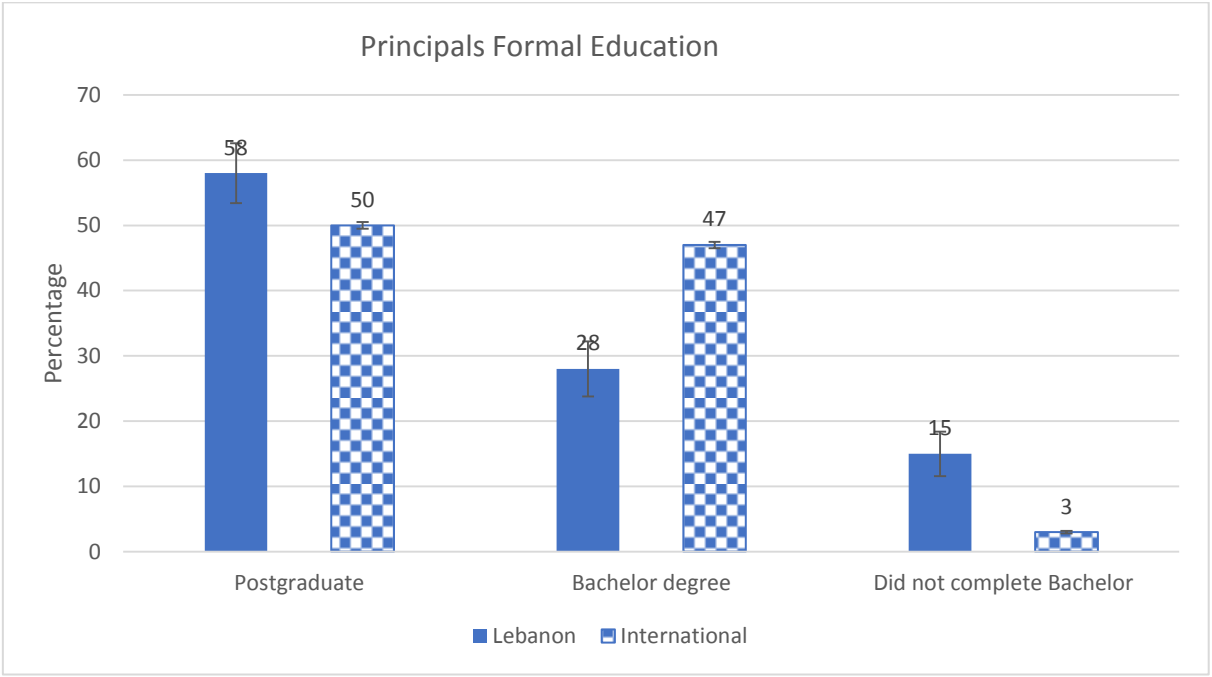


10.6. Principals Formal Education

Figure 10.13 provides a summary data about principals' formal education for both Lebanese and international principals, Lebanese school principals have previous teaching experience and also have completed a specialized school leadership program, unfortunately the existing data from TIMSS 2015 international results shows information about the principals' formal education but not linked to the students' achievement. Among the Lebanese students who participated in the TIMSS evaluation, 58% attended

schools whose principals completed postgraduate university degree while the international average is 50%, 28% of Lebanese students had principals completed bachelor's degree which is less than the international percentage (47%) furthermore, 15% of students had principals did not complete a bachelor degree. There is a significant difference between Lebanon and international principals in terms of formal preparation and qualifications.

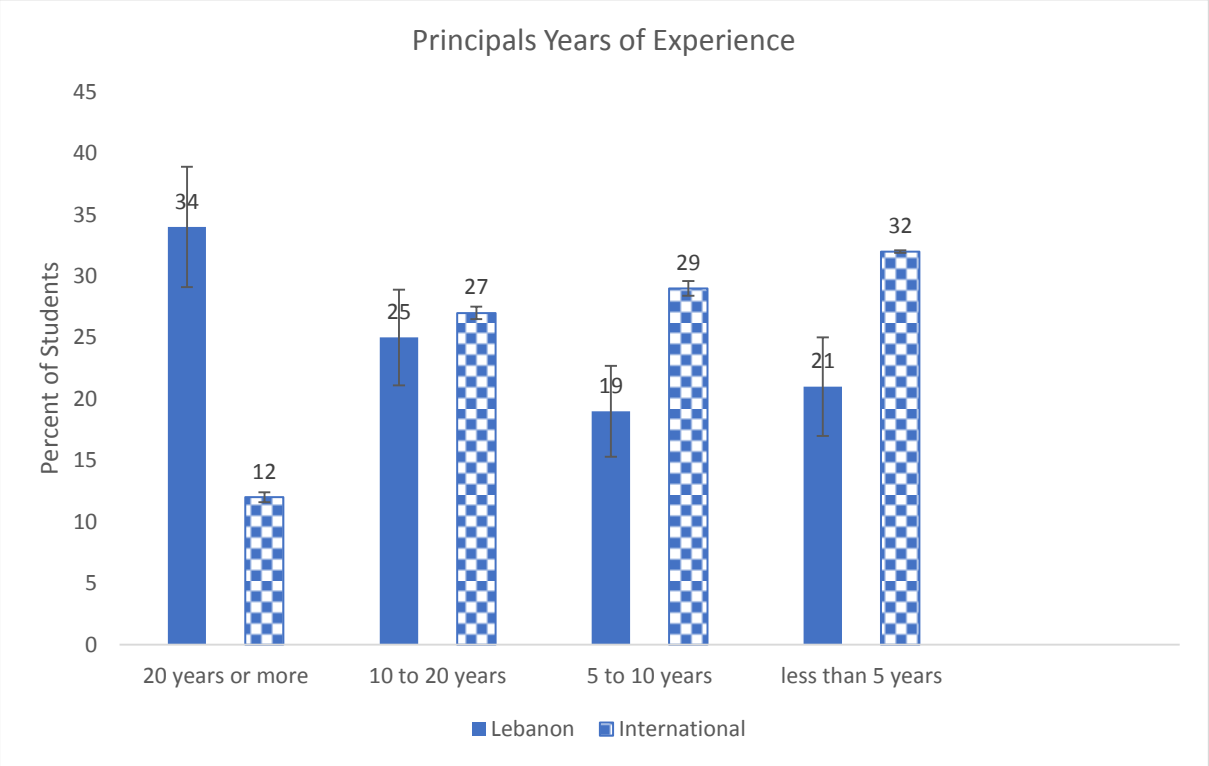
Figure 10.13 Percentage of Lebanese Students by Principals Formal Education



10.7. Principals Years of Experience

Figure 10.14 shows the percentage of Lebanese students according to the principals' years of experience. 34 percent of Lebanese students had very experienced principals with 20 years or more of experience but the international percent of the same category was (12%), 25 percent had principals with 10 to 20 years of experience close to the international percentage 27, 19 percent had principals with 5 to 10 years of experience which is less than the international percentage 29, 21 percent of students had principals with less than 5 years of experience. Lebanese and international principals significantly differ in terms of years of experience with the Lebanese ones tending to have longer years of experience. The data provided by TMSS 2015 does not link the students' achievement to the principals' years of experience which hinders the analysis of the relation between the two variables.

Table 10.14 Percentage of Lebanese Students by Principals Years of Experience



Conclusion:

The international results for both mathematics and science is related to the teachers major and it is clear that the achievement was the highest for students taught by teachers with both education and mathematics or science major with a slight difference from students taught by teacher with math or science major only, Lebanese students science achievement in relation to teachers major was similar to the international results while the highest Lebanese students mathematics achievement was for those who taught by teachers with math education major and the lowest for those who taught by teachers with math and education major.

The international results of students according to their teachers' years of experience in both mathematics and science does not show a significant difference between those who had teachers with more than 20 years of experience and 5 to 10 years of experience, the lowest achievement score was for those who had teachers experience less than 5 years.

The mathematics Lebanese results of students according to their teachers' years of experience was the best for those who had teachers with 20 years of experience or more, and students who had teachers with less than 10 years of experience had a score better than those who had teachers with 10 to 20 years of experience. This achievement gap could reflect the fact that the newer teachers still are learning the most effective instructional approaches. The science results of Lebanese students according to their teachers' years of experience shows that the highest score was for those who had teachers with 5 to10 years of experience and the others are almost the same result.

CHAPTER 11

Home environment support (Mathematics and Science)

Countless studies have shown time and time again the impact and significance home environment has on students' overall school achievements. Let us take a look at some specific examples of how home circumstances can influence the student's academic results. We will examine the relationship between the availability of educational resources at home and the student's achievement in mathematics and science, as well as the effect of speaking the language of the test at home. The study will only take into account Lebanese students.

