كلية دبي للإدارة الحكومية
DUBAI SCHOOL OF GOVERNMENT

Benchmarking Education

Dubai and the Trends in Mathematics and Science Study 2007

Dubai School of Government

Mike Helal

April 2009

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All comments, criticisms and suggestions are welcome.

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Executive Summary

Despite robust economic growth in recent years in Dubai and the United Arab Emirates, education and the development of human capital have been found underdeveloped by recent international studies into business competitiveness. In spite of this apparent deficit, a data-based study incorporating quantifiable measures of the standard and quality of education had not existed to guide reform efforts. This changed in 2007 with Dubai's entry into the international education debate through its participation in the Trends in International Mathematics and Science Study (TIMSS). The cyclical study assesses knowledge and skills in mathematics and science for 10-year-olds and 14-year-olds, formative years in a student's learning trajectory, for students in 63 countries and sub-national entities.

In combination with the TIMSS background survey of students, teachers and administrators, results allow Dubai's policy makers to benchmark the quality of its education system in comparison to best practices around the world, as well as to identify core areas for future reform efforts. The following paper examines and interprets Dubai's 2007 results in light of assessed contextual factors in an attempt to locate the determinants of Dubai's relatively low achievement. The aim is to enable policy makers to understand which facets of the educational landscape in Dubai are in need of reform, and what elements of reform are called for in order to elevate learning to desired outcomes.

A Comparison of Results

While results of the 2007 TIMMS show Dubai to have a strong standing among GCC countries and nations within the Middle East in general, room for improvement exists when compared to the rest of the world. On average, students at both the grade 4 and grade 8 levels failed to meet the international scale average (500) set by the International Association for the Evaluation of Educational Attainment. At the grade 4 level, students in Dubai achieved an average score of 444 in mathematics and 460 in science. Dubai's grade 8 students fared slightly better with an average of 461 in mathematics and 489 in science. For grade 4, the result places Dubai atop the list of all regional participants, notably surpassing Iran which otherwise maintains the highest regional scores in both mathematics (402) and sciences (436). The average marks of grade 8 students in Dubai also compare favorably to all other regional participants; the Emirate's average exceeds those of Lebanon and Jordan, which otherwise lead the region in regard to mathematics (449) and science (482) respectively.

Despite average marks that lead the Middle East region, Dubai's scores fall largely below those attained by Asian nations in particular. In mathematics for 10-year-olds, Hong Kong achieved the world's highest average mark of 607, with Chinese Taipei (Taiwan) achieving the highest among grade 8 students worldwide at 598. In science at the grade 4 and grade 8 levels, Singapore was the top performing country, with averages of 587 and 567 respectively. Dubai's average results thus fall around 30 percent lower than the scores of world leaders in mathematics, and 20 percent behind those that lead in science achievement.

Distribution of scores within Dubai

The distribution of mathematics and science achievement in Dubai was among the widest in the world, with scores ranging from 260 to over 600 on average at both year levels. In grade 4 science, there is a 132 percent difference between the lowest and highest scores within the Emirate. For 14-year-olds, the difference is still severe at 96 percent between the lowest and highest achieving schools. In mathematics, a similar performance differential exists between Dubai's schools.

Top-performing grade 4 students earned an average score of 589, compared to the lowest performing (5th percentile) students, who only averaged 293. In grade 8, the 95th percentile achieved an average of 611. At the same time, the 5th percentile earned an average score of only 294. By international comparison, students that scored at or below 300 find themselves behind all tested nations except Yemen.

Gender differences in mathematics and science

In TIMSS 2007, the average achievement of boys and girls in grades 4 and 8 in Arab countries (including Kuwait, Oman, Palestine, Qatar, Tunisia, and Yemen) generally shows a heavy skewing in favor of girls. Syria and Tunisia are the only countries in the region that showed contrary results: boys in these two countries outperformed girls in both mathematics and sciences at grade 8. At the same time, scores for boys and girls in Dubai show no significant difference at either grade in terms of mathematics or science achievement. However, the overall results for Dubai may be skewed, due to a possible pro-female bias in public schools coupled with a pro-male bias in private schools.

Attributes Affecting Outcomes

Public and private schooling

In grade 4, public schools in Dubai lag behind private schools by around 14 percent in mathematics and 15 percent in science. The disparity between public and private is even greater with grade 8 students, as public schools attained average scores around 27 percent lower than private schools in mathematics and 18 percent lower in science. The stark difference in achievement between public and private schools in Dubai emphasizes the serious challenges facing public education in the Emirate.

As a result of the Emirate's diverse expatriate population, 13 different curricula are on offer in private schools around Dubai. The British curriculum offered in private schools resulted in the highest average marks in mathematics and science. It is additionally important to note that the national curriculum, whether taught in public or private schools, is achieving lower results than all other dominant curricula, including the British curriculum, the American curriculum and the Indian curriculum.

Teacher characteristics

Pedagogical training poses a challenge in Dubai. Nearly 64 percent of grade 4 students had teachers who had majored in science or mathematics but did not have a major in primary or elementary education. Worldwide, this figure is only 13 percent. Grade 8 science teachers are slightly better qualified, as around 48 percent of students reported their teachers have both a education major and a science or mathematics major. Institutional trust in teachers' abilities, along with teachers' own confidence, appears low. According to the TIMSS teacher survey, 60 percent of grade 4 teachers and 64 percent of grade 8 teachers in Dubai use textbooks as the primary resource for science learning, which reflects their relatively poor grasp of the subject and inhibits advanced learning among students.

Time spent in school

Schools in Dubai are hindered by a significantly short school year. This is particularly the case for public schools, which have shorter school days and a short annual academic calendar. In fact, in real terms, it can be said that schools in Dubai fall one full day behind their international counterparts every week in regard to instructional time. While in school, nearly 55 percent of grade 4 students and 51 percent of grade 8 students reported that they spent at least one science lesson per week memorizing science facts. This exceeds the international average of 44 percent and indicates the prevalence of antiquated methods of teaching and learning at some schools in Dubai. This result comes despite significant investment in the professional development of teachers.

Parents and the home learning environment

Encouragingly, results of the student background survey show that 41 percent of students' parents in Dubai have completed a university degree and over 55 percent have completed some level of postsecondary studies. This is a substantial figure in comparison to the worldwide average of 38 percent, and suggests a home environment that strongly encourages learning. However, parents in Dubai do not play as strong a role in their children's schooling as others around the world. Only 27 percent of parents of grade 4 students reported sitting on school committees, compared to an international average of 71 percent of parents. There are no policies stipulated by education councils or ministries mandating the existence of parent committees unlike the majority of other participating countries.

Education and technology

It must be noted that students in Dubai are not making full use of the technological facilities at their disposal. Evidence suggests the underutilization of computers and technology at home and at school. While Dubai reported an above average share of students using the computer both at school and at home (a combined 69 percent), student scores remained significantly lower than worldwide averages. It should be recognized that the installation of technology alone, whether in the school or at home, will not automatically lift learning standards.

Conclusions and Recommendations

Dissecting the data

To fully benefit from their participation in TIMSS 2007, Dubai policy makers must compare results between individual schools, paying close attention to results differentials, performance and engagement statistics broken down on a gender basis, classroom strategies, and variations in teacher training and professional development. Furthermore, the results of each school should be disseminated to schools so that these schools can assist each other in developing clear ideas of best practice. Conferences bringing schools together should take place to discuss the results achieved across the Emirate, exploring implications and potential remedies. Collaboration for the implementation of data-driven reform is called for by all stakeholders to ensure that the state of education in Dubai is lifted to meet and transcend international thresholds.

Teacher qualifications and training

Teachers should come into Dubai's schools with an understanding of the intricacies of learning and the different ways in which students learn. Currently, most teachers come into schools in Dubai will only a nominal understanding of effective pedagogy, a factor that limits their effectiveness and appears to result in student disengagement and lower achievement. Without necessitating rigorous teaching qualifications, public schools are at particular risk of hiring individuals who do not have the right pedagogical skills to develop lifelong learners.

Addressing curriculum gaps

In the absence of a proper mechanism for filtering better quality teachers, Dubai should address the curriculum gaps in the quality of curricula offered by various school types, the differential between mandated curricula and what is actually taught in the classroom. This can be addressed through the inspection of individual schools and consultation with students and parents in order to align the curriculum as implemented with desired criteria. Issues of accountability will only be resolved when bodies such as the Knowledge and Human Development Authority (KHDA) and the Ministry of Education implement a proper follow-up mechanism.

Engaging parents and encouraging learning at home

Parents are key stakeholders in the education system and need to be involved in their children's schooling, especially at a young age. In Dubai, however, their involvement is nearly non-existent. Opening channels of communication with parents will ultimately assist in raising standards at any institution. Students and parents should be encouraged to take up and expand the learning resources that are readily available in their households. As discussed in this paper, students do not appear to be making use of literary and technological resources available to them in the household.

Preparing for future examinations

TIMSS will next be conducted in 2011, wherein Dubai will have an opportunity to participate again. This will allow schools to explore results for grade 8 students who participated in the 2007 test as grade 4 students, giving an important picture of average performance in the intermediate period. It will also allow Dubai to assess the success of current reforms underway through the KHDA. At the same time, it should be emphasized that the coming years should not result in pressure on schools to adopt a teach-to-the-test mentality, which would undermine any reforms.

As Dubai prepares for 2011, the implementation of the TIMSS test should be reviewed. In particular, policy makers should pay attention to how the background surveys are administered in Dubai. Less than 70 percent of teachers and students answered the background questions, and some questions were completely ignored. More rigorous practices for attaining this data should be set for future rounds.

Finally, Dubai should aim to participate in future testing cycles of other international examinations. International standardized tests, including TIMSS, the Progress in International Reading Literacy Study (PIRLS) and the Program for International Student Assessment (PISA) enable policy makers to juxtapose local procedures with international best practice and inform educators about the efficiency and effectiveness of current policies. For Dubai's aim of becoming an educational hub to be realized, education quality must be a priority for future reform.

Introduction: Dubai and TIMSS

Home to one of the world's fastest growing economies, Dubai has increasingly become a focal point for growth in the region. Recent reports such as the World Economic Forum's *Arab World Competitiveness Report 2007* have lauded Dubai – and the United Arab Emirates (UAE) in general – for its business environment but have found education, an element crucial to growth, underdeveloped (Hanouz, El Diwany and Yousef 2007). Education and the development of human capital have been identified as areas needing enhancement to ensure the sustainable growth of the 38-year-old nation. This is vital in light of the UAE's impending employment crisis, with the forecasted entry of 250,000 more Emirati jobseekers into the workforce by 2020 (Ministry of Labour 2008).[1] With the world embracing knowledge as an essential component of international competitiveness, the issue of adequately educating this growing workforce becomes paramount.

While policy makers, employers and residents of the UAE have criticized the local education system to varying degrees, no measure of educational quality has existed to serve benchmarking and accountability purposes. Dubai set out to change this in 2007 by participating in the Trends in International Mathematics and Science Study (TIMSS) examination. Overseen by scholars from the Lynch School of Education at Boston College, TIMSS has become one of the leading international indicators of comparative educational performance. It is one of two assessments that are conducted by the International Association for the Evaluation of Educational Attainment (IEA), along with the Progress in International Reading Literacy Study (PIRLS).[2]

Participating in the 2007 TIMSS examination in Dubai represents a brave undertaking for Dubai, a step that will allow it to enter the international educational debate. The results serve as the first authentic point of reference for stakeholders in education in Dubai. In addition to representing a baseline benchmark for future development, the 2007 results offer a rich data resource from which to examine the state of education in Dubai today. This paper provides an analysis of the overall results and accompanying data in order to assess the quality of education in Dubai's schools and to identify essential elements of any future reforms.

[1] This compares to the current estimated population of 900,000 Emiratis, 28 percent of whom are active in the labor market (Ministry of Labour 2008).

[2] The IEA confirmed that the UAE, at a federal level, has indicated its interest in undertaking PIRLS in 2011. Interviews with the Ministry of Education have confirmed that the UAE is also interested in participating in the upcoming round of TIMSS in the same year.

How TIMSS Works

Countries participating in TIMSS are tested once every four years in mathematics and science concurrently, with the test being conducted in schools sampled by multi-stage stratified cluster sampling that represents the social and demographic fabric of each nation. Students are tested at grade 4 (10-year-old students) and grade 8 (14-year-old students), which are seen as formative years during which students acquire key knowledge and skills that they will utilize for the remainder of their academic lives.

The grade 4 mathematics test is comprised of three core competency areas: number (arithmetic operations and the manipulation of numbers, decimals and fractions), geometric shapes and measures, and data display (comprised of the design and construction of tables, graphs and charts). For those in grade 8, the test includes assessment of number, algebra, geometry, and data and chance. The science component of the test in grade 4 assesses life science, physical science, and earth science, while the grade 8 assessment includes biology, chemistry, physics and earth science. At both levels, the examination is designed to gauge a range of student abilities. An approximately equal share is given to multiple choice questions and constructed response ones, a structure that enables students to demonstrate the full range of their skills and abilities.

