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Abstract. *This study focused on comparing science teachers' qualifications and practices between Saudi Arabia and Singapore. Data analysed in this study were the responses of science teachers to the Teacher Background Questionnaire-8th Grade from the Trend in International Mathematics and Science Study (TIMSS) in 2007. The Saudi sample consisted of 175 science teachers while the Singapore sample consisted of 377 teachers. This research is designed as causal comparative research in which attempts will be made to determine the cause or reason for the existing differences in the achievement of the students of the two participating countries. The comparison between two countries reveals that there were significant differences in teachers' preparation for teaching science topics (Biology, Chemistry, Physics, and Earth science), teachers' license, teaching experience, professional development programs, and teaching practices. Results were discussed and recommendations for science educators and policy makers were proffered.*

Key words: *8th grade, achievement, science, teachers' practices, teachers' qualifications, TIMSS.*

**Qasim Al Shannag, Hassan Tairab,
Hamza Dodeen**
*United Arab Emirates University,
Al-Ain, United Arab Emirates*

Faisal Abdel-Fattah
*King Saud University,
Riyadh, Kingdom of Saudi Arabia*

LINKING TEACHERS' QUALITY AND STUDENT ACHIEVEMENT IN THE KINGDOM OF SAUDI ARABIA AND SINGAPORE: THE IMPACT OF TEACHERS' BACKGROUND VARIABLES ON STUDENT ACHIEVEMENT

**Qasim Al Shannag,
Hassan Tairab,
Hamza Dodeen,
Faisal Abdel-Fattah**

Introduction

In 2007, The Kingdom Saudi Arabia joined 57 other countries and participated in the Trends in International Mathematics and Science Study (TIMSS). This internationally comparative assessment conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA) is designed to contribute to improving teaching and learning in mathematics and science for students around the world through evidence-based findings to inform educational policy and highlight similarities and differences between countries so that participating countries can learn from each other in relation to quantity, and quality of student learning.

In particular TIMSS focuses on three dimensions of learning: the intended curriculum; the implemented curriculum, and the attained curriculum. The intended curriculum concerns with what kind of mathematical and scientific knowledge that is expected to be learned by students and country-specific characteristics that may influence the development of such knowledge. The implemented curriculum refers to the curriculum as developed and implemented by teachers. The attained curriculum on the other hand refers to exact knowledge and skills that are learned and achieved by students.

It is obvious that teachers have eventually become the focus of TIMSS and placing more emphasis on their roles and responsibilities in achieving these three dimensions. In fact, teachers



constituted an important dimension in TIMSS studies. This was evident in the amount of data collected in TIMSS via the "Teacher Questionnaire" which examined a variety of issues related to curriculum implementation and opportunities provided for student learning such as qualifications, pedagogical practices, assessment and assignment of homework, and classroom climate.

The Literature Review

There is growing research based evidence that schools can make a great difference of student achievement. There is also a growing body of evidence based research that suggests that a substantial part of that difference is attributed to teachers (Darling-Hammond, 2000). Students are taught by effective teachers consistently showed better educational gains than those who are taught by less effective teachers (Brophy, 2001). Which factors that contributes to teacher effectiveness, however, has been a subject of debate among researchers. Nevertheless, teacher background characteristics were found to be related to and influence the way teachers facilitate student learning.

On the other hand, recent research studies dealing with teacher effectiveness contended that teachers vary in their contribution to student academic development according to various variables such as teachers' academic and professional background as well as their classroom practices. A recent studies conducted by Goe (2007) and Goe and Stickler (2008) revealed contradictory results in relation to how teachers effectiveness relate to student academic achievement. Goe and Stickler, in their synthesis focused on four categories of teachers' background variables, namely teachers' qualifications, characteristics, practices and effectiveness. These variables captured the primary concern of TIMSS 2007, the focus of this study. These variables are also of high concern among countries such as Saudi Arabia and Singapore and often closely linked to recruitment and retention of teachers. Other studies such as those of Aaronson, Barrow, and Sanders (2003), and Nye, Konstantopoulos, & Hedges (2004) suggested that teachers' background variables such as those mentioned in Goe (2007), Goe and Stickler (2008) are associated with higher student achievement.