11.1. Home Educational Resources

In this section, we look into the specifics of how material wealth (number of books, level of education of parents, and whether the student has his own room and/or access to the internet) affects student performances, in Math and Science.

Students were divided to into three categories, according to their responses concerning the availability of three home educational resources:

- Students "with many Resources", reporting that they had more than 100 books in the home, 2 home study supports (internet connection and a room on their own), and that at least one parent had finished university.
- Students "with Few Resources", reporting that they had 25 or fewer books in the home, neither of the 2 home study supports (internet connection or a room on their own), and that neither parent had gone beyond upper-secondary education.
- All other students were assigned to the "Some Resources" category.

Figure 11.1. Availability of Three Home Educational Resources

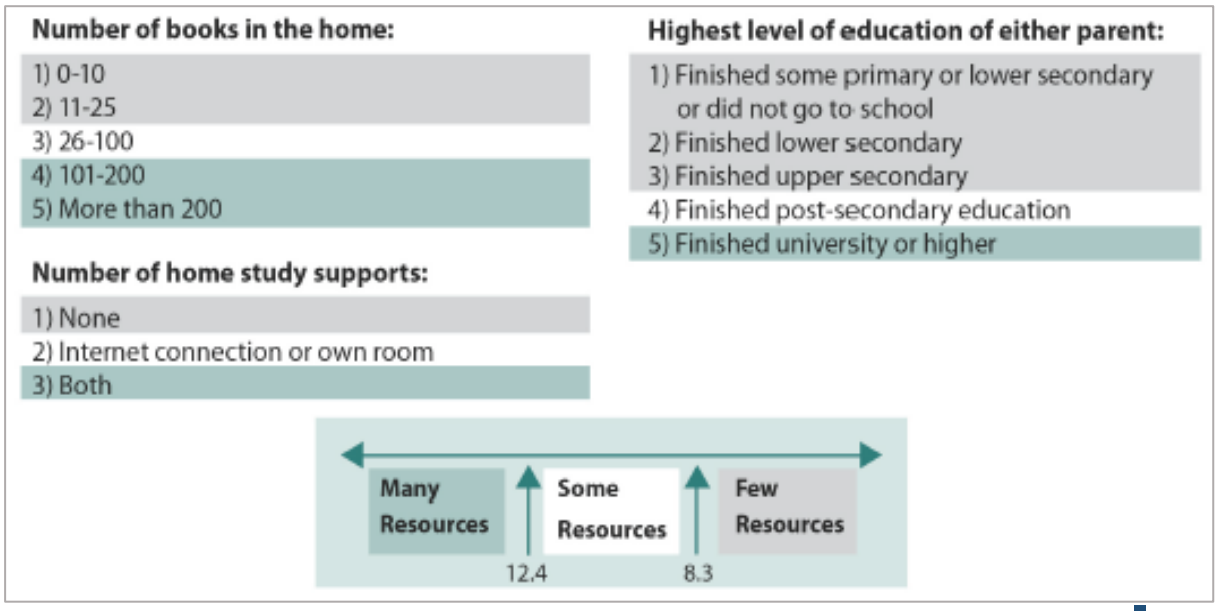


Table 11.1 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics and Science by Home Resources

	Percent of Students		Percent SE		Average Achievement in Science		Average SE in Science		Average Achievement in Math		Average SE in Math	
	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*
Many Resources	7	*13*	(0.6)	*(0.1)*	436	*547*	(9.5)	*(1.2)*	471	*540*	(6.7)	*(1.3)*
Some Resources	73	*72*	(1.0)	*(0.2)*	407	*486*	(5.7)	*(0.6)*	448	*481*	(3.8)	*(0.6)*
Few Resources	20	*15*	(0.9)	*(0.1)*	363	*432*	(6.7)	*(1.1)*	418	*431*	(4.6)	*(1.1)*

Figure 11.2 Performance of Grade 8 Students in Lebanon and Internationally in Science by Home resources

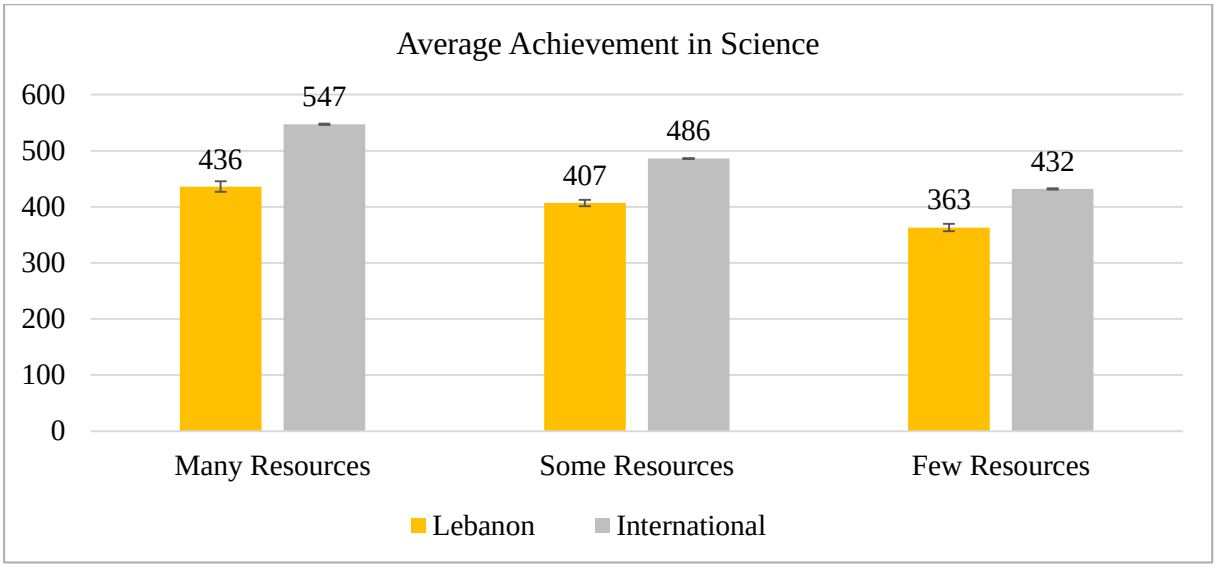


Figure 11.3 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Home resources

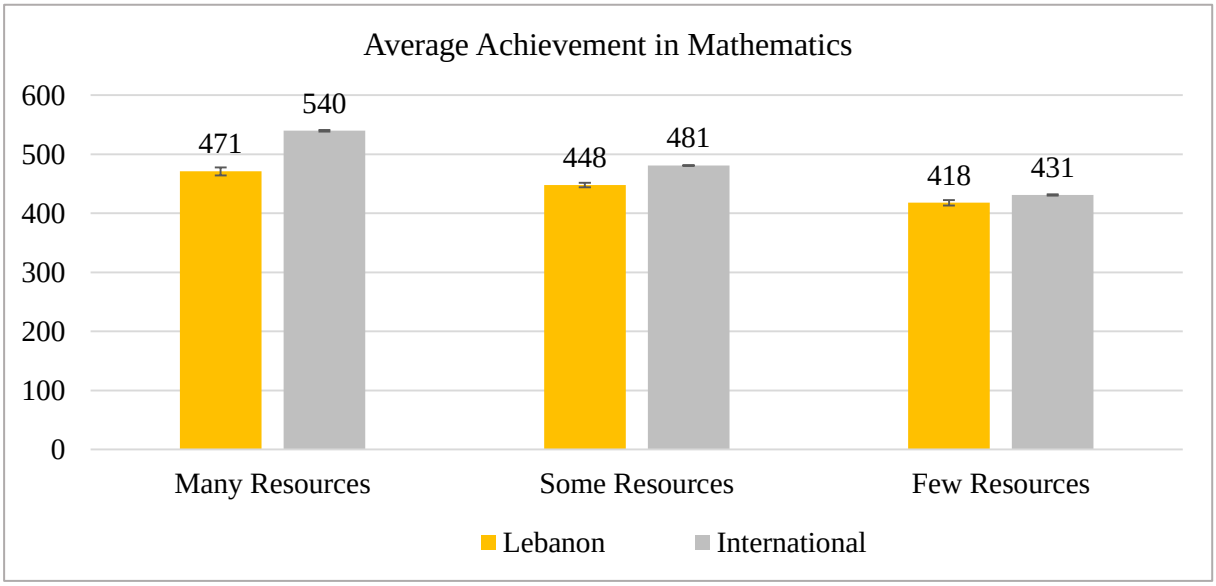


Table 11.1. , figure 11.2 and 11.3 above, show that:

- Lebanon science scores are significantly lower than international science scores for all categories.
- Lebanon math scores are significantly lower than international math scores for all categories.