The 2007 TIMSS testing cycle involved 37 countries and seven benchmarking entities at the grade 4 level, while 50 countries and seven benchmarking entities took part in the grade 8 tests (table 1). This amounts to a total of 424,763 students tested worldwide at both grade levels. Some cities or states—often those that have recently undergone education reform—can participate in TIMSS as independent entities known as benchmarking participants. Dubai was classified as a benchmarking participant since it participated in the TIMSS examinations without the rest of the UAE.

Table 1
Participating countries and benchmarking entities, TIMSS 2007

Participating countries			
Algeria	England	Kuwait	Serbia**
Armenia	Georgia	Lebanon**	Singapore
Australia	Germany*	Lithuania	Slovak Republic*
Austria*	Ghana	Malaysia**	Slovenia
Bahrain	Hong Kong	Malta**	Sweden
Bosnia and Herzegovina**	Hungary	Morocco	Syrian Arab Republic
Botswana**	Indonesia	Norway	Chinese Taipei (Taiwan)
Bulgaria**	Iran, Islamic Rep.	Oman**	Thailand**
Colombia	Israel	Palestine (PNA)**	Tunisia
Czech Republic	Italy	Qatar	Turkey**
Cyprus**	Japan	Romania	Ukraine
Denmark*	Jordan**	Russian Federation*	United States
Egypt	Kazakhstan*	Saudi Arabia**	Yemen*
El Salvador	Korea, Rep.	Scotland	
Benchmarking Entities			
Alberta, Canada*	British Columbia, Canada	Massachusetts, USA	Ontario, Canada
Basque Country, Spain**	Dubai, UAE	Minnesota, USA	Quebec, Canada

Note: Countries or entities marked with a "*" only participated in the grade 4 test. Those marked with a "**" only participated in the grade 8 test.

National coordinators are assigned within each country to independently oversee the operational aspects of conducting the examinations and to oversee the collection of data. In Dubai, the recently established Knowledge and Human Development Authority (KHDA) served this role. The KHDA decided to administer the TIMSS in early 2007. Actually, interviews with KHDA administrators leading this project reveal that the IEA initially attempted to dissuade Dubai from participating in the 2007 cycle due to the amount of time generally required to prepare countries participating for the first time (Mohammad 2008). Nonetheless, KHDA pressed ahead and was consequently congratulated by the IEA for successfully administering the tests with less than six months of preliminary groundwork. Additionally, KHDA prepared the Dubai entry in the TIMSS 2007 Encyclopedia, a publication produced by the IEA to provide a detailed dissection of curricula for each participating country or entity.

The national coordinators for each country are responsible for selecting a sample of schools to participate in the examinations and translating the examination into the language of instruction. To ensure robust results, the coordinators are required to sample at least 150 schools at each of the grade 4 and grade 8 levels, a sampling level that Dubai was not required to meet as a benchmarking participant (see section on sampling below). As for the language of the examination in Dubai, students in schools teaching the national curriculum (public schools and some private schools) sat for the Arabic version of the test, while the majority of private school students undertook both the mathematics and science tests in English.

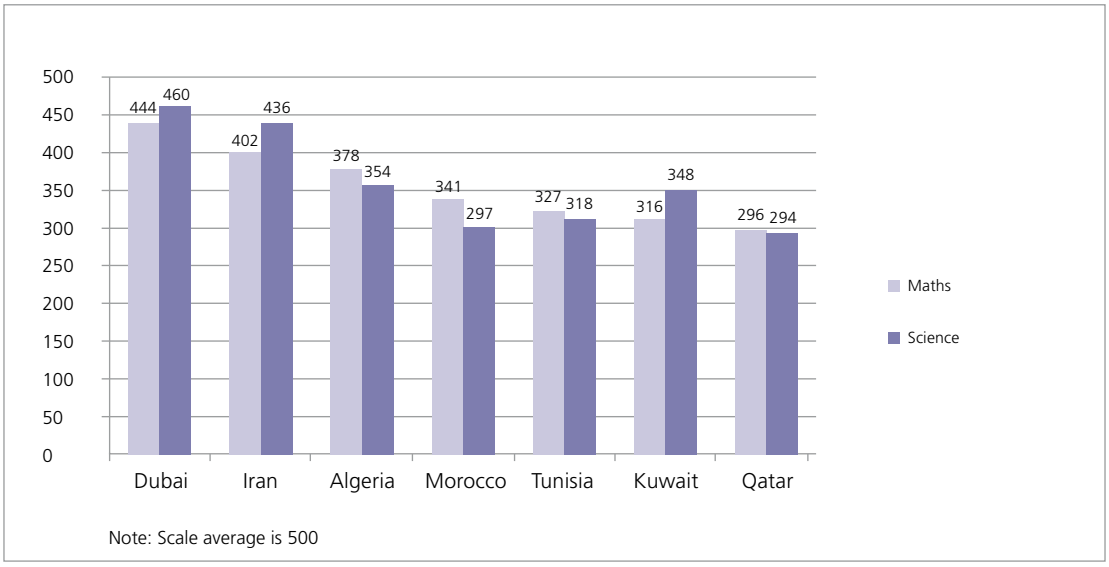
A key to the success of TIMSS as an educational policy tool has been its focus on collecting background information from sampled students, teachers and administrators. The significance of these questions stems from the recognition of learning as a cumulative exercise occurring within a context, never in isolation. The list of contextual factors that influence learning is infinite and includes issues such as the type of school, curriculum, school resources, instructional approaches, teacher characteristics and home support for learning, to name but a few. The background questions posed to students, teachers and administrators during the 2007 TIMSS attempt to address many of these factors. When performed in conjunction with an analysis of such contextual determinants, the assessment of overall student results in TIMSS provides stakeholders with a deeper understanding of the often complex landscape of education and can yield robust policy implications.

A Comparison of Results: Dubai, the Middle East and the World

TIMSS results in both mathematics and science are all comparable to an international scale average of 500, a score calculated by IEA regulators as an average international outcome that is comparable across countries and time.[3] The scale average accounts for the difficulty of questions answered, and controls for the different number and range of countries participating. This scale average has been maintained through each testing cycle of TIMSS so as to ensure the comparability of results over time. The IEA also provides four points by which to assess a country's outcomes: the advanced international benchmark (625), the high international benchmark (550), the intermediate international benchmark (475) and the low international benchmark (400).[4]

In 2007, average scores for Dubai's students at both the grade 4 and grade 8 levels failed to meet the scale average set by the IEA. For those in grade 4, the average mathematics score was 444 and the average science score was 460. These marks find grade 4 students in Dubai surpassing the low international benchmark for both mathematics and science, but 31 points away from achieving the intermediate benchmark for mathematics and 15 points away from achieving the intermediate benchmark for science. Their grade 8 colleagues fare better in regard to the international benchmarks: Dubai's average score for mathematics, at 461, lies only 14 points below the intermediate benchmark, and its average score for science, at 489, outperforms the intermediate benchmark.

Figure 1
Grade 4 average mathematics and science achievement in the Middle East

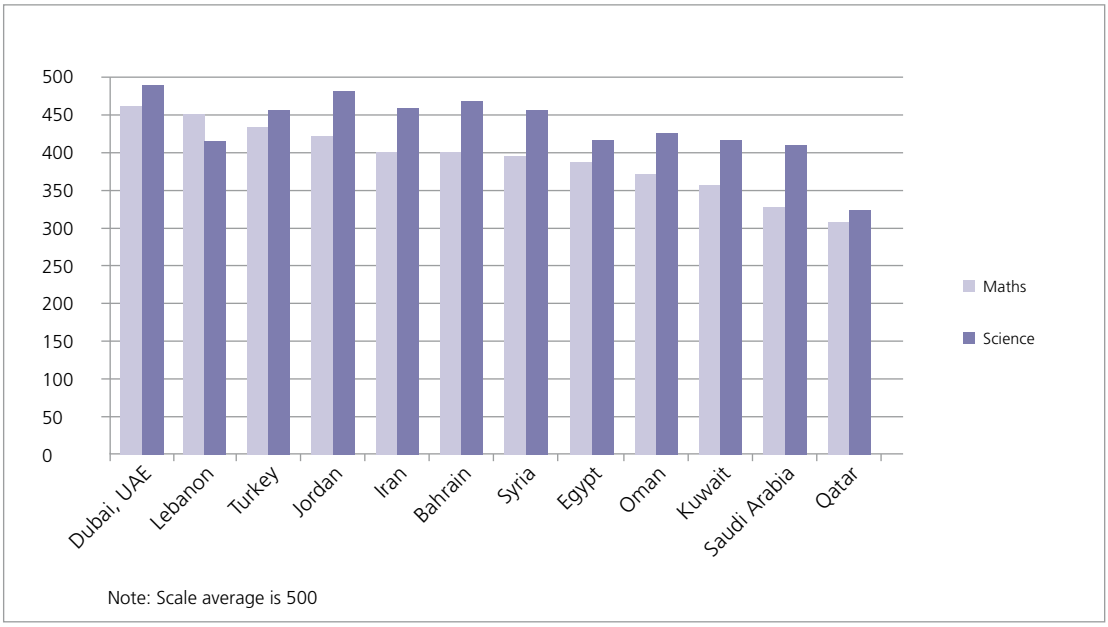


Note: Scale average is 500

[3] In comparing country outcomes, analysts often refer to the mean obtained by computing the average score of all nations undertaking the test in a particular year. In 2007, the international means at the grade 4 level were 469 (mathematics) and 476 (science), while the means at the grade 8 level were 450 (mathematics) and 466 (science). However, these means cannot be used as future comparators since they are volatile numbers that change substantially depending on what countries participate in a given year. Thus, this paper does not take these annual international means into consideration.

[4] For more information on the calculation of the international scale average and four benchmarks, see Mullis, Erberber and Preuschoff 2008.

Figure 2
Grade 8 average mathematics and science achievement in the Middle East



Dubai's results in both mathematics and science hold up well when compared with the rest of the Middle East, as evident in figures 1 and 2. At the grade 4 level, Dubai compares favorably to Iran, which otherwise maintains the highest regional scores in both mathematics (402) and science (436). In a comparison of grade 8 student results, Dubai surpasses Lebanon, which otherwise leads the region in regard to mathematics (449), and Jordan, which otherwise leads the region in regard to science (482). The Emirate performs particularly strongly when compared to neighboring countries in the Gulf Cooperation Council (GCC), exceeding Bahrain, Kuwait, Qatar, Oman and Saudi Arabia by a considerable margin. In fact, at the grade 8 level, Dubai's overall score of 461 in mathematics superseded that of the next highest GCC performer, Bahrain, by 16 percent. Its average score in science is five percent higher than that of Bahrain.

While Dubai compares favorably to the Middle East region, room for improvement exists when compared to the rest of the world, particularly Asia. Hong Kong, Singapore and Chinese Taipei top the TIMSS scores in both mathematics and science. In fact, 2007 marks the fourth consecutive instance of an East Asian country achieving the highest average score in TIMSS. Figures 3 and 4 reveal the strength of East Asian countries in both subject areas and both grades tested. In mathematics for 10-year-olds, Hong Kong achieved the highest average mark of 607, closely followed by Singapore at 599 and Chinese Taipei at 576. At the grade 8 level, students in Chinese Taipei had the highest achievement with an average of 598, followed by South Korea with 597 and Singapore with 593. In science at the grade 4 level, Singapore was the top performing country with an average of 587, followed by Chinese Taipei at 557 and Hong Kong at 554. Singapore also topped the results for grade 8 students, with its average score of 567 surpassing Chinese Taipei's 561 and Japan's 554.

These outcomes are a strong indicator of the success of human capital development programs in countries like Hong Kong, Singapore and Chinese Taipei. They also indicate the necessity of education reform in Dubai in order to meet international standards of education quality and to compete with global leaders in education.