Saudi Arabia is one of the countries that have invested heavily in education to maintain the country's future development and prosperity. Yet in TIMSS 2007 study, the average score of Saudi Arabia's grade 8 science sample was 403 well below the international average and below most of the countries that may have similar economic and cultural context. Furthermore the country is currently experiencing a hot debate on educational issues related to the quality of teaching and learning process as a result of this ranking in TIMSS findings. Recent studies that conducted secondary analyses of mathematics achievement of Saudi Arabia sample (Dodeen, Abdelfattah, Shumrani, & Abu Hilal, 2012) and Saudi Arabia science teachers' assessment practice, Al-bursan and Tighezza (2013) suggested that there is a need to look carefully into the teaching practices as well as teacher related variables so that meaningful conclusions can be formulated and consequently plans to improve student achievement can be developed. Dodeen et. al., (2012) found that compare to other Taiwanese mathematics teachers, the Saud Arabia teachers showed significant differences in most of the variables compared related to qualifications, professional development activities, and teaching practices. Similarly Al-bursan and Tighezza found almost similar significant differences between the science teachers in Saudi Arabia and those in South Korea when it comes to assessment practices with the Korean using more differentiated methods than the Saudi teachers.

It is intended in this study to conduct secondary analyses of the data collected from the Kingdom of Saudi Arabia participating Grade 8 science teachers and their students and compare these data with the data collected from Singapore, a country whose students produced the highest average score in the science achievement test (567) compared with the rest of the participated countries. This comparison will inform policy makers in the Kingdom as to the future directions needed to take science curricula and the teaching learning processes into positive direction.

Although data collected using the "Teacher Questionnaire" was extensive to an extent that it basically covered most aspects of teaching and learning processes, it is intended in this study to focus on selected teacher background variables that are related to curriculum implementation and deemed to be of high priority to both policy makers and student academic growth.



Research Focus

The purpose of this secondary analysis study was to investigate similarities and differences of Saudi Arabia and Singapore science teachers' experience, and teaching learning practices as measured by TIMSS's teacher questionnaire. In particular, we intended to

- i. determine the relationships of Saudi Arabia and Singapore science teachers' qualifications, experience, and teaching learning related variables and their student performance as measured by TIMSS scores;
- ii. identify factors that contributed to high achievement of science students in the two countries;
- iii. identify factors that contributed to low achievement of science students in the two countries.

We intended in this study to find answers to broad questions about opportunities provided for students to learn science, and factors that are linked to students' opportunity to learn. These broad questions can be detailed as follows:

- i. In what way do Saudi teachers differ from their Singaporean counterpart in relation to qualifications, experience, and teaching learning practices?
- ii. Do significant differences exist between Saudi and Singaporean science teachers in relation to qualifications, experience, and teaching learning practices?
- iii. What factors that can be linked to students' opportunity to learn in the two countries?

Methodology of Research*General Background of Research*

TIMSS was first conducted in 1995 and has been in operation since then every four years. The main purpose of TIMSS is to assess the quality of the teaching and learning of mathematics and science among Grades 4 and 8 students across participating countries, and thereby provide educational educators and policy makers with reliable and timely data to enhance education outcomes of the participating countries (Martin, et. al., 2003). The TIMSS 2007 assessment contained a questionnaire designed to be answered by teachers and consisting of 31 questions covering various background and professional characteristics.