Figure 11.4. Performance of Grade 8 Students in Lebanon and Internationally in Mathematics and Science by Home resources

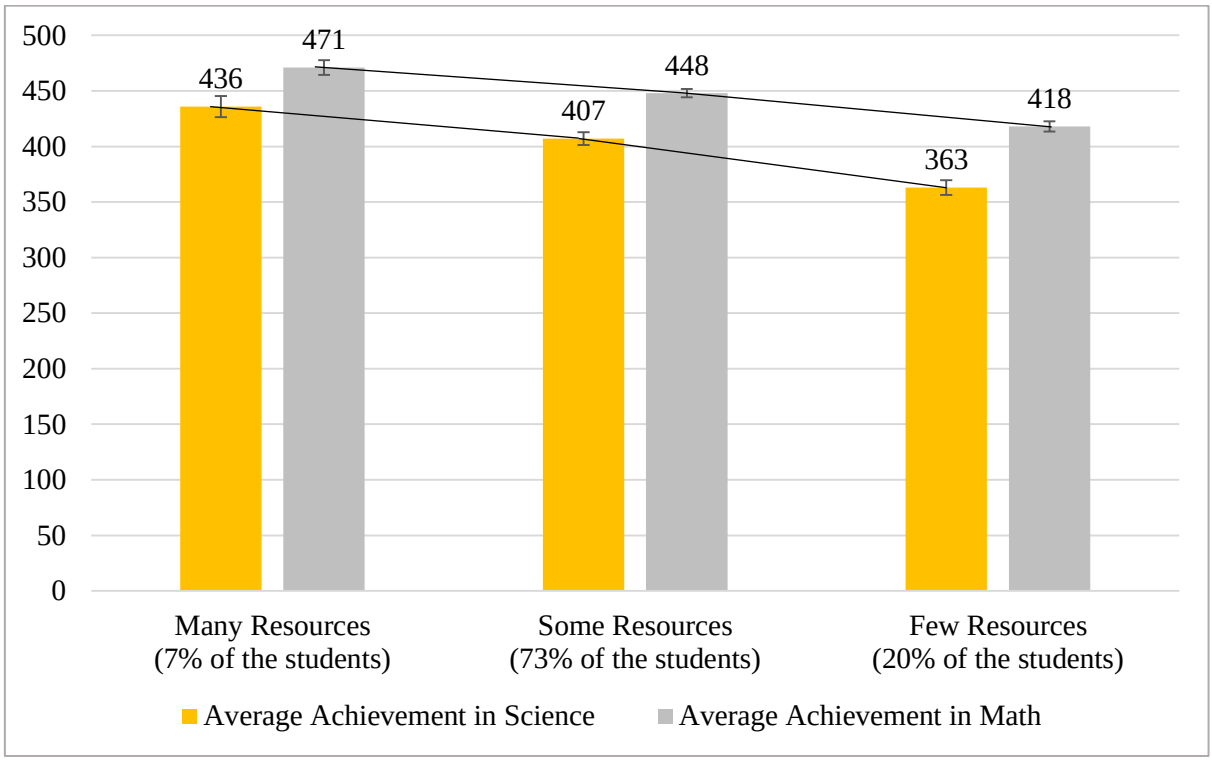


Table 11.1. and figure 11.4. above, show that:

- Lebanon math scores are significantly higher than Lebanon science scores for all categories.
- Home educational resources influence the science scores more than they influence the Math scores (cf. the slope), as there is a 73 point difference (17%) in achievement in sciences between those who have many resources and those who have few resources (436 vs. 363), while there is only a 53 point difference (11%) in math between same groups (471 vs. 418).
- Majority of respondents (73%) had some resources.

11.2. Students speak the language of the test at home

In this section, we study the effect the student's spoken language has on his/her performance in Math and Science.

Students were divided to into four categories, according to their responses concerning the language spoken at home:

- Students who "always" speak the language of the test at home.
- Students who "almost always" speak the language of the test at home.
- Students who "sometimes" speak the language of the test at home.
- Students who "never" speak the language of the test at home.

Table 11.2 Performance of Grade 8 Students in Lebanon and Internationally in Science by Language of the Test

	Percent of Students		Percent SE		Average Achievement in Science		Average SE in Science		Average Achievement in Math		Average SE in Math	
	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*	Leb.	*Int.*
Always	10	*62*	(0.8)	*(0.2)*	393	*489*	(9.1)	*(0.7)*	444	*482*	(6.8)	*(0.7)*
Almost Always	17	*15*	(0.7)	*(0.1)*	422	*499*	(6.6)	*(1.0)*	456	*494*	(4.8)	*(0.9)*
Sometimes	59	*19*	(1.2)	*(0.1)*	400	*459*	(6.3)	*(1.3)*	442	*458*	(4.3)	*(1.4)*
Never	14	*5*	(0.9)	*(0.1)*	369	*431*	(8.9)	*(2.1)*	430	*437*	(5.7)	*(1.9)*

Figure 11.5 Performance of Grade 8 Students in Lebanon and Internationally in Science by Language of the Test

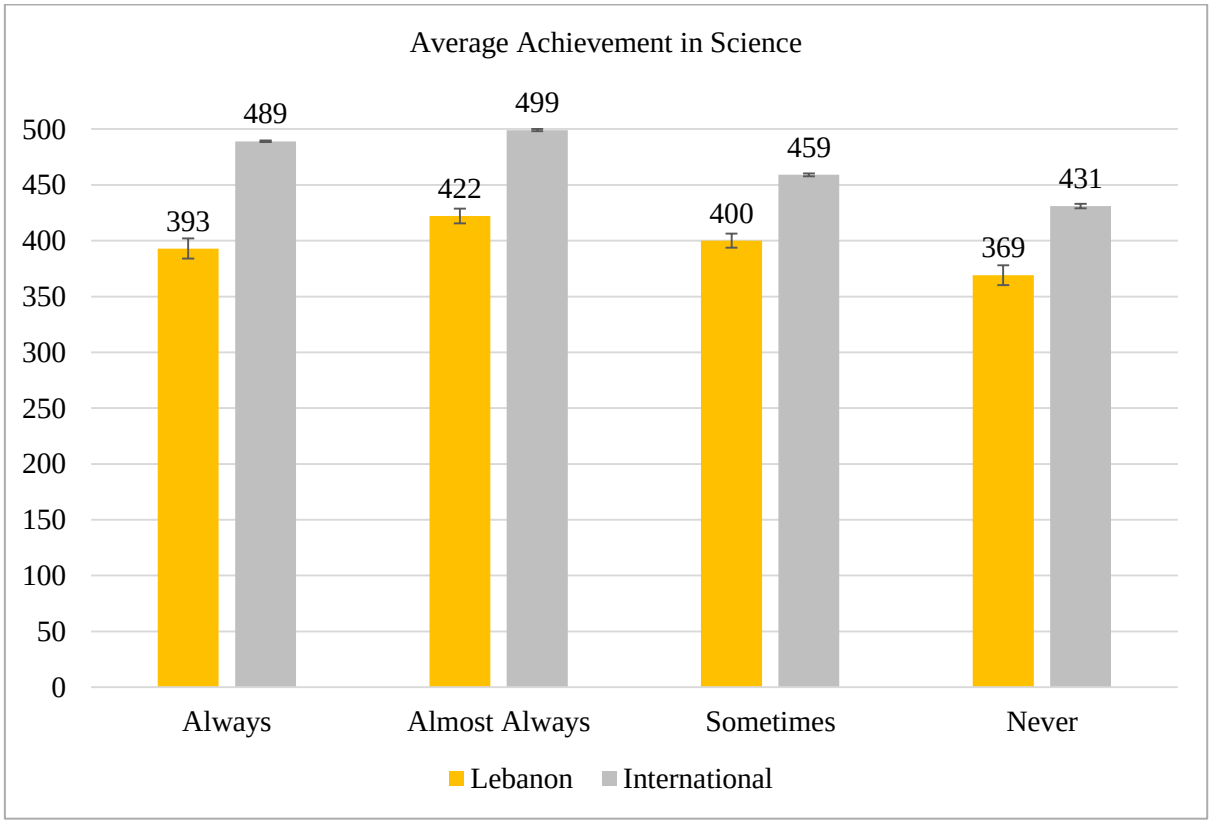


Figure 11.6 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics by Language of the Test