Figure 3
Grade 4 mathematics and science achievement: Dubai and world leaders

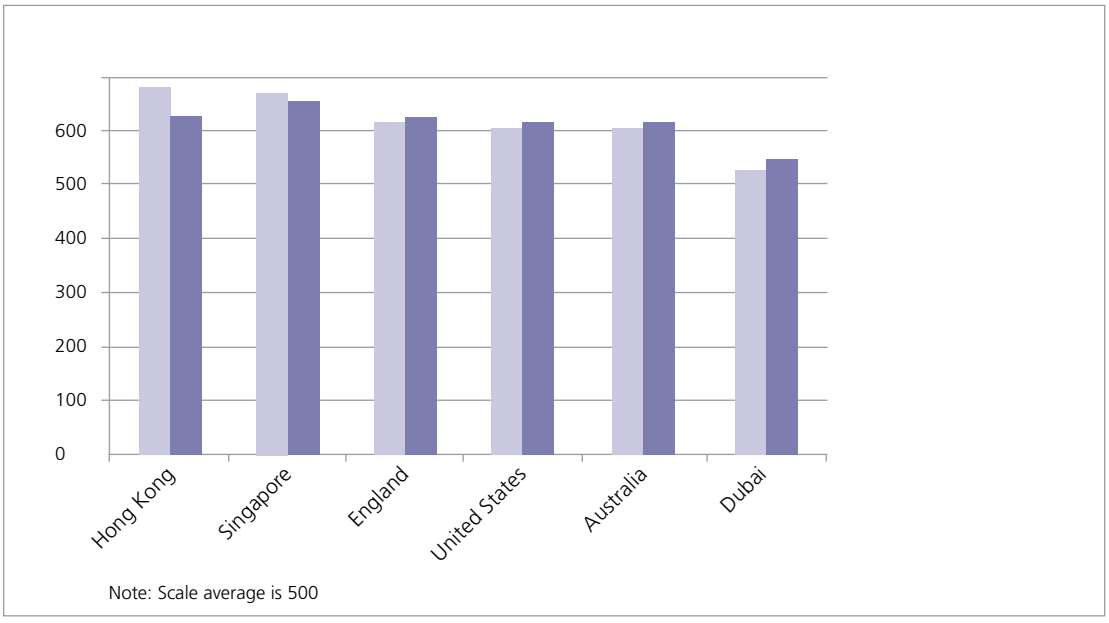
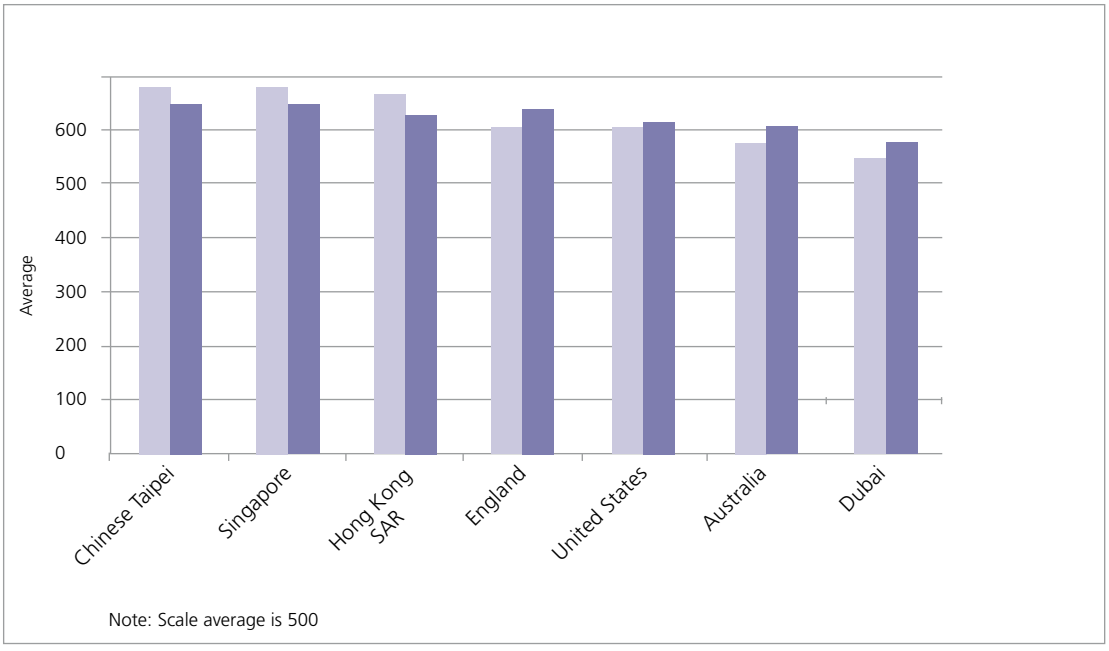


Figure 4
Grade 8 mathematics and science achievement : Dubai and world leaders



Dubai's Outcomes in Mathematics

The TIMSS mathematics questions test for knowledge of mathematical theory and the ability to apply it in problem solving. At the grade 4 level, the questions focus on assessing outcomes in three key content areas within mathematics: number, geometric shapes and measures, and data display. At the grade 8 level, students were assessed in number, algebra, geometry, and data and chance. Questions for both levels can be categorized into three cogitative domains: the assessment of what students know about mathematics, how students are able to apply that knowledge, and the ability of students to reason through problems.

As evidenced in table 2, grade 4 students in Dubai performed best in the area of data display. Their achievement in number and in geometric shapes was similar, at 444 and 440 respectively. However, it is apparent that Dubai's grade 4 students are better trained in data display, as their score on questions relating to graphs and tables was 461. Knowledge and skills in data display were thus nearly four percent higher than in the control of numbers and shapes for grade 4 students.

When considering proficiency in number, Dubai's grade 4 students achieved a score that was significantly higher than the scores achieved by regional countries, including Iran, Kuwait, Qatar and Yemen. Dubai's average score in this area (444) is 38 percent greater than the score achieved by Kuwait and 52 percent greater than that of Qatar.[5] The result is similar in the domains of geometric shapes and data display, with Dubai surpassing regional participants by an average of 44 percent.

Table 2
2007 mathematics scores by content and cognitive domain

Grade 4	Dubai	Singapore	Qatar	Iran
Number	444	611	292	398
Deometric Shapes and Measures	440	570	296	429
Data Display	461	583	326	400
Knowing	441	590	296	405
Applying	457	620	293	410
Reasoning	446	578	...	410

Grade 8	Dubai	Singapore	Qatar	Iran
Number	458	597	334	395
Algebra	475	579	312	408
Geometry	451	578	301	428
Data and Chance	457	574	305	415
Knowing	456	593	305	402
Applying	469	581	307	403
Reasoning	465	579	...	427

Source: TIMSS and PIRLS International Study Center 2008

[5] It should be kept in mind that these countries sampled a greater share of public schools than did Dubai. See section on sampling below.

Like grade 4 students, those in grade 8 in Dubai have a performance differential among subject areas. On average, their achievement in algebra (475) is over five percent higher than their performance in geometry (451) and around four percent higher than their proficiency in data and chance (457) and arithmetic operations (458). Dubai's overall mathematics average in grade 8 was 461. Algebra lifts this average, but it is pulled lower by performance in geometry primarily, followed by probability and arithmetic problem solving.

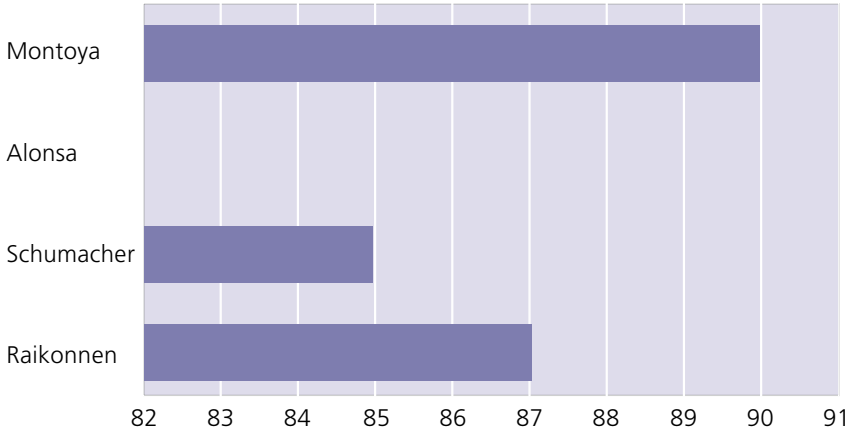
At the grade 8 level, Dubai again tops the list of participating Arab countries in number proficiency, exceeding neighboring GCC states Bahrain, Kuwait, Oman, Qatar and Saudi Arabia by a considerable margin. In regard to algebra, Dubai again surpasses neighboring states; in fact, Dubai enters the top half of all tested countries in regard to algebra results. On the other hand, students' answers to questions pertaining to geometry, data analysis and probability indicate significant gaps in these areas. Scores in each of those areas are around 50 marks less than international averages.

Students at both levels in Dubai showed higher achievement in applying mathematics than in mathematical knowledge. Mathematical knowledge relates to comprehension of mathematics facts while applying mathematics relates to direct problem solving. At the same time, a worrisome pattern emerges when analyzing individual responses: the majority of questions requiring logical deduction from acquired knowledge were answered incorrectly by Dubai students.

This implies that students were largely unable to transform learned information into further thinking and application. This outcome is consistent with education systems that have little reliance on knowledge building, and instead focus intensively on rote memorization and repetition of exercises. At the same time, the ability to cognitively analyze mathematical theories is a transferable tool vital to future learning. Effective education is that which stimulates higher order thinking, enabling students to apply acquired knowledge in real life situations for the remainder of their lives.

Box 1: A typical mathematics question answered incorrectly at the grade 4 level in Dubai

This graph shows the points obtained by four drivers in a car racing championship. Montoya is in first place. Alonso is in third place. Draw a bar which shows how many points Alonso has scored.



Source: TIMSS 2007 Mathematics Test Sample Questions

International benchmarks and student performance in mathematics

While Dubai's average performance is fairly high when compared to the region, a small share of the student population is performing at or above the advanced international benchmark. In fact, only two percent of Dubai's grade 4 students managed to achieve the advanced international benchmark of 625. This compares to 41 percent of Singaporean students, 10 percent of students in the United States and an international average of five percent. A slightly brighter picture emerges from grade 8, where three percent of Dubai's students surpassed the advanced international benchmark. However, the share meeting this advanced international benchmark compares to 40 percent of Singaporean students, six percent of American ones and a global mean of two percent.

In addition to the low level of advanced achievement in comparison to benchmarks, a cause of immediate concern for policy makers should be the number of students unable to reach low benchmarks. As many as 31 percent of grade 4 students were unable to meet the low benchmark in mathematics. At the same time, only 10 percent of their global counterparts failed to achieve the same benchmark, which showcases the size of the gap that Dubai must overcome. In grade 8, this remains a problem, but it is not as stark – 21 percent of students fell below the low benchmark. This is similar to international averages; however, this is not a sufficient comparator considering that in South Korea less than two percent of students achieved a mark less than the low benchmark.

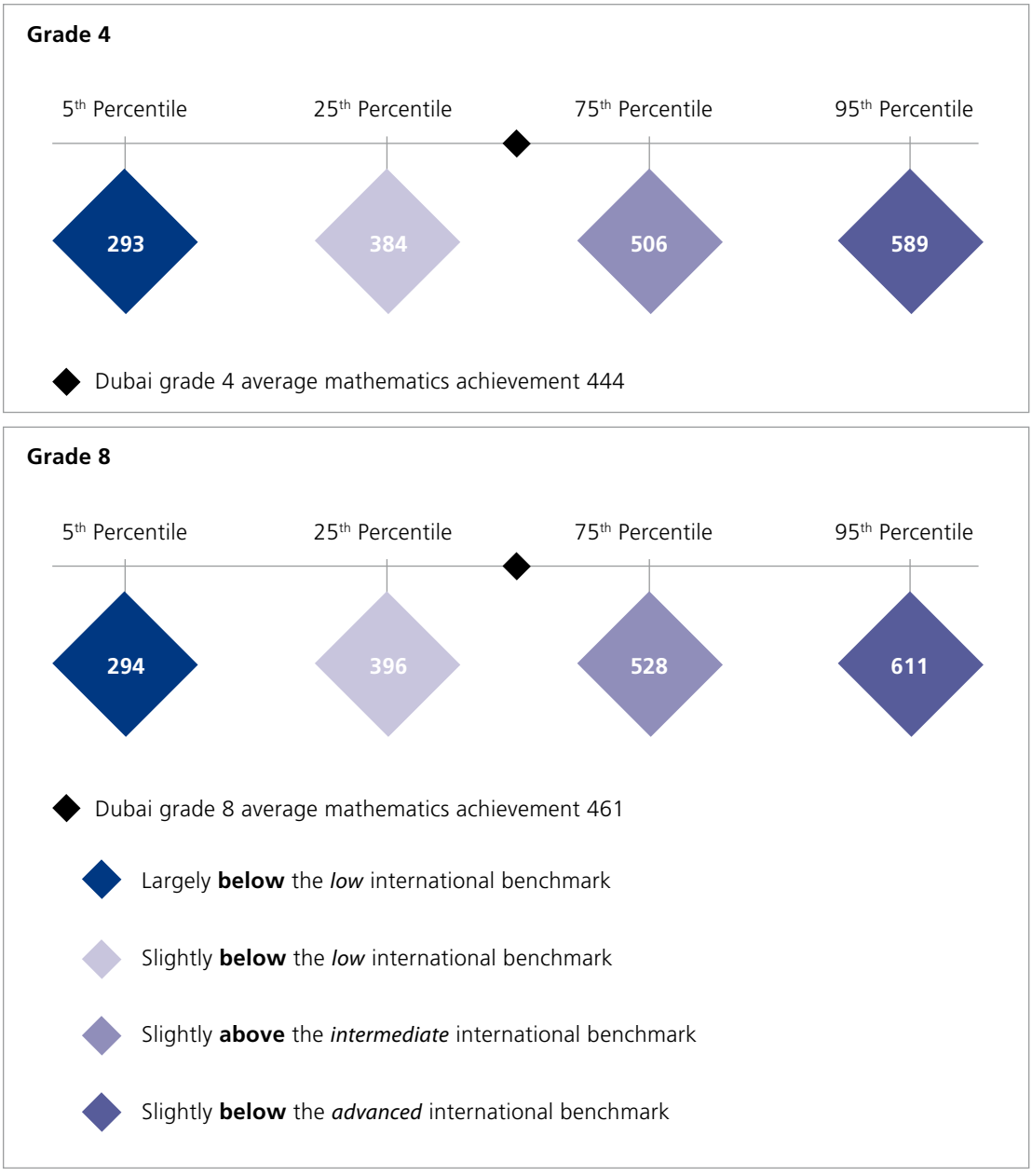
A clear aim of education reform should be to increase the percentage of students that achieve higher international benchmarks in mathematics. However, education reform does not only include increasing the number of high performers. It is imperative to focus on those that cannot meet the lowest benchmarks as they are the ones who are most left behind. For 31 percent of Dubai's grade 4 students and 21 percent of grade 8 students to achieve lower scores than the low international benchmark of 400 is a worrying sign. This invites policy makers to closely analyze results within Dubai and to construct comparisons by region and sector so as to identify gaps in educational quality.