The Kingdom of Saudi Arabia joined the TIMSS studies in 2007 whereby Singapore has joined the TIMSS studies in 1995. Both countries joined the TIMSS studies at both the 4th and the 8th grades. The Kingdom of Saudi Arabia has shares with Singapore some commonalities- the economic affluence and the modern educational infra structures, resources, and funding. Yet there are noticeable differences between the two countries such as cultural differences, language of instruction, and teacher training and supply. The Kingdom of Saudi Arabia has mostly a uniform culture (Arabic and Islamic culture) and uses Arabic as a language of instruction and about 90% locally trained teachers with small percentage of expatriates, whereas Singapore consists of more than one cultural and ethnic groups with noticeably Chinese, Malay, and Indian cultures dominating the culture. In Singapore English is used widely as a medium of instruction and teachers were locally trained.

Sample of Research

The sample of this study consisted of all grade 8 science teachers who participated in TIMSS 2007 in the Kingdom of Saudi Arabia and Singapore. The Saudi sample consisted of 175 teachers teaching 4243 students in Grade 8 while that of Singapore was 377 teachers with 4599 students. 49% of the Saudi sample were females, 51% were males. The Singaporean sample consisted of 64% females, 36% were males. Needless to say that the Singaporean sample although it was reported as made of 377 teachers, the actual record showed that 52 teachers have had more than one record resulting from entering data for more than one class. As such the total number recorded for the sample was 429 instead of the actual



377. However, the Singaporean science teachers were sampled from 164 schools with class sizes ranged from 10 to 17 students. on the other hand Saudi science teachers were sampled from 165 schools with class size ranged from 7 to 33 students. As such these trends might have very well explain the high performance of Singapore students in grade 8 science compared to Saudi students who studied in a relatively large classes. Tables 1 and 2 summarize the sample characteristics related to the total number of participated sample in both countries and their background characteristics.

Table 1. Sample distribution.

Country	Number of Schools	Number of Teachers	Number of Students
Saudi Arabia	165	175	4,243
Singapore	164	377	4,599

Instruments and Procedures

The study employed causal comparative approach in which attempts were made to determine the cause or reason for the existing differences in the achievement of the students of the two participating countries. Causal comparative research approach is useful when the groups (Saudi Arabian and Singaporean students) are already different in some variables (achievement) and the researcher attempts to the major factors that have led to these differences (Gay, Mills, & Airasian, 2009). The variables to be analysed were investigated by TIMSS and have already been known to be associated with science achievement (Darling-Hammond, 2000; Wayne & Youngs, 2003) such as teachers' academic preparation, their highest level of education, their perceptions and feelings of readiness to teach science subjects, and their participation in professional development activities.

In this secondary analyses study, "Teacher Questionnaire" developed by TIMSS which contains information related to the teacher background variables as well as how well were teachers prepared to teach science and the conditions under which science learning took place in TIMSS selected classes. All together, the questionnaire consisted of 31 often multiple questions to be answered by teachers. Questions related to teacher's background characteristics, education and training in teaching science, and how well prepared teachers feel to teach science as well as representation of their teaching practices represent the focus of the present study. Information on validity and reliability of this instrument have already been furnished by TIMSS during development as well as other secondary analysis studies (Dodeen et. al., 2012)

Data Analysis

The present study was designed as a secondary analysis of the data generated in TIMSS 2007 round. The study focusses on data related to grade 8 science teachers' characteristics, professional development, and performance in both countries Saudi Arabia and Singapore. To answer the study questions data pertaining to teacher questionnaire were examined, analysed and compared. Frequencies for each category within each variable assessed by the questionnaire were calculated. Chi-square (χ^2) test was used to examine the significance of differences between the expected frequencies and the observed frequencies in each country. Due to the nature of the data (secondary analysis) the study relies on data extracted from the TIMSS database. As such in some of the categories that were regarded as "not applicable" were not included in the analyses.



Results of Research

The findings of the study were presented in relation to the questions asked above and the two countries were compared so that differences can be identified.

Comparison of Teachers' Background Characteristics (Qualifications, experiences and teaching practices)

Table 2. Teacher background characteristics.