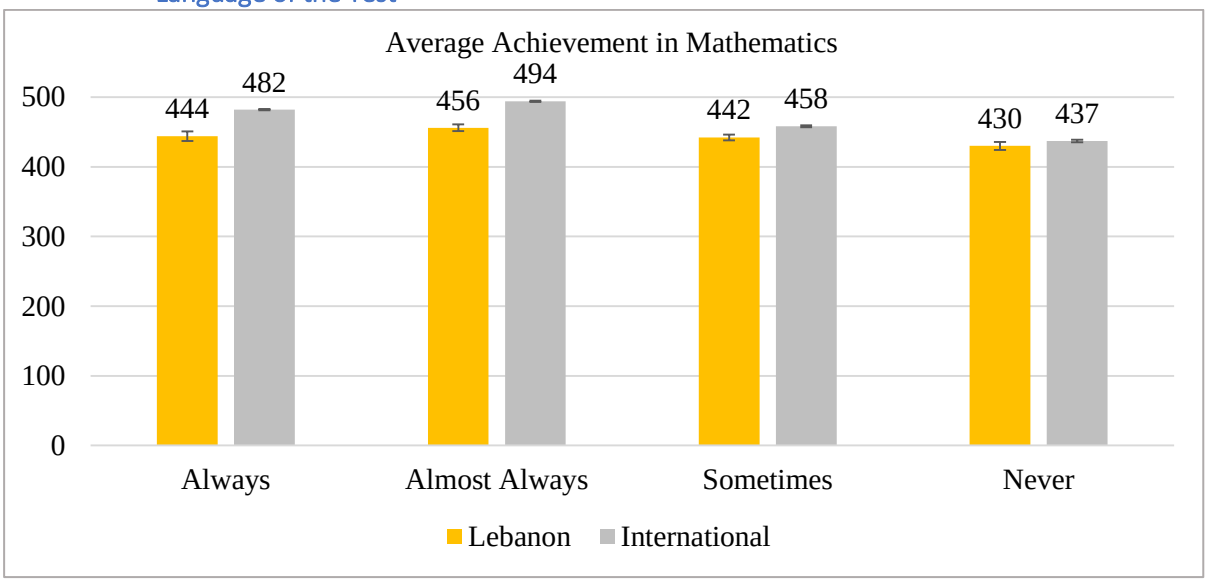


Table 11.2. and Figures 11.5 and 11.6. above, show that:

- Lebanon Science scores are significantly lower than international Science scores for all categories.
- Lebanon math scores are significantly lower than international Math scores for all categories except for the category "Students who never speak the language of the test at home" where achievements were so close due to overlapping standard errors of measurement.

Figure 11.7 Performance of Grade 8 Students in Lebanon and Internationally in Mathematics and Science by Language of the Test

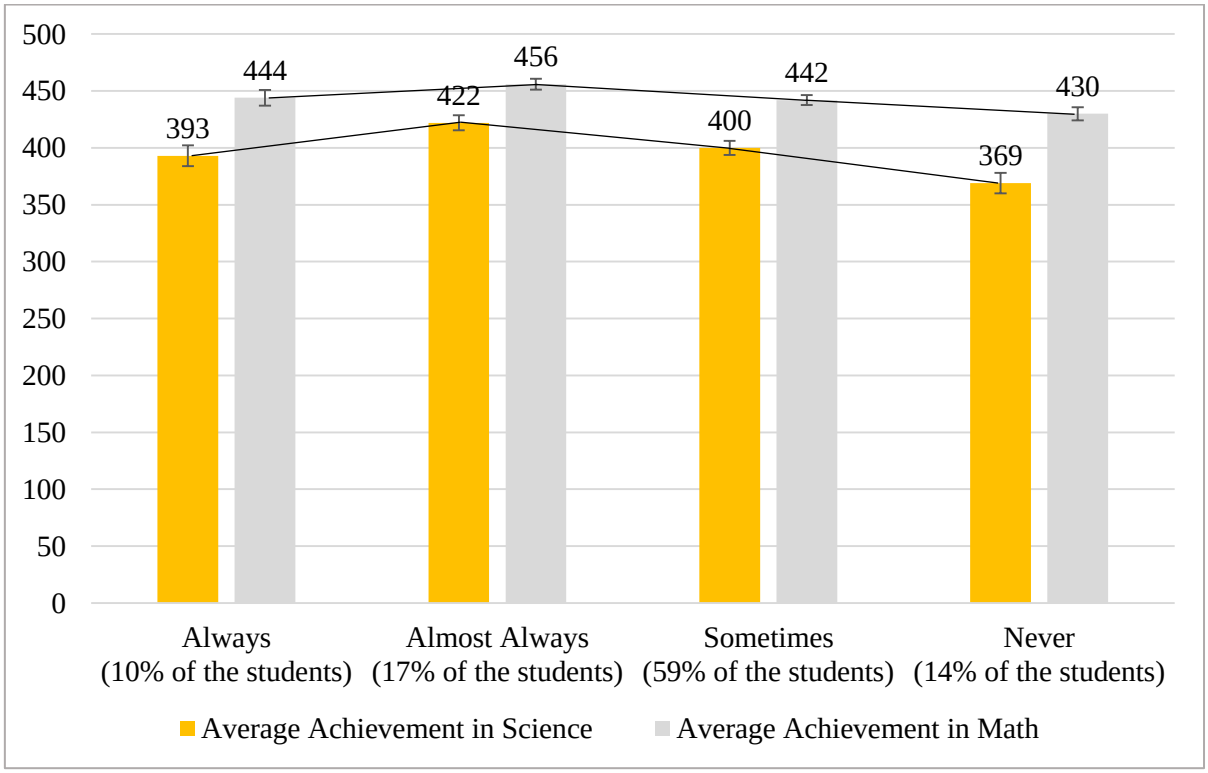


Table 11.2. and figure 11.7. above, show that:

- Lebanon Math scores are significantly higher than Lebanon Science scores for all categories.
- "Students speak the language of the test at home almost always" got the highest scores in both science (422) and math (456).
- The language of the test, if spoken at home, influence the science scores more than it influences the Math scores (cf. the slope), as the difference in science achievement, between those who speak the language of the test at home almost always and those who never speak it, is 53 points (12%), while it is only 26 points (6%) in math. This is well confirmed as students need more language in science than in math.
- What is strange is lower score in science for those who always speak the language of the test at home and needs to be further investigated by looking at other variables.
- The majority of students (59%) speak the language of the test "sometimes".

11.3. Conclusion:

- Whether for "Home Educational Resources" or for "Students speak the language of the test at home":
  - Lebanon scores are significantly lower than international scores for all categories, in Science and in Math (except for the category "Students who never speak the language of the test at home" in Math where achievements were so close).
  - Lebanon Math scores are significantly higher than Lebanon science scores for all categories, in Science and in Math.
- Home educational resources influence the science scores more than they influence the Math scores.
- Majority of respondents (73%) had some resources.
- "Students speak the language of the test at home almost always" got the highest scores in both science and math.
- The language of the test, if spoken at home, influence the science scores more than it influences the Math scores. This is well confirmed as students need more language in science than in math.
- What is strange is lower score in science for those who always speak the language of the test at home and needs to be further investigated by looking at other variables.
- The majority of students (59%) speak the language of the test "sometimes".

CHAPTER 12

Summary

This chapter summarizes findings from the study of TIMSS 2015 in terms of science and math performance for Grade 8 students in Lebanon. Although this wrap up is by no means comprehensive to all issues and queries, it draws out several themes that are important for improvement and better achievement.

12.1. Lebanese factors

Results among Lebanese factors show that grade 8 Lebanese students' "3873 students" scores in both mathematics and science were related to the geographic location. There were differences in performance among the districts. Governorates listed in decreasing order according to their TIMSS scores are: Beqaa, North Lebanon, Mont Lebanon and suburbs, Nabatieh, Beirut and South Lebanon.

The data about the school sector "35% public schools and 65% private schools" show that the scores of students' in public schools were slightly higher than students' scores in private schools but the difference was not statistically significant and it was mainly in schools taught in English.

The data about students' language does not show a difference in students' overall achievement and also the students' gender does not show any effect on the students' achievement in math, however in science girls outperformed boys.

Since the sample is not a stratified sample we cannot study the relation between school sector and governorate or school sector and gender or gender and governorate.

As for the subjects, results show that the decreasing order according to the Lebanese scores was as follows: Algebra (465.7), Geometry (443.56), Chemistry (437.81), Physics (412.31), Biology (365.96) and Earth Science.

12.2. Overall Math Achievement

Results show that the percentage of grade 8 students in Lebanon was always lower than their international counterparts in the four content domains: Numbers, Algebra, Geometry and Data analysis and Probability with the difference largest in Data analysis and Probability. As for numbers, the difference was highest in problems. In Algebra, it was highest in algebraic reasoning which is not included in the Lebanese program. Most of the geometry TIMSS items are taught in grade 9 and not in grade 8. Statistics items are mainly taught in grade 9 and above.

Probability is not tackled before grade 11.