Distribution of scores within Dubai

TIMSS scores can be broken down to show the range of outcomes for students within an individual country or entity. The range reveals scores by percentiles which show the percentage of observations below each score. Here, the scores distribution in Dubai at grades 4 and 8 show a wide range of scores at the individual student level, from just below 300 to nearly 600, indicating a range of abilities within the Emirate (figure 5). At the grade 4 level, top-performing students (95th percentile) in Dubai earned an average score of 589. On the other hand, the 5th percentile – representing the lowest five percent of average scores attained across Dubai – shows dramatically low numbers. The lowest in grade 4 score an average of 293. In grade 8, the 95th percentile achieved an average of 611, while the lowest performers (5th percentile) earned an average score of only 294. By international comparison, students that scored at or below 300 find themselves behind all tested nations except Yemen.

The 25th percentile in Dubai in grade 4 mathematics was 385, and 396 at grade 8. The distribution in figure 5 again shows that over a quarter of students could not meet the low benchmark of 400. The 75th percentile shows that three-quarters of students in Dubai at the grade 4 level achieved less than 506 in grade 4 and 528, in grade 8. It must be noted that less than 20 percent of Singaporean students achieved below these marks at grade 4. At the grade 8 level, around 30 percent of students in Singapore achieved below 528, which is notably less than the figure for Dubai.

Figure 5
Mathematics scores distribution in Dubai



Note : The value for the *n*th percentile is the score below which *n* percent of observation lie.

The mathematics distribution in Dubai therefore shows a wide range of achievement throughout the Emirate. A distribution this large, that encompasses scores which span from 290 to 600, reflects the variation in performance among Dubai schools. Policy makers can use the distribution, detailed on a school-by-school basis, to identify low performing schools that need immediate assistance. This information can assist in locating high percentile schools that can be partnered with schools in lower percentiles to cooperate with and benefit from modeling teaching and learning strategies.

Box 2: Mathematics report card for Dubai

What students know in Dubai, on average:

Grade 4

- Basic mathematical knowledge
- Familiarity with triangles and informal coordinate systems
- Reading from simple bar graphs and tables
- Understanding of adding and subtracting with whole numbers

Grade 8

- Basic knowledge of numbers and operations
- Little familiarity with decimals
- Understanding of basic geometrical concepts
- Constructing basic graphs

What students do not know in Dubai, on average:

Grade 4

- Extending numeric and geometric patterns
- Solving word problems involving multiple steps and operations with numbers
- Applying appropriate knowledge of a range of two- and three-dimensional shapes
- Understanding fractions and decimal operations
- Interpreting and using data in tables and graphs to solve problems

Grade 8

- Recognizing basic notions of likelihood
- Relating and computing fractions, decimals and percents
- Operating with negative integers
- Solving word problems involving probability
- Modeling situations in mathematical notation

Source: TIMSS and PIRLS International Study Center 2008

Dubai's Outcomes in Science

Like the mathematics examination, the science examination was designed to gauge a range of student abilities. The science component for those students in grade 4 covers material in three content areas: life science, physical science and earth science. For grade 8, it covers material related to biology, chemistry, physics and earth science. As in mathematics, both grades are assessed in the three cognitive areas of knowing, applying and reasoning.

The science component of TIMSS tells a relatively similar story of the education system in Dubai, but with some key differences. Students performed relatively better on questions about topics under earth science such as environmental phenomena and the

solar system. The section's average across Dubai was 471, compared to 467 in physical science questions which explore the interaction of physical forces. Earth science knowledge appears more advanced than life science in Dubai, as students on average attained marks nearly three percent higher in the former. Importantly, administrators of the TIMSS in Dubai did not gather data on the time allocated for each of these science areas in the various curricula. A glance at the time and resources dedicated to the different fields would assist policy makers in understanding whether disproportionate structuring of the curricula is inducing different results.

At grade 4, students in Dubai were, on average, able to answer only 51 percent of questions pertaining to science knowledge, interpreted as factual information such as planet names and animal body parts. This is not a high figure by international comparison. In the United States, for example, 65 percent of students correctly answered fact-based questions. Furthermore, in Dubai, only 41 percent of 10-year-old students were able to answer practical science questions. This suggests that their method of instruction is disconnected from applicable reality.

Grade 8 students in Dubai achieved their highest science marks in chemistry, in which the average score was eight full marks above their lowest science mark, which came in biology. Less than half a percentage point separated the average marks in physics and earth science from chemistry. Grade 8 students met international averages in their attainment over the three cognitive domains of knowing, applying and reasoning. However, they remained behind world leaders in these areas. Only 35 percent of students correctly answered questions that required some reasoning. This compares to 45 percent of American students and 55 percent of Singaporean students.

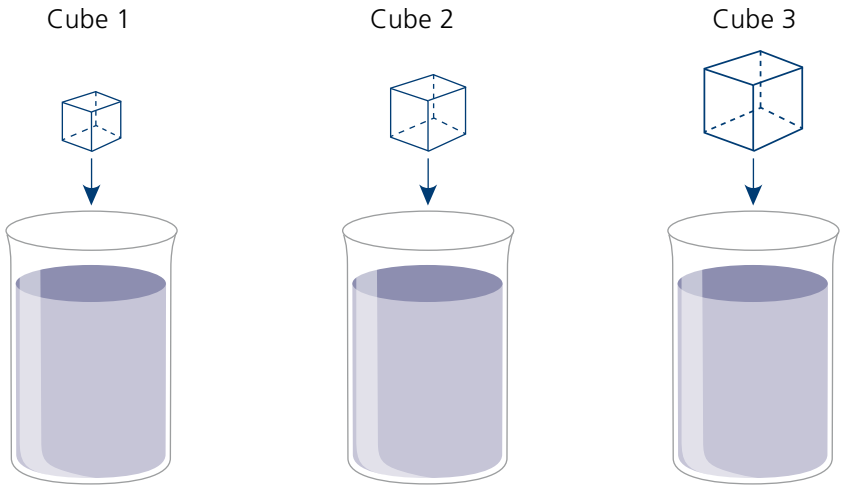
Table 3
2007 science scores by content and cognitive domain

Grade 4	**Dubai**	**Singapore**	**Qatar**	**Iran**
Life science	457	582	291	442
Physical science	467	585	303	454
Earth science	471	554	305	433
Knowing	463	579	283	451
Applying	463	587	304	437
Reasoning	462	568	293	436
Grade 8	**Dubai**	**Singapore**	**Qatar**	**Iran**
Biology	485	564	318	449
Chemistry	493	560	322	463
Physics	489	575	347	470
Earth science	490	541	312	476
Knowing	489	567	322	454
Applying	495	554	325	468
Reasoning	483	564	...	462

Source: TIMSS and PIRLS International Study Center 2008

Box 3: Typical science questions answered incorrectly by students in Dubai

Grade 4



What happens to the ice cubes when they are placed in the water?

a. Cubes 1, 2, and 3 will sink
b. Cubes 1, 2, and 3 will float
c. Cube 1 will float, and cubes 2 and 3 will sink
d. Cubes 1 and 2 will float, and cube 3 will sink

Grade 8

There is a giant turtle that lives on an island. He is the only turtle left of a special type of giant turtle. Can he reproduce so that this type of turtle does not die out? Give a reason for your answer.

Source: TIMSS and PIRLS International Study Center 2008

International benchmarks and student performance in science

In science, Singapore had the highest percentage of students reaching the advanced benchmark as specified by the testing body: 36 percent of fourth graders and 32 percent of eighth graders exceeded this mark. The worldwide median percentage of students reaching this benchmark of 625 was seven percent in grade 4 and three percent in grade 8. In comparison, four percent of grade 4 students in Dubai achieved the advanced benchmark, while six percent of grade 8 students had marks over 625. This is twice the median percentage worldwide, and is again proof of the existence of some good practice at this year level at some, but not all, schools in Dubai.

Alarmingly, 28 percent of grade 4 students tested in Dubai failed to meet the science low benchmark of 400. Compared to the international median of seven percent of students, the size of the problem in some

schools in Dubai becomes apparent. It is anticipated that students in this category are from the disadvantaged public sector schools since the mean mark in science for public schools was 64 marks less on average than that of private schools. The utmost priority for policy makers should be to address this figure and target its immediate reduction.

In grade 8 this was less of an issue for Dubai, with only 18 percent of all students unable to meet the low benchmark. This is slightly above the international median of 12 percent, but it remains well above Singapore's seven percent, Chinese Taipei's five percent and Japan's four percent. It must also be noted that the numbers from Qatar call for immediate intervention by education authorities to save the nation's schools, as 71 percent of grade 8 students and 77 percent of students in grade 4 could not attain the science low benchmark. While Qatar has undergone major transformations in its higher education sector by assisting numerous world-renowned universities set up branch campuses, school reform should be prioritized. Similarly low marks were also noted in Morocco, Yemen, Kuwait and Tunisia.

It is thus apparent in both mathematics and science education that students in Dubai do not meet international averages in achieving advanced benchmarks. Moreover, policy makers must consider that Dubai has a dangerously large number of students that achieve scores below the low international benchmark. Any goal setting for educational reform must aim to reduce the number of students below the low benchmark in the immediate future, aiming to meet and surpass higher benchmarks in the years to come.