Characteristic	Saudi %	Singapore %
Male	51.0	36.0
Female	49.0	64.0
Teaching certificate	71.0	96.4
Teachers holding first degree	97.1	86.6
Teachers holding higher degree	0.6	6.8

Data presented in Table 2 suggests that Saudi Arabia and Singapore teachers had comparable teaching experience judging by the similarity of the average mean score of teaching experience (Saudi teachers= 10.2, Singapore teachers=10.0) . However, differences emerged with regard to the gender of science teachers at Grade 8 with more female teachers found in the Singapore sample than male teachers and comparable gender percentage in the Saudi sample.

With regard to teacher qualifications, The Singapore sample showed most teachers (96.4%) were certified and licensed teachers compared to (71.2%) of the Saud sample. The difference in certification is obviously in favour of the Singapore sample with clear emphasis on certification whereas in Saudi, to date there is no clear policy on teachers' licensure. Instead the emphasis was heavily placed on obtaining a university degree on education and related subjects. Furthermore, Table 2 suggests that the Singapore sample included more teachers with higher degree (6.8%) compared to that found in the Saudi sample (0.6%).

Table 3. Percentage of science teacher main major.

Science major	Yes (Saudi Arabia)	Yes (Singapore)
Biology	48.0	49.0
Physics	15.3	47.6
Chemistry	29.3	62.3
Earth science	17.9	11.7

Findings presented in Table 3 clearly suggest that in Saudi sample more teachers were specialized in biology (48%) followed by chemistry (29.3%) some remarkable differences between the Saudi and the Singaporean samples, with earth science and physics following with (17.9%) and (15.3%). The Singaporean sample showed that more teachers were majoring in chemistry followed by biology, physics and finally the earth science. These trends could very well reflect the curriculum emphasis on the two countries judged by the science topics emphasized by TIMSS and not studied in the two countries (Table 4).



Table 4. Percentage of averages of science topics not yet taught in the two countries.

Subject	Saudi Arabia	Singapore
Biology	21.0	47.7
Chemistry	66.8	33.5
Physics	42.7	36.0
Earth Science	36.5	84.0

How Well Science Teachers in the Two Countries Prepared to Teach Science at Grade 8?

Tables 5, 6, 7, and 8 present findings related to self-perceived preparedness to teach the science related subjects. The sample in both countries was asked to indicate how well they feel prepared to teach these subjects. Findings presented in Table 5 suggest that in general the Saudi sample felt better prepared to teach topics related to biology than the Singaporean sample. The Saudi samples saw themselves were very well prepared than their Singaporean counterparts. In fact the expressed value of preparedness ranged from (57.1% to 80.8%) for the Saudi teachers and only from (23.6% to 49.4%) for the Singaporean teachers. Table 5 showed that the overall average for preparedness regarding biological topics was found to be (67.4%) for Saudi sample compared to (37.2%) for Singaporean sample.

Table 5. Percentage of teachers' level of preparation for teaching biology.

Topic	Saudi Arabia			Singapore		
	Very well prepared	Somewhat prepared	Not well prepared	Very well prepared	Somewhat prepared	Not well prepared
Major organs and organ systems...	77.2	21.6	0.6	42.3	29.7	12.3
Cells & their functions...	80.8	16.3	1.7	49.4	23.8	11.3
Reproduction (sexual and asexual) and heredity...	62.6	29.8	4.7	42.0	31.0	10.6
Role of variation and adaptation...	57.1	33.5	2.5	31.3	30.8	17.7
Interaction of living organisms and the physical environment...	72.0	24.4	1.2	41.2	29.9	10.6
Trends in human population & its effects on the environment	57.4	36.1	3.6	23.6	35.4	18.2
Impact of natural hazards...	64.7	27.6	4.1	30.9	33.6	14.0
Average	67.4	24.0	2.6	37.2	30.6	13.5

In order to statistically ascertain whether preparation of teachers was similar in both countries, a Chi-square (χ^2) test was conducted using the average percentages of teachers in the three preparation levels. The result was statistically significant, ($\chi^2 (2, N=308) = 27.9; p < 0.01$). This means that, on average, the express confidence of preparedness of teachers of biology is different in both countries favouring Saudi Arabia teachers. This result suggests that Saudi teachers tend to overestimate themselves when it comes to preparation. Taking into account a large number of Saudi teachers are expatriates from



neighbouring countries and might very well overestimating their preparation to teach biology in order to maintain their employment.