It was noticed also that more than 30% of the math TIMSS items are taught above grade 8 or were not in the curriculum.

As for the objectives, results show that the international percent correct was higher than that of the Lebanese for all objectives except for "expressions and operations" in algebra. The reason for that is the focus of the Lebanese curriculum on the notion of algebraic expressions in grades 7, 8 and 9.

Lebanese grade 8 students perform lower in the three cognitive domains: Knowing, Applying and Reasoning compared to students internationally. The huge difference between the Lebanese and international students' achievement in applying and reasoning might be due to the teaching level which tends to use direct application of formulas with little access to real life situations.

The noticeable difference in reasoning items may be due to the types of assessment in schools which does not involve problems at the reasoning level. A possible reason lies in the math grade 9 (Lebanese Brevet national exam) in which students mostly use their memory rather than their reasoning.

As for the type of questions, the absolute difference is highest for open questions and this may be due to unfamiliarity of Lebanese students with these type of questions which require from students that they need to determine the method to use in solving a problem.

As for the document used in the problem, Lebanese students tend to perform lowest when the document used refers to a graph or to schema and this result may be due to the fact that students in Lebanon are used to problems in which information is extracted from a text or a table more than from a graph and schema.

The types of questions were also classified into "action verbs" or "Wh" questions.

An action verbs usually shows the student the method to be used like "determine, solve, find, calculate…).On the other hand, a "wh" question is either "what, who, when,.." which doesn't show clearly the method or the action the student need to take. The Results show that grade 8 Lebanese students performed better when an action verb is used and less when a "wh" question is used.

As for the suspended material in the Lebanese curriculum, results show a difference more than 10 points between Lebanese and International means whether the items were suspended or not. But the difference was larger for suspended items which shows that suspended items had a direct effect on the performance of Lebanese students.

12.3. Overall Science Achievement

Results show that grade 8 students' performance of all the Arab countries was below the international mean. For Lebanon, student achievement in TIMSS 2015 was lower than the achievement in both 2011 and 2007, but slightly higher than student achievement in TIMSS 2003. With no significant variation in Lebanese students' performance across the four benchmarks in the last four TIMSS assessment years, the percentage of students at the four levels of performance remained low compared to student achievement at international benchmarks.

As for content domains, Lebanese Grade 8 students performed best in Chemistry and weakest in Earth Science and Biology. International comparison of performance at the different content domains also shows that Lebanese Grade 8 students performed significantly lower in the four subject areas. With respect to cognitive domains, students in Lebanon performed lowest in the Reasoning domain and highest in the Knowing domain, which is in line with the increasing difficulty of the levels.

How does student achievement compare in Biology & Earth Science?

Akin to the overall science performance, the percentage of Grade 8 students in Lebanon who correctly answered test items related to the different topic areas in Biology and Earth Science was significantly lower than international counterparts. While student performance in Earth science was quite similar to achievement in Biology, Grade 8 students in Lebanon could not outperform students in other countries in any of the objectives related to Earth Science. It was only in two biology objectives which assess student knowledge in identifying organs and organ systems in the human body that Lebanese students surpassed other countries with a relatively small deviation from the international mean. It is worth noting that for Biology and Earth Science, the deviation in performance from the international mean was mainly associated with objectives studied at grade levels lower or higher than grade 8 or objectives related to suspended themes.

In addition, performing significantly lower in the three cognitive domains compared to students internationally, the average percent correct in Lebanon decreased with the increase in the level of mental processes and thinking required to answer questions for both Earth Science and Biology; the difference between performance on Knowing and Applying items was more prominent in Earth Science.

On another hand, despite the lack of a definite pattern that reflects variation in students' performance as a function of the document types, student achievement remained low irrespective of the action verbs, test items, or type of question used in both disciplines. Lebanese students tended to perform lower in Earth Science compared to Biology for all types of questions, and lower than their international counterparts on all types of questions. Results showed that students in Lebanon and internationally performed highest on MCQs questions which constitute the major type of questions in TIMSS. Also similar to international results, Lebanese students performed significantly better in "Wh" questions and were more likely to perform better in Biology relative to Earth Science irrespective whether "Wh" questions or "Action Verbs" were used; yet, the former difference was not statistically significant.

Lastly, the percent correct and relative difference of questions with misconceptions was approximately the same compared to questions with no misconceptions for Lebanon and internationally in Earth Science. Analogous to other indicators, however, Lebanese students performed significantly lower than their international counterparts in questions with and without misconceptions when items are related to Biology. Although there was no significant difference between Biology and Earth Science on items that do not target misconceptions, the difference was significant otherwise.

Chemistry

In chemistry, the total number of TIMSS objectives in chemistry are 23, where only 18 objectives (78%) are present in the Lebanese Curriculum till the 8th grade. The other 22%, are partially present or not present, or present in a higher grade from 8th grade.

For the Topic areas, **Chemical Change** topic, presents no significant evidence of similarities or difference between Lebanon's and international performances. In **Composition of Matter** topic, presents no significant difference between the Lebanon's and international performance in this topic. As for the third topic, there is a strong evidence of significant differences between Lebanon and international performance in the topic of **Properties of Matter**, so Grade 8 Lebanese students performed significantly lower than the international students in **Properties of Matter** Topic, and Lebanon's significantly lower score is due to this component.

The analysis according to the cognitive level, In **Knowing** cognitive level, Lebanon and international scoring are almost identical while the other two domains, **Applying** and **Reasoning** indicates that there is a significant difference in favor to the international mean. This means that Grade 8 Lebanese students performed significantly lower in these two cognitive domains compared to the international mean.

For the other studied factors, the Lebanese students performed significantly better only when the exercises are given as text, and they performed much lower when the exercises contained other types of documents like (graphs, schema or tables). These types of documents are often associated with exercises of types **Applying** and **Reasoning**. This explains the relative low performance of Lebanese students when the exercises contain such type of documents. On the other hand, a significant difference in favor of the international students in the exercises that belong to 7th grade objectives.

Finally, there is no strong evidence on the effect of scientific misconception on the relative low performance of our students in this assessment

Physics

- The Lebanese student's achievement in % correct is lower than the international student's achievement with a relative difference (in average) of -30%.
- In the Lebanese Curriculum, in Physics, we cover:
  - Until the 8th grade, 41% of the TIMSS objectives, which is a low proportion.
  - After the 8th grade, 40% of the TIMSS objectives.
  - Throughout all the grades, 81% of the TIMSS objectives.
- Our students' achievement in the topic area "I-Physical States and Changes in Matter" is the best even though their highest % correct is in the topic area "Light and Sound". Lebanon's performance is lower on all topic areas, moreover the difference between Leb% and Int % are statistically significant for all the topics except for "I-Physical States and Changes in Matter" and "II-Energy Transformation and Transfer".

- Students' achievement on grade 8 material is the highest, which is expected. But what seems quite weird, is that, the questions corresponding to objectives that are not taught yet, got a relatively good mean compared to the ones that are already given in the 8th grade, however the differences were not significant among the three categories of objectives.
- There is no significant differences between the mean correct % of "objectives that are in the Lebanese Curriculum and not suspended" and "objectives that are not in the Lebanese Curriculum". This observation seems weird.
  The differences between Leb % and Int % are statistically significant for "questions corresponding to objectives that are not suspended" and "questions corresponding to objectives that are not given in the Lebanese Curriculum".
- Our students need to be more trained on "Reasoning". They achieve higher in "Knowing" than in "Applying" and achieve higher in "Applying" than in "Reasoning", however difference is only significant between knowing and reasoning.
- We have 45 questions corresponding to "D1 Lebanese cognitive domain" and just 1 question corresponding to "D3 Lebanese cognitive domain". Hence one cannot do any study concerning the Lebanese cognitive domains.
- Our students achieve significantly better in "Multiple-Choice" questions than in "Open questions".
  The relative decrease for "Open questions" is almost 3 times the one for "Multiple-Choice" questions. Our students need to be more trained on "Open questions".
- Our students achieve significantly better in "Wh" questions than in "Action Verb" questions. This can be explained: 25 "Wh" questions out of 26 are "Multiple-Choice" questions too and 11 "Action Verb" questions out of 17 are "Open questions" too. As we already know that "Multiple-Choice" questions scored higher than "Open questions", this could be an explanation in addition to the use of action verbs.
- Our students' achievement in "Text" questions is better than the one in "Schema" questions.
- The % correct mean of the questions with misconception is lower than the one of questions with no misconception for Lebanon and internationally, which is expected.
  There are just 3 questions with misconception that are at the same time 8th grade questions. Therefore, we do not have enough data to have a clear idea about the nature of mistakes done by our students.
  Review appendix 1.