Disparity among nations and within Dubai

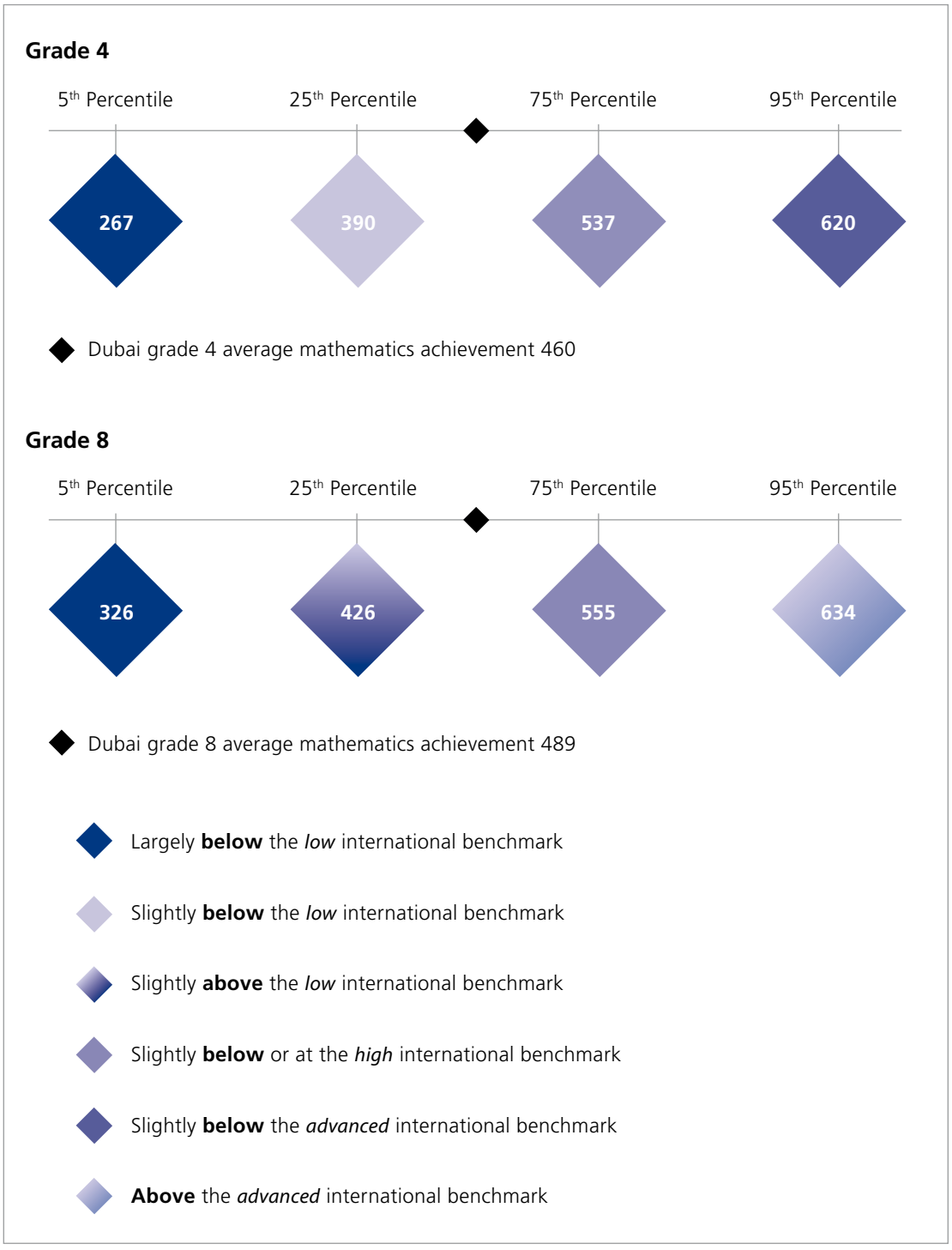
The distribution of science achievement in Dubai was among the widest in the world, with scores ranging from 260 to over 600 at both year levels. In grade 4, there is a 132 percent difference between the lowest and highest scores in the Emirate. For 14-year-olds, the difference is still severe, at 96 percent between the lowest and highest achieving schools. The 5th percentile score was 267, while the 25th percentile was 390. The 75th percentile of 537 shows that three-quarters of Dubai's students sample below this mark, while the 95th percentile of 620 reveals that only five percent of students in Dubai scored above this threshold.

Consider Singapore, for example, as a global comparator in grade 4 science. The distribution shows that Singapore's average score of 586 is higher than nearly 88 percent of all schools in Dubai. In grade 8, Singapore's world-topping average of 567 falls slightly above Dubai's 75th percentile; i.e., the East Asian country's average score is greater than that of over three-quarters of Dubai's schools.

On average, students in grade 4 around Dubai surpassed all other Arab countries and Iran. The 14-year-old students in Dubai were also the highest science achievers, on average, in the Arab world; however, they were only separated from Jordanian students by six points, indicating the success of recent policy modification in Jordan. Overall, 21 countries (and all benchmarking entities except Dubai) had higher average achievement than the scale average in grade 4. At the grade 8 level, the Emirate was close to meeting the international scale average, but was surpassed by 14 countries and five benchmarking entities.

The distribution of science scores, like those of mathematics, shows that some schools achieve internationally competitive marks while others are in need of urgent support. It is imperative for decision makers to construct a distribution with details of schools at each percentile. This should include both subject areas in order to encourage cooperation between schools and to raise the overall standard of education throughout Dubai.

Figure 6
Science scores distribution in Dubai



Note : The value for the *n*th percentile is the score below which *n* percent of observation lie.

Box 4: Science report card for Dubai

What students in Dubai know, on average:

Grade 4

- Elementary knowledge of life sciences and physical sciences
- Early understanding of the solar system and Earth's resources
- Recognition of some factual properties of matter
- Providing short written responses to questions requiring factual information (e.g., human health behaviour or characteristics of animals

Grade 8

- Recognition and communication of basic science knowledge across a range of topics
- Extracting information from tables and interpreting pictorial diagrams
- Understanding animals, food webs, and ecosystems
- Elementary comprehension of chemical change

What students in Dubai do not know, on average:

Grade 4

- Applying knowledge and understanding to explain everyday phenomena
- Understanding plant and animal structure
- Developing the ability to interpret investigation results
- Acquiring a practical knowledge of electricity
- Showing knowledge of the solar system, Earth's structure and resources

Grade 8

- Recognizing biological concepts such as cell processes, human biology and health
- Applying knowledge to situations related to light, sound, heat and forces
- Undertaking work requiring and involving scientific inquiry skills
- Combining information to form conclusions and provide extensive explanations portraying scientific knowledge
- Utilizing physical and chemical principles to solve quantitative problems

Sampling Issues in Dubai: The Balance of Public and Private Schools

Throughout Dubai, a total of 184 public and private schools, including 6,259 students, were tested in 2007.[6] The sample included 3,064 students at the grade 4 level from 97 schools and 3,195 students at the grade 8 level from 88 schools. The KHDA sampled a far greater proportion of private schools than public schools. This can be partly explained by the fact that the educational portrait of Dubai greatly differs from other entities, as private schools dominate the field (TIMSS and PIRLS International Study Center 2008).

Unlike the majority of countries in the world, the population of the UAE is characterized by an expatriate population that greatly outnumbers nationals. Recent estimates have found that the number of Emirati citizens does not exceed 900,000 people, while the total population is around 6.3 million (Federal National Council 2008). Public schooling is available to UAE nationals only, with a minimal uptake of children of expatriate government employees that is set by a quota. Private schools thus make up a majority of schools due to the absence of alternatives for expatriate families. In addition, international private schools vary in costs, but the majority of schools remain relatively expensive, with a fee structure that limits their student body to comparatively wealthy students.[7]

However, it is unclear why Dubai did not sample all of its schools like neighboring GCC countries. Bahrain, Kuwait and Qatar – all home to large expatriate communities and, consequently, a proportionally high number of private schools – sampled the entire school population since their total number of schools fell under the mandated 150 schools at each level. In contrast, Dubai excluded a large number of schools from its sample. Under TIMSS, nations are permitted to exclude schools in rural areas or those at a financial disadvantage; however, Dubai maintained the highest exclusion rate of any included entity in 2007. The exclusion of rural and disadvantaged schools, and the inclusion of a large number of private schools, suggests that a positive bias may exist in the overall achievement levels of Dubai. Results should be read with this in mind.

Table 4 shows the sample of schools in Dubai that sat for the 2007 TIMSS test. The total number of schools is after school exclusions were made. In the sample, private schools made up 74 percent of tested grade 4 schools and 68 percent of grade 8 schools. This somewhat compares to the actual breakdown of Dubai's private and public schools, wherein public schools account for nearly 20 percent of all schools. The testing authority, however, excluded all schools who taught in neither English nor Arabic (18 schools). This represents nearly 15 percent of the total population of private schools in Dubai that were excluded, which may have skewed results in a direction that cannot be postulated due to the diversity of these schools.

Table 4
Schools sampled in Dubai, TIMSS 2007

	Number of schools	Number of students
Year 4		
Public	25	618
Private	71	2446
Year 8		
Public	28	1105
Private	60	2090

Source: Knowledge and Human Development Authority 2008

[6] The IEA requires countries to sample a minimum of 150 schools from each year level to meet the TIMSS sampling standards. As a benchmarking participant, Dubai did not have to meet this condition.
[7] Expatriate workers can only bring dependents to the UAE if their monthly salaries exceed 4,000 AED ($1096). The Federal National Council is likely to adopt a suggested increase in this minimum to 10,000 AED ($2739) a month if the worker's employer does not provide accommodation and 8,000 AED ($548) if the employer does (Federal National Council 2008).

Public and Private Schooling in Dubai

Table 5 shows a breakdown of Dubai's results by private and public schools. In grade 4, public schools lag behind private schools by around 14 percent in mathematics and 15 percent in science. The disparity between public and private is even greater with grade 8 students, with public schools achieving average scores around 27 percent lower than private schools in mathematics, and 18 percent lower in science. These results give a greater indication of the performance of both private and public schools, and the impact of private schools on Dubai's overall score due to their disproportionately large presence in the sample. The stark difference in mathematics and science achievement between public and private schools in Dubai emphasizes the serious challenges facing public education in the Emirate.

Table 5
Dubai mathematics and science achievement by school type

School Type	Share of Students	Mathematics Mean	Science Mean
Year 4			
Private	84%	452	471
Public	16%	398	404
Year 8			
Private	78%	783	506
Public	22%	378	427

Source: Knowledge and Human Development Authority 2008

Table 6
Dubai TIMSS 2007 achievement by curriculum

Type of curriculum	% of students	Mathematics Mean	Science Mean
Year 4			
Public schools			
National Curriculum	16	398	404
Private schools			
National Curriculum	7	374	367
CBSE (Indian)	27	422	458
US	9	461	465
UK	41	480	469
National average		**444**	**460**
Year 8			
Public schools			
National Curriculum	22	378	427
Private schools			
National Curriculum	8	424	453
CBSE (Indian)	26	474	507
US	9	471	488
UK	35	505	522
National average		**461**	**489**

Results by Instructed Curriculum

As a result of Dubai's diverse expatriate population, 13 different curricula are on offer in private schools around the Emirate. These are predominated by the British curriculum, American curriculum and the Indian Central Board of Secondary Education (CBSE) curriculum. Unable to include assessments of all of these curricula within the test, KHDA only sampled schools teaching the national curriculum (public and private), the British curricula, the American curricula, and the Indian curriculum. A significant performance differential exists among these curricula, as evidenced in table 6. Schools providing the British curriculum achieved the best results in both mathematics and science in Dubai's 2007 TIMSS assessment. At the grade 4 level, this is followed by the American curriculum, while at the grade 8 level the Indian curriculum comes in second. All three of these curricula outperform the national curriculum by a wide margin.

In regard to the teaching of the national curriculum, it is important to note that public schools appear to be delivering the national curriculum better than their private counterparts in grade 4. On the other hand, in grade 8, private schools delivering the national curriculum achieved a higher result than public providers of the same curriculum. This differential suggests that curriculum designers and subject heads of the national curriculum from both private and public schools could benefit from collaborating on delivery methods. At the intermediate and secondary levels of education, in particular, public schools should look to the private sector to explore ways in which the curriculum is being delivered in order to identify whether alternative books or teaching methods are resulting in higher achievement. Furthermore, there could be a difference in students' attitude in public schools that can impact their approach to learning (see section on students' attitude toward learning below).

Overall, it is important to note that the national curriculum, whether taught in public or private schools, is achieving lower results than other dominant curricula taught in schools in Dubai. TIMSS has revealed that students of the national curriculum fall short of achieving desired benchmarks. It is imperative for stakeholders to recognize that TIMSS results exhibit a 13 percent deficit between the national curriculum in public schools and the national average in grade 4. This figure is as high as 22 percent for private schools delivering the national curriculum. Grade 8 students appear to receive similarly low benefit out of the national curriculum, as private schools using the system fall eight percent below the Dubai average. The situation is exacerbated for public schools, where students studying the national curriculum underperform by 18 percent compared to the national average, 19 percent in comparison to the US curriculum and a full 27 percent compared to the British curriculum.

The poor performance of national curriculum schools in TIMSS is due perhaps to the heavy reliance that these schools continue to place on rote memorization and teacher-centered learning. This suggests that national curriculum schools in Dubai must evolve towards student-centric learning, as other educational systems in the world have done. Curriculum is often thought of as a panacea for education reform, but this paper strongly refutes the argument, advocating instead that contextual factors work hand-in-hand with syllabus in determining academic achievement. However, that is not to say that curriculum reform is not essential in Dubai, where it is evident that the national curriculum, delivered in varying contexts, is insufficiently equipping students with essential knowledge and aptitude.

Gender Differences in Mathematics and Science

While policy concerns regarding gender outcomes in mathematics and science education in the West have long centered on a perceived bias towards boys, recent outcomes in Arab countries suggest the opposite. Girls have begun outperforming boys in these areas by a significant margin, particularly in regard to mathematics achievement. In TIMSS, the average achievement of boys and girls in grades 4 and 8 in Arab countries (including Kuwait, Oman, Palestine, Qatar, Tunisia, and Yemen) generally shows a heavy skewing in favor of girls. Syria and Tunisia are the only countries in the region that showed contrary results; boys in these two countries outperformed girls in both mathematics and science at grade 8.