Table 6 presents findings related to how well the teachers in the two countries prepared to teach chemistry. The overall average of preparedness was clearly higher for Singapore teachers than that of Saudi sample (65.9% compared to 51.9%). There were clear differences in favour of Singaporean teachers related to the topics "Particulate Structure of matter", "Solutions", and "Properties & uses of acids and bases" whereby the differences were clearly significant (71.1%, 67.2%, and 66.2% for Singapore and 62.4%, 52.4%, and 27.2% for Saudi respectively). With regard to the topic "Properties & uses of acids and bases", (19.1%) of the Saudi sample indicated that they were not well prepared to teach this topic.

Table 6. Percentage of teachers' level of preparation for teaching chemistry.

Topic	Saudi Arabia			Singapore		
	Very well prepared	Somewhat prepared	Not well prepared	Very well prepared	Somewhat prepared	Not well prepared
Classification and compositions of matters...	60.0	26.5	5.9	68.4	17.0	4.4
Particulate Structure of matter...	62.4	27.6	5.3	71.1	14.6	4.4
Solutions (solvent, solute, ...)	52.4	31.3	9.6	67.2	17.0	4.9
Properties & uses of acids & bases	27.2	38.3	19.1	66.2	17.5	5.4
Chemical change (transformation of reactants, ...)	57.4	26.5	11.1	56.5	24.9	8.1
Average	51.9	30.0	10.2	65.9	18.2	5.4

In order to statistically ascertain whether preparation of teachers was similar in both countries, a Chi-square (χ^2) test was conducted using the average percentages of teachers in the three preparation levels. The result was statistically significant, ($\chi^2 (2, N=500) = 14.9; p < 0.01$).

This means that, on average, the level of preparation of teachers in chemistry is different in both countries with higher preparedness shown by the Singaporean teachers.

The average of how well teachers in the two countries continued to increase in favour of Singapore teachers with regard to the physics topics. As shown in Table 7, that only (45.3%) of Saudi sample compared to (56.2%) of the Singapore sample who expressed that they were very well prepared to teach physics topics. Topics such as "Electric circuits", "Properties of permanent magnets and electromagnets", and "Forces and motion" proved to be high concern to the Saudi teacher as only few teachers who felt very well prepared to teach these topics.

Table 7. Percentage of teachers' level of preparation for teaching physics.

Topic	Saudi Arabia			Singapore		
	Very well prepared	Somewhat prepared	Not well prepared	Very well prepared	Somewhat prepared	Not well prepared
Physical states and changes in matter...	52.1	33.5	6.0	61.2	23.2	3.5
Energy types, transformation, heat & temperature	62.7	31.9	1.8	57.5	23.5	5.7
Basic properties/ behaviors of light...	54.2	32.7	4.8	57.3	23.0	7.2



Topic	Saudi Arabia			Singapore		
	Very well prepared	Somewhat prepared	Not well prepared	Very well prepared	Somewhat prepared	Not well prepared
Electric circuits (flow of current, ...)	27.2	34.9	20.1	57.5	24.4	6.4
Properties of permanent magnets & electromagnets	37.0	33.3	15.8	49.1	26.9	11.1
Forces and motion (types of forces, ...)	38.7	38.7	11.3	54.8	22.7	8.6
Average	45.3	34.2	10.0	56.2	24.0	7.1

In order to statistically ascertain whether preparation of teachers was similar in both countries, a Chi-square (χ^2) test was conducted using the average percentages of teachers in the three preparation levels. The result was statistically significant, ($\chi^2 (2, N=485) = 8.4; p < 0.05$). This means that, on average, the level of preparedness preparation of teachers of physics is different in both countries favouring Singapore teachers.