12.4. School Composition and Resources

This chapter dealt with issues related to school composition and resources. The variables discussed were economic home background of students as reported by principals; language home background as reported by principals, school shortages as reported by principals also and problems in school conditions and resources as reported by teachers. Results showed that majority of Lebanese students came from more disadvantaged homes and their average was the lowest. As for students having their native language as the

language of the test, results in Lebanon were opposing to those on the international level. Less than 5% of the Lebanese students were in schools where the majority of students have the language of the test as their native language as compared with 64% internationally. Most of the Lebanese students were in schools where the minority have the language of the test as their native language as compared to 22% internationally. It was noticed that there was a weak association between language of the test being the native language of students and the average achievement. The reason for this is that majority of students in Lebanon study math and science in English or French and not in their native language. Concerning the school shortages as reported by the principals and the problems in school conditions and resources as reported by teachers were contradictory. On one hand 73% of Lebanese students whose principals reported that they have school shortages in sciences and 78% of students whose principals reported that they have school shortages in mathematics, 50% of students have their science teachers and 45% having their mathematics teachers reporting that they have hardly any problem in school resources and conditions. It was also noted that school conditions as reported by teachers were compatible with students' achievements whereas that was not the case when the shortage in the resources was reported by principals. The minimal averages were attained by students whose principals reported that their schools were affected by shortage in resources not those who were affected a lot by resources.

12.5. School Climate

Index 1: academic Success

Results show that students' achievement in Math was consistently higher than their achievement in science for all levels of principal and teacher emphasis on academic success. Internationally, however, the average achievement of Grade 8 students taught by Science teachers was higher than achievement of students taught by Math teachers across all levels of emphasis on academic success; association between this emphasis and students' average achievement was positive.

Index 2: Challenges

Results show that grade 8 Lebanese students who were taught by teachers facing fewer challenges achieved higher compared to their peers internationally. While there was a negative association between the level of challenges and average achievement in Science both in Lebanon and internationally, this observation was not replicated in Math in Lebanon due to missing data.

Index 3: Teachers' Job Satisfaction

For both Science and Math, the highest percentage of Lebanese students were taught by teachers who are very satisfied with their teaching. Nevertheless, student achievement in Math was highest for teachers who were less than satisfied in their teaching. Such contradictory and an unexpected result could question the seriousness of participants filling the questionnaire or students' attitude and motivation toward learning math irrespective of teachers' job satisfaction.

Index 4: Sense of belonging

The percentage of Lebanese Grade 8 students who have a high sense of belonging, a sense of belonging, and little sense of belonging to their school was the same for both Science and Math. Though, in science, there was a positive association between students' achievement with varying sense of belonging and their achievement in Lebanon and internationally, a decrease in performance in Mathematics was documented internationally but not in Lebanon.

12.6. School safety

In summary, having or not having disciplinary problems had no significant effect on Lebanese students' achievement in both math and science, but it was noted that internationally disciplinary problems had an effect on students' achievement.

Similarly, having or not having safe and orderly school had no significant effect on Lebanese students' achievement in both math and science, but it was noted that internationally safe and orderly school had an effect on students' achievement.

While students in Lebanon, and internationally, who experience bullying behaviors perform lower than peers who do not, so there is an association between the extent to which year 8 Lebanese students experienced bullying and their average achievement: the lesser the extent to which students experience bullying, the higher their average achievement in both math and science.

12.7. Classroom Instruction

Lebanon represents the second country that allocates the largest number of teaching hours for science instruction in the world. Similar for Mathematics, it is still considered among the highest worldwide, however this did not reflect positively on the student performance in TIMSS exam.

While Science investigation represents an effective index on the improvement of student performance average internationally this index has not worked in Lebanon with more than 50% of the teachers claiming that they emphasized science investigation in About Half of their Lessons or More.

There is no direct correlation between time spent on homework and score average of 8th grade students in science and mathematics.

The frequency of absentees of Lebanese student is slightly higher than that of international students in grade 8. On the other hand, and as expected, the high frequency of absence has a negative effect on the average achievement of the Lebanese and international students and in both subjects (science and math).

12.8. Student Engagement and Attitudes

Lebanese grade 8 students who participated in TIMSS 2015 were likely to be very engaged in mathematics and science. These students tended to have higher averages than those who are engaged or not engaged. On the other hand, majority of Lebanese students tended to like math and sciences while others who very much liked learning math and sciences were less but got the highest averages. Similar results were found also with respect to confidence in their abilities to learn mathematics and sciences. Majority of the Lebanese students were confident and a smaller percentage were those who were very confident or not confident and the higher the confidence, the higher the achievement. Lebanese students who strongly valued mathematics and science were the majority and got the highest averages.

12.9. Teachers' and principals' preparation

In summary, Lebanese students' mathematics achievement was the highest among students taught by teachers with a major in math education only followed by students taught by teachers with math major only while the students taught by teachers with other majors or no formal education achieved a score higher than those who were taught by teachers with both majoring in mathematics and education. Internationally the result was as follows: the mathematics achievement was the highest for students taught by teachers with both education and mathematics major with a slight difference from students taught by teachers with math major only. Students taught by teachers with education major followed by students taught by teachers with other majors and the lowest for students taught by teachers with no formal major.

Lebanese students' science achievement was the highest among students taught by teachers with a major in science and education and almost the same achievement for students taught by teachers with science only while the students taught by teachers with other major education achieved a score higher than those who were taught by teachers with no formal major. Internationally the result was similar. The science achievement was the highest for students taught by teachers with both education and science major with a slight difference from students taught by teacher with science major only, students taught by teachers with science education and other major achieve similar scores followed by students taught by teachers with no formal major.

Mathematics Lebanese results of students according to their teachers' years of experience was the highest for those who had teachers with 20 years of experience or more while those who had teachers with less than 20 years of experience almost achieved close scores. Internationally, the mathematics achievement was close between students who had teachers with different years of experience.

Science Lebanese results of students according to their teachers' years of experience was the highest for those who had teachers with 5 to 10 years of experience while those who had teachers with more than 10 years of experience or less than 5 years almost achieved close scores. Internationally, the science achievement was close between students who had teachers with different years of experience.

12.10. Home environment support

- Whether for "Home Educational Resources" or for "Students speak the language of the test at home":
  - Lebanon scores are significantly lower than international scores for all categories, in Science and in Math (except for the category "Students who never speak the language of the test at home" in Math where achievements were so close).
  - Lebanon Math scores are significantly higher than Lebanon science scores for all categories, in Science and in Math.
- Home educational resources influence the science scores more than they influence the Math scores.
- Majority of respondents (73%) had some resources.
- "Students speak the language of the test at home almost always" got the highest scores in both science and math.
- The language of the test, if spoken at home, influence the science scores more than it influences the Math scores. This is well confirmed as students need more language in science than in math.
- What is strange is lower score in science for those who always speak the language of the test at home and needs to be further investigated by looking at other variables.
- The majority of students (59%) speak the language of the test "sometimes".
- The sample should be stratified in order to take into consideration the different groups, that is to cover the different groups such as a stratified sample that represents each governorate and in each governorate the public and private sector besides the gender and students' language so the sampling should be proportionate stratified sampling.
- The study should be completed by others to verify the resultants because one study is insufficient to make a strict or safe conclusions.

  Review appendix 2.

12.11. Recommendations

12-11-1 Recommendations math

In planning for the new curricula, the following recommendations can be taken into consideration:

- The mathematics content domains need to be reorganized. Important topics need to be included in lower grades like algebraic reasoning and functions. Another important topic to be added is "probability" which can be introduced as early as grade 1. Other topics need to be stressed like "analysis of data" and "ratio, proportion and percent".
- The mathematics cognitive domains should be taken into consideration when developing new curricula. More emphasis should be made on higher levels like applying and reasoning.

- Real life situations should be emphasized in exams to enable students to model situations mathematically and solve them.
- Suspended topics need to be returned back into action since they represent an important part of TIMSS curriculum.
- Misconceptions need to researched and studied so that they can be avoided in development of new curricula.
- Varied types of questions should be used in assessments especially open questions which make students responsible of their decisions. Also, other types involving diagrams and tables need to be used too.

12-11-2 Recommendations sciences

According to the aforementioned results and derived conclusions, the following recommendations can be taken into consideration:

First: Lebanese Science Curriculum:

- Restore the suspended themes, particularly in Earth science.
- Re-design the curriculum to include real-life situations that target higher level thinking skills, such as applying and reasoning.
- Include assessment questions that encompass open-ended questions that demand reasoning and critical thinking.
- Establish a committee of experts that would refine the Lebanese science curriculum
- (content and scope of sequence of themes) in light of TIMSS requirements and content, to ensure the validity and reliability of TIMSS test items to the actual Lebanese students' performance. Moreover, there is a high demand for re-addressing the classification system of the thinking processes and levels required by students in answering test questions. The discrepancy in categorizing the level of test items adopted by TIMSS and the evaluation system in Lebanon is a major issue that must be seriously considered in comparing Lebanese students' performance with their counterpart internationally.