However, scores for boys and girls in Dubai show no significant difference at either grade in terms of mathematics achievement. Grade 4 boys in Dubai achieved an average mathematics score of 438, which nearly matched the girls' score of 452. At grade 8, girls attained an average mathematics score of 461, identical to the boys' average score. In science, the overall average achievement for girls is only slightly higher than that of boys internationally. Dubai's grade 4 girls do perform significantly higher than boys in science, with an absolute difference of 26 points between their two average scores. However, at the grade 8 level there was a much smaller difference, which was found to be statistically insignificant.

On the surface, results from Dubai suggest that educational outcomes here better fit the trends found in Western countries, wherein boys slightly outperform and are more confident than girls in regard to mathematics and science. The pro-male gender bias in Western mathematics and science learning has been the focus of much research, which finds that cultural attitudes play a role in engaging and supporting boys to learn mathematics more than girls (Scherer 2002). Research has also found that there exists some differentiated treatment of boys and girls by teachers in co-educational schools (Bailey 1992).

It is important to note here that the large presence of private schools and students of Western origin may be skewing Dubai's results. First-hand evidence in public schools, coupled with recent research into gender achievement in public schools in the UAE, suggests that the relatively gender neutral outcomes in Dubai do not hold for public schools (Ridge 2008). Instead, Emirati girls seem to be performing better in mathematics and science at primary and secondary levels of education (Badowah 2008). The overall results for Dubai might be due to a pro-female bias in public schools coupled with a pro-male bias in private schools. Only a detailed breakdown of these results on a school-by-school basis will lead to a better understanding of boys' and girls' learning in Dubai.

According to Ridge (2008), girls in schools in the Northern Emirates displayed keen motivation and a positive attitude towards learning mathematics.[8] This is a result which confirms literature on engagement issues facing boys in education – while some may interpret the disengagement to stem from low achievement, the prism should also be looked at from the other end (Vygotsky 1986); low achievement on TIMSS may very well stem from their actual increasing disengagement. The subsequent section discusses student attitudes towards learning finding Dubai students overall value their mathematics and science education less than some neighboring counterparts. This data, broken down by gender, has not been made available and policy makers can benefit from constructing this categorization to find trends in engagement by gender and overall achievement.

[8] The Northen Emirates include Ajman, Fujairah, Ras Al Khaimah, Sharjah and Umm Al Quwain.

A Contextual Understanding of the Findings

With education such a key component of a nation's policy agenda, due to its expansive effect on children, parents, job seekers, employers and policy makers, it is important to recognize that various determinants impact on educational outcome. As underscored above, learning does not happen in isolation and is influenced by a wide range of contextual factors. To a degree, the contextual factors influencing learning can be measured through an assessment of the background questions posed to students, teachers and administrators during the TIMSS examination. The following sections attempt to shed light on key determinants of the overall TIMSS marks for Dubai.

Student Attributes Affecting Outcomes

Student attitudes toward learning

Research into pedagogy has shown that effective student engagement in education will translate into efficient learning and improved results (Scherer 2002, Marzano 2007). It is thus important to ensure that students are interested in their classes, understand the importance of the subject to their lives, and claim ownership of their own learning. An inclusive curriculum that gains students' trust and affect will shift the onus of learning onto the student, thereby increasing the incentive for him or her to actively pursuing learning.

In this regard, it is important to note that the index of students' affect towards mathematics found that younger students in Dubai have a closer bond to the subject of mathematics than do their older colleagues.[9] Among grade 4 students, 81 percent gave a highly positive response to statements related to their affection for mathematics. That this figure drops to 54 percent at the grade 8 level shows a gap in the way mathematics is taught at the primary and secondary levels. More primary school students in Dubai appear to be enjoying the study of mathematics than secondary students. Nearly a quarter of all grade 8 students indicated that they dislike mathematics or find it boring.

At the same time, the problem that students in Dubai face in regard to the study of mathematics does not seem to stem from not appreciating its importance. At the grade 8 level, 83 percent of all students in Dubai agree or strongly agree to the following statements:

- "I think learning mathematics will help me in my daily life."
- "I need mathematics to learn other school subjects."
- "I need to do well in mathematics to get into the university of my choice."
- "I need to do well in mathematics to get the job I want."

Dubai students' affect for science was found to be significantly higher than the international average, with 84 percent of those in grade 4 responding positively to statements related to their affection for science compared to 77 percent globally. Grade 8 students around the world displayed less affinity for the subject than their grade 4 colleagues, but older students in Dubai again exceeded the international average. It must be noted that while grade 8 Dubai students also exceed the international average in valuing science as a learning matter, they fall behind the majority of Arab countries in this category. Thus, grade 8 students in Dubai hold learning mathematics and science in lower regard than their regional counterparts. This may stem from a lack of real-life learning which fails to link subject matter to one's daily life, or could be the result of career guidance programs that insufficiently clarify the link between education and adult life.

[9] The index of students' affect collates the students' attachments to the following statements: "I enjoy learning mathematics," "Mathematics is boring," and "I like mathematics."

Overall, given the recognized importance of mathematics as an interdisciplinary subject from which quantitative and qualitative deduction skills are developed, students' low affect in regard to mathematics is of particular concern. It extends the aforementioned argument that memorization of mathematics and science education is taking precedence in place of conceptual development of theory and genuine real world application. The former often causes disaffiliation among students, as it cannot often be related to the world around them while the latter can indeed be a magnet for engagement.

Confidence in learning

Following the international trend, students at grade 8 in Dubai showed less confidence in their mathematical abilities than students in grade 4. Nearly 68 percent of grade 4 students maintained a high confidence in learning mathematics, a score that places them in the top quarter of their international counterparts. At the grade 8 level, there is a decline in confidence, as only 51 percent of students in Dubai feel confident in their mathematics learning. Students at this level in other regional countries, including Bahrain, Egypt, Jordan, Kuwait and Qatar, display higher feelings of confidence in mathematics. The varying degree of confidence invites further consideration of the mathematics curriculum and its delivery at the secondary level.

Broken along gender lines, results show that 10-year-old boys in Dubai show higher confidence in mathematics learning than boys in other regional countries. Nearly 70 percent of grade 4 boys are highly confident in their mathematics learning, compared to 51 percent in Kuwait, 60 percent in Qatar, and 34 percent in Yemen. The result is similar for 10-year-old girls in Dubai, where 65 percent expressed high confidence in mathematics learning ability. This compares to 60 percent in Kuwait, 63 percent in Qatar and 36 percent in Yemen.

Among 14-year-old girls, high confidence in mathematics learning ability was registered by 47 percent in Dubai. This is significantly lower than for girls in Bahrain (58 percent), Egypt (52 percent), Jordan (56 percent), Kuwait (55 percent), Qatar (57 percent), and Saudi Arabia (50 percent). In comparison, 54 percent of 14-year-old boy students in Dubai registered high confidence in learning mathematics. This is less than the confidence of students in Egypt (57 percent) and Jordan (59 percent), but higher than that of students in Bahrain (47 percent) and Saudi Arabia (44 percent).

One cannot overlook the fact that girls in schools around Dubai lose confidence in their mathematics ability at a much higher rate than those in comparator countries. As with the discussion of gender differentials in performance in the TIMSS examination, this is due to a number of potential reasons. These may include differentiated teacher treatment of boys and girls at the grade 8 level in Dubai, or varying cultural attitudes which can encourage and support males to learn mathematics more than their female colleagues. Whether this occurs at public or private schools cannot be ascertained. Historically, Western education systems – which form the majority of private curricula in Dubai – have suffered from a gender bias in mathematics and science education. This is manifested by higher levels of attention granted to boys in class and more negative attention received by girls (Bailey 1992). Is this occurring in Dubai? At the same time, recall that public schools are single-sex schools, which challenges the likelihood of the above occurring in government schools. Therefore, it is likely that girls in coeducational private schools in Dubai receive less attention, leading to a lower level of self-confidence.

Absenteeism

Absenteeism in Dubai is not seen to be a problem from the statistical perspective, but it is important to recall that the results are heavily skewed in favour of private schools. Anecdotal evidence suggests a high rate of absenteeism in Dubai's public schools, especially for boys. This cannot be dispelled or confirmed with TIMSS data; however, it seems to be a serious issue related to student performance and learning that should be addressed more effectively.

Students' sense of security

While teachers in Dubai report the highest satisfaction with personal security among teachers of all participating entities, student personal security seems to be a concern. When asked about their views on their personal safety while at school, students in Dubai only just meet the international average. This suggests that there is possibly an underlying phenomenon of bullying in the classrooms and playgrounds of Dubai's schools. This is a serious matter which should be targeted at the national level in addition to in-school campaigns and policies.

Teacher Characteristics, Qualifications and Training

Teachers in Dubai reported the highest index of adequate working conditions around the world, and 57 percent of them on average reported having had sufficient resources at their schools. This is an encouraging figure, but it must be read in conjunction with the fact that the opinions of public school teachers (and those teaching in lower-quality private schools) would have been overshadowed by private school responses. Furthermore, it may be impossible to ascertain the conditions under which teachers answered this (and other) survey questions whereby they may have been pressured directly or indirectly to overestimate this figure.

It is important to note that 11 percent of grade 4 teachers felt their resources were at the lower end of the scale, a situation that should be immediately addressed to help schools overcome any structural obstacles to education provision. A breakdown by school of the answers to this question is not available; however, it is presumed that the teachers reporting a shortage of resources are mainly from the public sector school system. Such a breakdown would help policy makers better understand the resource shortfall.

While resources are not a constraint for most schools, teacher qualifications do pose a significant obstacle to educational quality in Dubai. This is evidenced partially in data on the age and experience of Dubai's teachers.

According to the TIMSS teacher surveys, primary school teachers in Dubai are among the youngest in the world, and their experience is limited. For example, the average number of years of experience for science teachers in grade 4 was only nine years in 2007 compared to the international average of 17. Grade 4 mathematics teachers in Dubai have four years less experience than their international counterparts. Grade 8 mathematics and science teachers are heavily concentrated in the 30- to 39-year-old age bracket (50 percent) while worldwide there is an even spread of teachers from under 29 to over 50 years old. Grade 8 science teachers have one year of experience less (14) than the international average, while their mathematics colleagues just meet the international average of 15 years of experience on average.

In Dubai, neither the schools nor the teachers themselves appear confident in teachers' abilities. Institutional trust in teachers' abilities, along with teachers' own confidence, appears low. This is reflected in the dependence on textbooks as the primary resource for science learning. According to the teacher survey, 60 percent of grade 4 teachers and 64 percent of grade 8 teachers use textbooks as the primary resource for science learning. Textbook-based education inhibits advanced learning and boxes teaching into the confines of the pages between students' hands. Furthermore, a complete reliance on textbooks acts as a disincentive for teachers to enhance their pedagogy and develop novel ways of engaging students.

Teacher training also poses a significant problem for education in general in Dubai. Anecdotal evidence suggests that many teachers in Dubai, particularly in the public school system, entered the profession without a passion for teaching and learning. This is backed by data from the TIMSS background survey, which reports that 64 percent of grade 4 students, on average, had teachers who had majored in science or mathematics but did not have a major in primary or elementary education. Worldwide, this figure is only 13 percent.

This suggests a significant policy gap that is allowing teachers without adequate pedagogical training to teach children around Dubai. Coupled with the Ministry of Education's focus on content knowledge as a near-sufficient prerequisite for hiring teachers, this suggests that teaching could be the second career choice of individuals who did not complete degrees in education. By signing teachers that do not have an education background, Dubai is entering into a process plagued with information asymmetry that may lead to adverse selection of new teachers. This could ultimately result in student disengagement and lower achievement.

It is evident that students across Dubai are mainly taught by teachers who have an undergraduate degree or less. Only one percent of mathematics and science teachers at grade 4 have a postgraduate degree, while only three percent of grade 8 teachers hold a postgraduate qualification. This is a substantially low number when compared to the international average of 17 percent for grade 4 teachers and 23 percent for grade 8 teachers, with this figure reaching up to 60 percent for countries such as Australia and the United States.

International practice varies from country to country, but it is important to observe global best practice to determine what can work in the local context. As the majority of teachers' regulatory bodies stipulate the need for teachers to have a postgraduate teaching degree following a generalist or discipline-specific degree, it is believed that the reported postgraduate degree is at least in teaching, if not in the specific discipline as well (TIMSS and PIRLS International Study Center 2008). For example, Australia, Canada, Britain and the United States all require teachers to have a specialized degree in education. On the other hand, some countries such as Colombia only mandate a degree of any sort for pre-service training. Egypt, a country where most foreign teachers in the UAE's public schools come from, requires teachers to complete pre-service courses at university, although three-quarters of the total program is allocated to studying content and only 25 percent of the time is spent on pedagogical studies (TIMSS and PIRLS International Study Center 2008). Amid the wide range of international models, education authorities in the UAE have mandated that teachers carry any undergraduate degree as of the 2008-2009 academic year. This should be followed with the requirement of education qualifications as a necessity for any beginning teacher, coupled with pedagogical training for existing teachers.

It can be claimed that grade 8 science teachers are slightly better qualified, as 48 percent of students reported their teachers have both an education and a science major. Half of the tested students had mathematics teachers qualified in both mathematics and education, which again fell below the international average of 54 percent. Hence, while grade 8 teachers have comparatively higher preparation, it remains substandard and must be increased at this pivotal year of education in which students first encounter complex subjects such as algebra, geometry, biology, physics and chemistry that extensively shape future learning.

Table 7
Teacher qualifications in Dubai

Grade 4	**Dubai**	**Global Average**
Hold major in science or mathematics but in primary education	64%	13%
Grade 8		
Hold major in science or mathematics but not in secondary education	26%	18%

When considering the importance of teacher training, it is important to highlight that the overwhelming majority of students in Dubai do not speak the test language as their native language (English or, in the case of national curriculum schools, Arabic). Furthermore, most attend schools where less than 50 percent of students speak a language other than the test language as their native language. In fact, given that public schools are only open to Arab nationals, we can conclude that nearly 80 percent of private school students are non-native speakers of English but take the test in English. This suggests a particular need for teachers highly trained in teaching English as a second language (ESL).[10] This fortifies the recommendation to introduce strict teacher registration based on formal training in pedagogy and teaching methodology.

Dubai does have a high level of in-service professional development for teachers in science at both the grade 4 and grade 8 levels. There are also high levels of peer collaboration. It is impressive to note that Dubai schools stand on par with the likes of Australia, England, New Zealand, Singapore and the United States in having the most emphasis on professional development of teaching skills for science teachers. At the same time, this training is not necessarily inducing better learning. This signifies its inefficacy or over-reporting on behalf of teachers that may fear honestly answering survey questions.

Mathematics teachers receive above average professional development, but it remains below that offered to their science colleagues. Furthermore, the time dedicated to professional development for mathematics teachers appears to have potential for more efficient allocation, since most of it is currently spent on mathematics content. The following table highlights the need for effective professional development for these teachers in Dubai that can enhance a variety of skills required for educating students.

The share of grade 8 mathematics teachers undergoing curriculum and content training is seven percent more than those who undergo training in pedagogy and alternative instruction methods. This should be remodelled in Dubai, since the majority of teachers do not have a background in education, and therefore would require intensive support in pedagogy training which they would have never received in any prior education.

Time Spent in School

Schools in Dubai are hindered by a significantly short school year. This is particularly the case for public schools, which maintain a shorter school day over a reduced academic calendar. The Ministry of Education estimates that public schools in Dubai have an academic year of 175 days of schooling, with at least 20 of those days dedicated to testing. This leaves only 155 school days for teaching and learning. Furthermore, the school day is only five hours long, with approximately 30 minutes of recess (some schools have 45 minutes of recess per day). Therefore, total instructional time per day is 4.5 hours; i.e., 22.5 hours per week. This is a grave gauge, as it falls well below the 27 hours per week averaged internationally.

Table 8
Share of grade 8 mathematics teachers undergoing professional developement

Type of professional development	Dubai	United States	Global average
Curriculum and content	63%	81%	54%
Pedagogy and instruction	57%	76%	59%
Using ICT for learning	57%	61%	45%
Alternative assessment techniques	62%	69%	48%

[10] Teaching English as a Second Language

Students in public schools in Dubai therefore spend a dangerously reduced amount of time in schools every week over a shorter length of the academic year.

In comparison, countries such as Japan and Singapore maintain academic years of around 200 days, while the United States and Australia teach for around 190 days a year (National Foundation for Educational Research 2008). If Dubai maintains its average of 22.5 hours per week of real learning, the Emirate effectively would be falling 4.5 hours behind schools worldwide every week. This is equivalent to an entire Dubai school day. In fact, in real terms, it can be said that schools in Dubai fall one full day behind their international counterparts every week.

In addition to the short school year, schools in Dubai are only required to teach science for eight percent of total instructional time, and mathematics for 17 percent. Both of these requirements fall below international averages. Private schools and some public schools might be teaching more than the mandatory number of hours, but the less resourced schools would more likely be adhering to the regulated minimum, and are not keeping up with international standards.

The Curriculum in Dubai's Schools

TIMSS measures the curriculum to explore ways in which educational opportunities are provided to students and the factors that influence student learning. Three measures of curriculum are employed for this end: intended curriculum as planned by the countries, the implemented curriculum actually taught and the actual curriculum as learned by the students. The first two are accumulated through surveys of administrators and educators in each country, while the last is revealed by student achievement in each cognitive and content domain in addition to aggregated scores.

According to the KHDA's National Research Coordinator, 28 of the 35 topics found in the grade 4 mathematics test are intended to be taught up to and including grade 4 (TIMSS and PIRLS International Study Center 2008). All 39 topics in the grade 8 examination should have been taught up to and including grade 8. It cannot be then said that the examined topics were outside the curriculum being used at different schools around Dubai, as over 80 percent of the test is intended by the KHDA to have been covered by the time students sat for the test.

When teachers are asked the same question, however, only 57 percent reported having taught their students all the included mathematics topics at grade 4. A closer look reveals that this deficiency occurs precisely in the domains of "geometric shapes and measures" and "data display," thereby justifying Dubai students' below average performance in these two areas at grade 4. Only 69 percent of teachers reported that students were taught the material included in the grade 8 mathematics examination. Additionally, fewer than 45 percent of students in grade 8 have been taught tested material in "data and chance" – recall that grade 8 students achieved below average scores in this domain.

Therefore, while the intended mathematics curriculum in Dubai is slightly under-equipped for 10-year-olds, and almost precisely formulated for 14-year-olds, individual schools are not teaching the desired material. Similar curriculum gaps in science exist. Topics lacking coverage in the science curriculum were predominately in the areas of organisms' life cycles, reproduction and heredity, in addition to trends in human population and its effect on the environment.

In the area of teacher quality and curriculum coverage, Singapore provides an interesting contrast to Dubai. Like those in Dubai, curriculum bodies in Singapore impose a relatively low number of minimum hours for teaching science. However, the number of actual instructional hours is high, implying a comfortable level of manoeuvrability for teachers to introduce their own innovation into their teaching practices. Teachers in Singapore also noted that nearly 47 percent of their grade 8 students had not been taught the science material tested, yet the nation's students achieved the highest marks in the world. This is resounding evidence that education has transformed away from content, books-based learning. While students in high-achieving countries had not necessarily come across the questions in their textbooks or teacher's explanations, they were able to correctly answer. Students in these countries are hence equipped with the expansive thinking skills required to navigate through life, as opposed to the factual memorization which remains commonplace in Middle Eastern schools.

What Happens in Dubai Classes?

As suggested above, due to a lack of confidence in teacher ability and a comparatively low level of teacher training in education, instruction in Dubai is largely focused on textbook-based learning. Nearly 55 percent of grade 4 students reported that they spent at least one science lesson per week memorizing science facts. This exceeds the international average of 44 percent and indicates the prevalence of antiquated methods of teaching and learning at some schools in Dubai. This is despite Dubai's significant investment in professional development for teachers. Of graver concern is the fact that the majority of grade 8 students (51 percent) reported that memorizing science facts and principles was a regular practice in every lesson or almost every lesson. Despite the significant hands-on learning opportunities available in science classrooms, 73 percent of all tested students in Dubai spent more than half of their lessons reading textbooks and worksheets.

A monitoring and accountability issue can be found in a deeper analysis of this field. Contrary to the above student reports, 76 percent of teachers of grade 8 students reported that they seldom or never taught classes based on memorizing facts and principles. The direct contradiction between teacher and student statements calls for bodies such as KHDA's Schools Agency to undertake genuine monitoring of classroom practices. Teachers may indeed believe they are conducting engaging classes, but students constantly perceive their learning to be commensurate to spoon-feeding.

Parents and the Home Learning Environment

Household characteristics and parental engagement in education are important determinants of student outcomes in education. The literature suggests that parents' education and household income, in particular, are key determinants in student achievement (Marginson, Martin and Williamson 1995). Furthermore, parental engagement, both in regard to a child's studies and school governance, promotes better educational outcomes. Evidence from TIMSS background surveys suggests mixed impact in these areas.

Data on household income taken from the background survey of administrators suggests that many schools in Dubai host students who come from economically disadvantaged backgrounds. A full 19 percent of school principals classified more than 50 percent of their student body as "economically disadvantaged."[11] Considering that only 28 percent of all tested schools overall were public schools, and given the education landscape in Dubai, it can be inferred that some proportion of public schools had a mostly disadvantaged student body. Analyzing responses to this specific question from each school would reveal to policy makers the specific geographic locations of such schools and which schools require the most assistance.

[11] Principals did not receive advice in defining the term "economically disadvantaged," and its interpretation was left to their discretion.

The educational background of students paints a more encouraging picture. Results of the student background survey show that 41 percent of students' parents in Dubai have completed a university degree and over 55 percent have completed some level of postsecondary studies. This is a substantial figure in comparison to the worldwide average of 38 percent. It indicates the prevalence of an educated population throughout Dubai that can contribute to a culture of learning. Worldwide, students whose parents had pursued post-secondary studies displayed higher average mathematics and science achievement rates.

However, parents in Dubai do not play as strong a role in their children's schooling as others around the world. Only 27 percent of parents of grade 4 students reported sitting on school committees, compared to an international average of 71 percent of parents. This may provide an explanation of the several clashes that have occurred between parents and schools around the Emirate, often playing out in the national media (Lewis 2009). Unlike in other countries, education councils and ministries in the UAE do not stipulate any policies mandating the existence of parent committees. This could be an avenue for policy makers to explore as a means of quality control.

The background data suggests a need for strong linguistic programs at school, as Dubai finds itself well below the international average for the exam language being spoken at home. Only 55 percent of grade 4 students who took the TIMSS test said that they spoke the test language at home, compared to 84 percent globally. Given that public schools conducted the test in Arabic, it cannot be said that private school students gained competitive advantage over their government schooled colleagues from their language proficiency. While the Ministry of Education has recognized the lower level of English in public schools by setting the elevation of this key skill as one of its targets, this was not a factor in TIMSS 2007, where public school students were examined in Arabic.

That the test language was not spoken at home by most students is a result born out of private school data and is most likely the result of an immigrant population. Nearly 72 percent of grade 4 students reported that either one or both of their parents were born outside Dubai. This is a substantial figure compared to the global average of 10 percent, but accurately fits the largely expatriate population profile of the UAE. The results are similar at the grade 8 level, where 58 percent of students spoke the test language at home and 70 percent of all students' parents were born outside Dubai. The large immigrant population in Dubai contains a large proportion of students that are non-native speakers of English, the implications of which will be discussed later in this paper.

The TIMSS study asked students to estimate the number of books they believe to exist in their homes. Respondents selected from 5 ranges spanning from less than 10 books to over 200 books. Students at schools in Dubai reported numbers that met the international averages. The significance of having a higher number of students reporting greater ownership of books at home cannot be underestimated. All previous studies undertaken by TIMSS and other international standardized tests have found strong correlations between the number of books owned and higher skills not only in literacy, but also numeracy and mathematical analysis (TIMSS and PIRLS International Study Center 2008).

The number of books available in homes across Dubai matches those available in Singapore, yet the latter achieved a TIMSS score over 150 points higher. It is clear that the presence of books in every household is not enough to spur students to acquire an interest in lifelong learning. But a reading culture of both fiction and non-fiction books, in addition to news and information sources, should be instilled in all youth.

Table 9
Distribution of the number of books in households

	Number of books in household					TIMSS score (math/science)
Grade 4 students	**200+**	**101-200**	**26-100**	**10-25**	**0-10**	
Dubai	11%	12%	31%	29%	17%	444/460
Singapore	13%	18%	37%	21%	10%	599/587
Hong Kong	12%	15%	34%	22%	16%	607/584
Grade 8 students						
Dubai	11%	14%	29%	29%	17%	461/489
Singapore	14%	15%	32%	24%	16%	593/567
Hong Kong	10%	9%	26%	30%	26%	572/530

Education and Technology

Of particular benefit to local policy makers is viewing the results from the TIMSS survey of computer and Internet availability in the household. Across all countries, students reporting the presence of a computer and Internet connection at home attained higher marks in the TIMSS mathematics and science examinations. In the world of rapid technological advance, the Internet has become an essential means of transmitting and creating knowledge. Notably, Dubai is not far from taking full advantage of the technological revolution, as 89 percent of grade 4 students and 95 percent of grade 8 students reported that their home had a computer. Nearly 78 percent of all 10-year-olds surveyed could access the Internet from home, and 84 percent of 14-year-olds could.