Second: Research

- Conduct future research that explores students' perceptions about learning topics covered in the Lebanese science curriculum
- Conduct future research to identify the nature of students' misconceptions in both Biology and Earth science; then, compare it with misconceptions identified by AAAS and highlight these misconceptions in teachers' edition science textbook to help teachers be aware of these misconceptions prior to classroom instruction.

Third: Teacher training

- Deliver teacher training on writing test items according to blooms taxonomy and on applying classroom strategies that favor students' critical thinking and reasoning.

Finally, there is a high need to compare Lebanese student achievement with other countries - the ones we call 'fast movers' in TIMSS analysis – that merit further research in order to understand how they have made their improvements.

12-11-3 Others recommendations

- The parents' economic background plays an important role in students' performance in TIMSS. Thus, it is important to take this factor into consideration.
- The school conditions referring to the building and resources are consistent with students' performance in TIMSS, thus the schools must be installed with all required resources for the educational process to be successful.
- There is a need to conduct a research to explore variables/ parameters that (a) impact principals' and teachers' perception, definition and practices related to academic success and (b) explain the variation in student achievement in science versus math
- It would be of value to conduct a study that could categorize the challenges faced by Lebanese Math and Science teachers and identify their causes.
- Future research might be done to interview students on their values and attitudes toward learning math and science.
- It is obvious that students who have high sense of belonging to their schools tend to achieve higher than students who lack sense of belonging. This finding was observed in both science and math. Such findings set the stage for classroom teaching that better promote a higher student sense of belonging to their schools as it would enhance their learning. At a macroscopic level, teacher training programs must include PD activities that help teachers effectively implement strategies that could induce students sense of belonging which can lead to their success.
- Lebanese students should learn in a rich environment where they engage in activities so that they build self-confidence and like learning the material and correspondingly value the subjects taught by feeling their importance and applicability in real life situations.

Finally, it is highly recommended to do analysis to identify the index which contribute most to student achievement and to explore the discrepancies in the impact of teacher-level variables on science achievement between science and math.

Appendix 1

Overall math and Science achievement

Items	Mathematics	Life Sciences	Earth Science	Physics	Chemistry
General	1. Lebanon score of 442 significantly lower than international mean. 2. Across administrations, Lebanon's performance improved from 2003 to 2007 from the 28th to 42nd percentile, then it stabilized in 2011 and slightly went down in 2015 to the 31st percentile. 3. The percentage of Lebanese students at the four levels of performance is lower than the international medians at TIMSS international benchmarks in each benchmark: Advanced 5 (0), High 26% (8), Medium 62% (35%), Low 84% (71). 4. Across administrations, the percentage of students in 2015 in the intermediate and high international benchmarks was significantly higher than that in 2003, but was same or slightly lower than in 2007 and 2011.	1. In Biology, 27% of grade 8 students in Lebanon provided correct answers on the overall test items compared to an average of 44% in other participating countries. 2. The percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the six biology topic areas was lower than their international counterparts.	1. Student Performance in Earth science was nearly the same as that for Biology. 2. The largest discrepancy between student performance in Lebanon and internationally was observed in items which are not taught in the Lebanese science curriculum. 3. Grade 8 students in Lebanon could not outperform students in other countries in any of the objectives related to Earth Science. The deviation in performance from the international mean was mainly associated with objectives studied at different grade levels, in different subjects, or related to suspended themes.	The Lebanese student's achievement in % correct is lower than the international student's achievement with a relative difference (in average) of -30%.	The Lebanese students' achievement in % correct is lower than the international student's achievement with a relative difference (in average) of -8%
Content Domains	1. Grade 8 students performed best in algebra, than in geometry and were weakest in data analysis and probability. 2. Compared to the international mathematics mean for each content domain, Grade 8 Lebanese students performed significantly lower in the four subject areas, except for Algebra where difference was not significant. 3. With respect to development across administrations, Lebanese students performed significantly lower in Number in 2015 than in 2011 (-11) and 2007 (-13) and significantly lower in Geometry which showed a decrease of 12 points from that in 2007. There were no significant differences in other domains	1. The percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the six biology topic areas was lower than their international counterparts. 2. The greatest difference in performance was in topic III addressing concepts related to life cycles, reproduction, and heredity. 3. Grade 8 students in Lebanon outperformed students in the other countries in only two objectives related to Biology which assess student knowledge in identifying organs and organ systems in the human body and comparing them with those in other vertebrates.	1. The percentage of grade 8 students in Lebanon who were able to correctly answer test items related to the four topic areas on Earth Science was lower than their international counterparts. 2. 8th graders in Lebanon performed the highest on test items related to topic I (earth's structure and physical features) and topic IV (Earth in the solar system), while the highest percent of items answered correctly for international counterparts was documented for topic II on Earth's processes, cycles, and history. 3. 8th graders in Lebanon registered the lowest performance in topic III addressing concepts related to the use and conservation of earth's resources, which is a suspended theme in the Lebanese curriculum.	1. Grade 8 students performed best in "Physical States and Changes in Matter" even though their highest % correct is in the topic area "Light and Sound". 2.compared to theinternational grade 8 Lebanonese students performed significantly lower on all topic areas except for "I-Physical States and Changes in Matter" and "II-Energy Transformation and Transfer". 3.Students' achievement on grade 8 material is the highest, which is expected.	Grade 8 Lebanese students performed significantly lower than the international students in Properties of Matter Topic, and lebanon's lower score is due to this component.

Items	Mathematics	Life Sciences	Earth Science	Physics	Chemistry
Cognitive Domains	1. Grade 8 students performed best in Knowing, then in Applying and were weakest in Reasoning. 2. Compared to the international mathematics mean for each cognitive domain, Grade 8 Lebanese students performed significantly lower in the three cognitive domains areas. 3. Across administrations, there was a significant drop in 2015 in Reasoning with respect to 2011 and 2007.	1. In Lebanon and internationally, the average percent correct decreases with the increase in the level of mental processes and thinking required to answer a question. 2. Grade 8 students performed lower in the three cognitive domains (Knowing, Applying, and Reasoning) compared to students internationally. 3. Students' performance in D1 was higher than their performance in D2 for both Lebanon and internationally. 4. Internationally, the percentage of students who correctly answered test items was 1.5 times and 2 times higher than the percentage of Lebanese students who answered correctly the same D1 and D2 test items respectively. 5. A correlation analysis between the percent of correct answers according to cognitive domains for Lebanon and TIMSS indicated a significant difference at 0.01 level.	1. In Lebanon, as was the case internationally, the average percent correct decreased with the increase in the level of mental processes and thinking required to answer a question, the percentage being the lowest in Reasoning and highest in Knowing. 2. Grade 8 students performed lower in the three cognitive domains: Knowing, Applying, and Reasoning, compared to students internationally; particularly in the reasoning domain. 3. In Lebanon, the average percent correct decreased with the increase in the level of mental processes and thinking required to answer a question for both Earth Science and Biology, although the difference between performance on Knowing and Applying items was more prominent in Earth Science. 4. Students' performance was higher in Biology for both Applying and Reasoning cognitive domains, but not significantly different on the three domains. 5. Students' performance in D1 was higher than their performance in D2 for Earth Science and Biology. However, there was less than 1.5% difference between the performances between the two disciplines for both Lebanese cognitive domains, but the difference was not significant.	Grade 8 students achieve higher in "Knowing" than in "Applying" and achieve higher in "Applying" than in "Reasoning", however difference is only significant between knowing and reasoning.	Grade 8 Lebanese students performed significantly lower in Applying and Reasoning cognitive levels compared to the international mean.
Curriculum Mapping\alignment	Only 16% of items were taught at Grade 8, 52% before and 27% taught above Grade 8 or not present in curriculum.	1. Great deviation in performance from the international mean was highly associated with objectives related to suspended themes or to themes taught in lower grades. 2. Grade 8 student performed well on test items related to some biology notions not taught in grade 8 with a relatively small deviation from the international mean.	1. 8th graders in Lebanon performed the highest on test items related to topic I (earth's structure and physical features) and topic IV (Earth in the solar system) 2. The deviation in performance from the international mean was mainly associated with objectives studied at different grade levels, in different subjects, or related to suspended themes.	In the Lebanese Curriculum, in Physics, we cover: - Until the 8th grade, 41% of the TIMSS objectives. - After the 8th grade, 40% of the TIMSS objectives. - Throughout all the grades, 81% of the TIMSS objectives. Grade 8 students performed well on test items related to some physics notions not taught in grade 8.	In the Lebanese curriculum, in Chemistry, we cover: -Until 8th grade, 78% of TIMSS objectives. - 22% of the TIMSS objectives are partially present or not present, or present in grades higher than 8th grade.
Type of Questions	1. Lebanese students do best on TF followed by MC and DCQ, while their weakest point was open-ended items. 2. Their performance is lower on all item types but the difference is significant on MC, Open and short answers are significantly lower than international sample.	1. Lebanese students tended to perform lower than their international counterparts for MCQ, short answer, and open-ended questions. 2. Both Lebanese students and internationally perform highest in MCQs.	1. The major type of question in TIMSS was multiple choice for both disciplines. 2. Lebanese students performed significantly highest in MCQs and lowest on the short answer type. 3. Lebanese students tended to perform lower in Earth Science compared to Biology for all types of questions. 4. Lebanese students performed lower than their international counterparts on all types of questions.	1.Our students achieve significantly better in "Multiple-Choice" questions than in "Open questions". 2.The relative decrease for "Open questions" is almost 3 times the one for "Multiple-Choice" questions. Our students need to be more trained on "Open questions".	Our students achieve significantly better in "Multiple-Choice" questions than in "Open questions".