It must be noted, however, that students in Dubai are not making full use of the technological facilities at their disposal. Those 10-year-olds in Dubai reporting household access to a computer achieved an average mathematics score that was 28 points below that of their international counterparts. The Dubai average in mathematics for those who had online access was 22 points lower than their international comparators. Fourteen-year-olds who had a computer at home just surpassed the international average by seven points (achieving an average mathematics score of 469); however, in comparison to students in countries with similar computer possession rates such as Spain, the United States and Singapore (average scores of 502, 511 and 599 respectively), the average mathematics score in Dubai was low. The trend continues with Internet users, whose average scores in Dubai trail those of the above countries by an average of 67 points.

Evidence also suggests the underutilization of computers and technology at school. While Dubai reported an above average share of students using the computer both at school and at home (a combined 69 percent), student scores remained significantly less than worldwide averages. Grade 4 students who only had access to a computer at school achieved a mathematics score that was 63 points below their international counterparts. This number improves for students at the grade 8 level who met the international average. This suggests that schools around Dubai have not efficiently used the Internet for learning and teaching practices, especially for those at younger ages.

Overall, these findings are an indication that the education system is not equipping students in Dubai with the necessary skills and the appropriate direction for utilizing technology as a learning tool. Internet and communications technology (ICT) saturation has largely been achieved throughout Dubai, but this is not adequate for stimulating the full benefits of ICT in regard to education. It should be recognized that the installation of technology (whether in the school or at home) alone will not automatically lift learning standards.

A conceptual leap is in order, wherein students, teachers and the larger community are aided in learning how to use this technology as the next step. A key standard of pedagogical theory worldwide is the instilling of a culture of lifelong learning in students of all ages. This should translate to the extension of learning activities beyond the classroom into the home and indeed all aspects of life. Also, time and resources could be more efficiently used by encouraging students to take part in blogs, forums and Web searches that are tied in to their curriculum at school.

An overall assessment of background characteristic

Moving forward, the outlook for Dubai appears hopeful, as teachers and principals on average perceive the school climate to be highly conducive to learning. This is calculated based on ratings (very high, high, medium, low and very low) to the following queries: teachers' job satisfaction, teachers' understanding of the school's curricular goals, teachers' degree of success in implementing the school's curriculum, teachers' expectations for student achievement, parental support for student achievement, parental involvement in school activities, students' regard for school property, and students' desire to do well in school. Nearly 58 percent of principals at the grade 4 and grade 8 levels reported an average response of "very high" to questions about the aggregate school climate, while 49 percent of grade 4 teachers answered similarly.

However, this number drops to 40 percent when the questions were posed to mathematics and science teachers at the grade 8 level. The figures are also earmarked by IEA since only 50-70 percent of teachers responded to this question. As discussed below, the KHDA must aim to increase the proportion of schools accurately completing all background questions. Considering that not all sampled teachers answered the questions, and that some teachers may have been pressured to over-report, the low number of teachers responding positively at the grade 8 level suggests that most teachers do not find the school climate to be highly conducive to learning. The figure is above the international average, but should be targeted to ensure that all or most teachers at all levels operate in beneficial school environments.

Conclusion and Recommendations

Dubai's policy makers have established a vision wherein the Emirate becomes a world leader in education. It has invested heavily, both in the public and private sector, in basic education and education at the university level. However, outcomes at the lower and intermediate levels of education, as evidenced by the recent TIMSS results, are far from meeting the needs required for Dubai's future development. Given Dubai's vision of pioneering education in the region and its ambition of becoming a knowledge hub, this calls for genuine reform. Dubai is lauded around the world for its prolific growth, and the time has come for it to lead the world in knowledge development.

That Dubai participated in TIMSS 2007 is a commendable act as the Emirate enters a level of maturity in regard to education policy. This marks the beginning of its recognition of the importance of data-driven policies that take into account the broad range of stakeholders in the policy process. Education policy is a particularly complex field, one in which the entire society has a vested interest. As Dubai embarks on efforts to reform its education system, TIMSS reveals a variety of pathways which policy makers can pursue. Furthermore, the Emirate's experiences in this regard will provide lessons for the rest of the UAE and the other Gulf states.

According to the results from 2007, the primary stakeholders in Dubai's education system – the students themselves – appear to have a positive mindset towards education and understand the importance of mathematics and science study to their future success. However, students' ability to draw the most from their education is handicapped by a number of factors, including the classroom learning environment, teacher quality and training, elements of the home learning environment and the limited amount of time they spend in school. Below, we suggest some basic areas in which educational reforms need to be initiated for short- and long-term benefits.

Dissecting the Data

To fully benefit from their participation in TIMSS 2007, Dubai policy makers must compare results between individual schools, paying close attention to results differentials, performance and engagement statistics broken down on a gender basis, classroom strategies, and variations in teacher training and professional development. These schools should be considered individually to identify if financial, structural or procedural circumstances are preventing their progress.

Collaboration for the implementation of data-driven reform is called for by all stakeholders to ensure that the state of education in Dubai is lifted to meet and transcend international thresholds. In this regard, the results for each school should also be revealed so that schools may assist each other in developing clear ideas of best practice. Also, a conference bringing schools together should take place to discuss the results achieved across the Emirate and explore the implications. Schools achieving the lower averages should be supported by education bodies as well as by schools that succeeded in achieving 550+ marks. Mentoring partnerships could be arranged for strong performing schools to host teachers and administrators from other schools to assist in developing best practices. Furthermore, due to similar demographic structures to other Gulf countries, it is recommended that policy makers in Dubai consider teaching practices and curriculum implemented for 14-year-olds in the neighboring countries to identify best practices in student motivation and engagement.

Teacher Qualifications and Training

Teachers should come into Dubai's schools with an understanding of the intricacies of learning and the different ways in which students learn. Currently, most teachers come into schools in Dubai will only a nominal understanding of effective pedagogy, a factor that limits their effectiveness and appears to result in student disengagement and lower achievement (DeBono 2008). This calls for an ideological shift: effective teachers today are seen as facilitators who moderate classes in a way that allows students to explore, discover and create knowledge themselves.

Without necessitating rigorous teaching qualifications, public schools in particular risk the chance of hiring individuals who do not have the right pedagogical skills, consequently causing students to suffer through ineffective "chalk and talk" rote memorization lessons. Furthermore, by hiring those who are not necessarily motivated by the desire to teach, as signaled by their training, schools risk hiring teachers with poor attitudes and low performance. It is recommended that education training be imposed as a necessary condition for teaching at any level in Dubai's public schools.

One particularly important area of teacher training is ESL. The TIMSS results reveal that a large proportion of Dubai's students consider English as their non-native language. Modern education theory purports that the best method for achieving higher standards of English proficiency among ESL speakers is to adopt a school-wide approach, wherein teachers of all subjects – not just English classes – structure their lessons in an ESL-friendly manner. However, the current level of teaching staff credentials around Dubai shows a deficit of ESL training, meaning that there can be no effective ESL strategy aiming to enhance students' language skills. ESL training should be a primary focus for Dubai's schools, particularly for private schools which are tested in English.[12]

While professional development of existing teachers in Dubai ranks highly, it emphasizes training in content over training in pedagogy. Mathematics teachers in particular spend a disproportionate amount of their training time on content training. It is recommended that initiatives expand to include a larger focus on training in pedagogy and alternative assessment of students. A more productive way of structuring professional development would be to assist teachers of mathematics and science in learning how to improve students' critical thinking and problem solving skills, as well as using ICT for education purposes.

Overall, schools may need to begin introducing incentives or support schemes for teachers to secure higher degrees in education or disciplines related to curriculum development, assessment and pedagogy. This could count towards a minimum standard of professional development set for every teacher by an official education body that regulates teaching licensure.

Addressing Curriculum Gaps

In the absence of a proper mechanism for filtering better quality teachers, Dubai should address the curriculum gaps discussed above. These include both the quality of curricula offered by various school types (such as the national curriculum, American curriculum, British curriculum, and the CBSE) and the differential between mandated curricula and what is actually taught in the classroom. This can be addressed through the inspection of individual schools and consultation with students and parents in order to align the curriculum as implemented with desired criteria.

Also, local authorities are encouraged to analyze TIMSS data on a school-by-school basis to identify areas of deficiency, either in regard to the differences in quality in delivering specific curricula (see differences in performance between public and private schools teaching the national curriculum discussed above) or

[12] This is not to undermine the importance of English training in the public schools, where it is also important. This is particularly the case since the UAE's university system has recently switched over to English instruction, and where there is a marked performance divide between graduates of public and private secondary schools (Badowah 2008).

the reported contradictions in student and teacher responses to questions about teaching methods. This issue of accountability will only be resolved when bodies such as the KHDA and the Ministry of Education implement a proper follow-up and inspection mechanism.

Engaging Parents and Encouraging Learning at Home

Parents are key stakeholders in the education system and need to be involved in their children's schooling, especially at a young age. In Dubai, however, their involvement is nearly non-existent. Opening channels of communication with parents will ultimately assist in raising standards at any institution. Parents are most able to detect educational outcomes, as they are in direct contact with students outside school and can thus provide invaluable feedback to inform the educational process. Their input into schooling issues, from curriculum to extracurricular and administrative procedures, can act as a feedback loop for schools to ensure that their primary stakeholders – students – are gaining the benefit they need and desire from education.

Students and parents should also be encouraged to take up and expand the learning resources that are readily available in their households. As discussed in this paper, students do not appear to be making use of literary and ICT resources available to them in the household. If schools involved parents in the learning cycle and indeed educated parents about the importance of utilizing their educational capital, it would help students grasp the importance of lifelong learning that begins at school. This gives credence to initiatives set up in Dubai such as the Dubai Cares charity campaign that encourages students to read for a cause, thereby making a difference to someone's life while advancing their own learning.

Preparing for Future Examinations

TIMSS is conducted on a four-year cycle. This means that in 2011, Dubai will have an opportunity to participate again. This will allow schools to explore results for grade 8 students who participated in the 2007 test as grade 4 students, giving an important picture of average performance in the intermediate period. It will also allow Dubai to assess the success of reforms currently underway through the KHDA such as the establishment of the Schools Support Unit and the Dubai Schools Inspection Bureau. In general, countries that implement educational reforms during the first two years after a TIMSS cycle exhibit higher results in the ensuing round (TIMSS and PIRLS International Study Center 2008).[13] At the same time, it should be emphasized that the coming years should not result in pressure on schools to adopt a teach-to-the-test mentality in order to keep scores high, which would undermine any reforms.

As Dubai prepares for 2011, the implementation of the TIMSS test should be reviewed. In particular, policy makers should pay attention to how the background surveys are administered. Ministries and education policy groups around the world eagerly await the results of the background surveys administered during the cyclical TIMSS tests so as to allow them to better design targeted reforms. However, in Dubai, only 50-70 percent of teachers and students answered the background questions, and some questions were completely ignored. More rigorous practices for attaining this data should be set for future rounds.

Finally, Dubai should aim to participate in future testing cycles of other international examinations. International standardized tests, including TIMSS, PIRLS and PISA enable policy makers to juxtapose local procedures with international best practice and inform educators about the efficiency

[13] Globally, most countries achieved similar or higher marks at the grade 4 level when taking the test for a second round; however, this is not generally the case for the grade 8 level. One-third of all participating countries increased their average achievement between the examination rounds in 2003 and 2007. At the same time, one-third achieved the same results, and one-third showed declines. Bahrain, Egypt and Palestine showed declines in their grade 8 mathematics achievement, while Lebanon and Tunisia displayed increases. Both Morocco and Tunisia, the only Arab nations to conduct 2003 grade 4 testing, had lower scores in 2007.

and effectiveness of current policies. As stated above, policies and reforms that are informed by TIMSS results and implemented in coming years will have a quantifiable success measure in the next cycle of testing.

Dubai and the UAE have come a long way since federation, when literacy rates around the country did not exceed a quarter of the population. However, it is important to recognize that near universal literacy is not a sufficient outcome for which to aim. Quality of education emerges as a challenge after saturation has been achieved. The TIMSS results indicate that reform is undoubtedly called for in regard to curriculum, teaching techniques and the time students spend in school. If Dubai aspires to become an educational hub and ascend to the leaders' ranks in today's knowledge economy, education quality must be a priority for future reform.

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About the Dubai School of Government

The Dubai School of Government (DSG) is a research and teaching institution focusing on public policy in the Arab world. Established in 2005 under the patronage of HH Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai, in cooperation with the Harvard Kennedy School, DSG aims to promote good governance through enhancing the region's capacity for effective public policy.

Toward this goal, the Dubai School of Government also collaborates with regional and global institutions in delivering its research and training programs. In addition, the School organizes policy forums and international conferences to facilitate the exchange of ideas and promote critical debate on public policy in the Arab world.

The School is committed to the creation of knowledge, the dissemination of best practice and the training of policy makers in the Arab world. To achieve this mission, the School is developing strong capabilities to support research and teaching programs, including

- applied research in public policy and management;
- master's degrees in public policy and public administration;
- executive education for senior officials and executives; and,
- knowledge forums for scholars and policy makers.

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