Items	Mathematics	Life Sciences	Earth Science	Physics	Chemistry
Type of Document	1- Significant difference in performance between the Lebanese students and internationally by document type, on all Lebanese lower. 2-Lebanese students tend to perform significantly lower when they extracting information from graphs and schema and perform best when the document used in the item is in text. The international percent score was highest for items using tables as documents and lowest for schema.	1. Students usually performed lowest on Knowing when the document type was text. 2, Students did not perform well on all types of documents (Text, Table, or Schema). 3. There was no definite pattern that reflects whether students performed better in the different document types. 4. Internationally, students performed better than Lebanese students on all types of documents. 5. Results revealed nearly similar performances in Lebanon on questions represented either in tables or texts. The highest relative change was on questions presented as text.	1. There was no definite pattern that reflected variation in students' performance in function of the document types. 2. Students internationally performed best in questions presented in tables, while students in Lebanon performed highest with items presented as either schemas or text. 3. In both Biology and Earth Science, most questions were in the form of Text.	Our students' achievement in "Text" questions is better than the one in "Schema" questions.	The Lebanese students performed significantly better only when the exercises were given as text, and they performed much lower when the exercises contained other types of documents like (graphs, schema or tables).
Types of Actions verbs	Lebanese students tend to perform significantly higher in "Wh" questions but significantly lower than their counterparts on both types of questions.	1. The lowest performance was observed when "Wh" questions were used. 2. When action verbs were used in any type of question (short answer or open ended), student achievement tended to be the lowest.	1. Students' achievement remained low irrespective of the action verbs test items or type of question used. 2. Similar to international results, Lebanese students performed better in "Wh" questions. 3. Students were more likely to perform better in Biology relative to Earth Science whether "Wh" questions or "Action Verbs" were used.	Our students achieve significantly better in "Wh" questions than in "Action Verb" questions. we already know that "Multiple-Choice" questions scored higher than "Open questions", this could be an explanation in addition to the use of action verbs.	The Lebanese students had a low performance whatever the type of question (with or without an action verb), but they perform better on wh questions than on ones with action verbs.
Suspended Topics	For Lebanese students, percent correct on suspended items was significantly lower on than on the remaining ones, and it was also significantly lower than international sample.	1. Great deviation in performance from the international mean was highly associated with objectives related to suspended themes or to themes taught in lower grades. 2. Grade 8 student performed well on test items related to some biology notions not taught in grade 8 with a relatively small deviation from the international mean.	1. 8th graders in Lebanon registered the lowest performance in topic III addressing concepts related to the use and conservation of earth's resources, which is a suspended theme in the Lebanese curriculum. 2. Grade 8 students in Lebanon could not outperform students in other countries in any of the objectives related to Earth Science. The deviation in performance from the international mean was mainly associated with objectives studied at different grade levels, in different subjects, or related to suspended themes.	There is no significant difference between the mean correct % of "objectives that are in the Lebanese Curriculum and not suspended" and "objectives that are not in the Lebanese Curriculum". This observation seems weird. The differences between Leb % and Int % are statistically significant for "questions corresponding to objectives that are not suspended" and "questions corresponding to objectives that are not given in the Lebanese Curriculum".	The Lebanese students preformed lower for "question corresponding to objectives that are suspended or not present in the Lebanese curriculum"
Misconception	Lebanese students performed significantly lower on items with misconceptions than on ones without, and their performance was significantly lower than international sample on both.	1. Only 8.75% of Biology TIMSS test items revealed misconceptions. 2. The percent correct of questions targeting misconception was lower than the one of questions with no misconception for Lebanon and internationally. 3. Lebanese students perform lower than their international counterparts in questions with and without misconceptions.	1. The percent correct and relative difference of the questions with misconceptions was approximately the same as the questions with no misconceptions for Lebanon and internationally. 2. The relative difference between Earth Science and Biology for items targeting misconceptions and questions that do not target misconceptions was around 8.5 times smaller. 3. There was no significant difference between Biology and Earth Science on items that do not target misconceptions, while there is significant difference on items that target misconceptions.	The % correct mean of the questions with misconception is lower than the one of questions with no misconception for Lebanon and internationally.	There is no strong evidence on the effect of scientific misconception on the relative low performance of our students in this assessment

Items	Mathematics	Life Sciences	Earth Science	Physics	Chemistry
governorates	The decreasing order of governorates according to their achievement in mathematics is as follows: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs, Nabatieh, Beirut, South Lebanon.	The decreasing order of governorates according to their achievement in Life Science is as follows: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs, Nabatieh, Beirut, South Lebanon.	The decreasing order of governorates according to their achievement in Life Science is as follows: Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South Lebanon.	The decreasing order of governorates according to their achievement in physics is as follows: Beqaa, Mount Lebanon, North, Mount Lebanon suburbs, Nabatieh, Beirut, South Lebanon.	The decreasing order of governorates according to their achievement in Chemistry is as follows: Beqaa, North, Mount Lebanon, Mount Lebanon suburbs, Nabatieh, Beirut, South Lebanon.
gender	There were no significant differences in performance by gender in math.	Girls outperformed boys in the overall achievement in biology.	There were no significant differences in performance by gender in Earth Science	There were no significant differences in performance by gender in Physics.	Girls outperformed boys in chemistry.
language (french\english)	The French students' scores in Math were better than the English students' scores.	The English students' scores in Biology were better than the French students' scores.	French students' scores and English students' scores seem to be the same in Earth Science.	French students' scores and English students' scores seem to be the same in Physics.	The French students' scores and English students' scores seem to be the same in Chemistry.
Public school\private school	The public students' achievement in Math is slightly higher than the private school students' achievement, but it is not statistically significant.	The public students' achievement in Life Scienc is slightly higher than the private school students' achievement, but it is not statistically significant.	The public students' achievement in Earth Science is slightly higher than the private school students' achievement, but it is not statistically significant.	The public students' achievement in Physics is slightly higher than the private school students' achievement, but it is not statistically significant.	The public students' achievement in Chemistry is slightly higher than the private school students' achievement, but it is not statistically significant.

Appendix 2

Parameters

parameters	Indicies that have impact	Indicies that don't have impact
School Composition and Resources	Disadvantaged Homes- School Conditions as reported by teachers	Native language as the language of the test- school shortages as reported by principals
School Climate	School principals' emphasis on academic success Teachers' emphasis on academic success level of challenges and average achievement in Science Science teachers job satisfaction. Students' Sense of School Belonging and science achievement.	Level of challenges and average achievement in Math. Math teacher Job Satisfaction.
School safety	Student bullying	School Discipline Problems Safety and orderly school
Student Engagement and Attitudes	Engagement in math and science classes- Like math and science- Confidence in abilities in math and science- Students value math or science	
Classroom instruction	Teachers Emphasize Science Investigation (Science), Resources for Conducting Science Experiments (science Only), Teaching Limited by Student Needs, Frequency of Student Absences.	Instructional Time Spent on Science, Computer Activities During Science Lessons and using internet in schoolwork, Weekly Time Students Spend on Assigned Science Homework.
Teachers' and Principals' preparation		Teachers Years of Experience Teachers Majoring in Education and subject
Home environment support	Home Educational Resources Students speak the language of the test at Home	

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- TIMSS 2015 International Results in Science – Chapter 4: Home Environment Support – Exhibit 4.4
- TIMSS 2015 International Results in Mathematics – Chapter 4: Home Environment Support – Exhibit 4.4