Finally the earth science topics were found to be problematic for all participating teachers in both countries. Table 8 showed that teachers in both countries were not that confident in their preparation to teach earth science topics, with the Saudi sample felt more very well prepared than their Singaporean counterparts. This trends of overestimation is more likely to be shown by Saudi Arabia science teachers in light of the general perception that showing high level of positive self-perception may contribute to securing and maintain employment. The overall average was found to be (47.7%) for Saudi sample compared to only (10.2%) for the Singaporean sample. The topic of "Earth on the solar system & the universe" received the highest percentage from the Saudi sample who felt very well prepared to teach this topic. The topic of "Environmental concerns" received the highest percentage form the Singaporean sample.

Table 8. Percentage of teachers' level of preparation for teaching earth science.

Topic	Saudi Arabia			Singapore		
	Very well prepared	Somewhat prepared	Not well prepared	Very well prepared	Somewhat prepared	Not well prepared
Earth's structure & physical features ...	49.1	38.5	4.7	2.5	14.0	27.5
Earth's processes, cycles & history ...	35.9	42.5	10.2	2.0	14.8	27.8
Environmental concerns ...	43.3	34.1	8.5	23.5	21.0	10.0
Use & conservation of Earth's natural resources ...	48.2	35.5	6.0	15.0	24.3	13.8
Earth on the solar system & the universe ...	62.1	29.6	1.8	7.8	15.8	24.3
Average	47.7	36.0	6.2	10.2	18.0	20.7

In order to statistically ascertain whether preparation of teachers was similar in both countries, a Chi-square (χ^2) test was conducted using the average percentages of teachers in the three preparation levels. The result was statistically significant, ($\chi^2 (2, N=342) = 66.4; p < 0.01$). This means that, on average, the level of preparedness of teachers in earth Science is different in both countries with a significant level of preparedness in favour of the Saudi sample.



Comparison of Teachers' Instructional Practices in the Two Countries

TIMSS questionnaire collects information on instructional practices that, in addition to the traditional practices are closely linked to inquiry and student centred teaching such as making observations and describing what was seen, designing or planning experiments or investigations, conducting experiments or investigations, working together in small groups, and, relate what is being learned in science to daily life. To place science teachers' instructional practices in context of student achievement in the two countries, Table 9 shows remarkable differences between the two countries. Teachers' demonstration and domination of investigative activities were very common among Saudi sample.

Data reported in Table 9 suggests that (46.4%) of the Saudi sample reported that they conduct experiments and make students watch them in every, or almost, every lesson compared to only (1%) among the Singapore sample. Other strategies that were found to be highly practiced by the Saudi teachers were having students to memorize facts and principles and providing students with explanations (50.9% and 46.7% respectively compared to 6.6% and 34.1% for the Singapore sample). These findings suggest that Saudi science teachers showed teaching practices that can be described as traditional by emphasizing teacher demonstration of experiments rather than allowing students to perform experiments, and focus on memorization of facts and principles in every or almost all lessons. However, in almost all behaviours associated with inquiry and student-centred teaching such as observation of natural phenomena, design and plan experiments, and conducting experiments, the Singapore sample significantly showed these practices in some lesson more than the Saudi sample, it is an indication that could very well describe the Singapore teaching as inquiry oriented and student-centred teaching.

Table 9. Percentages of science teaching practices on both countries and it is significant.

Topic	Saudi Arabia				Singapore				(χ^2)
	Every or almost every lesson	About have the lessons	Some lessons	Never	Every or almost every lesson	About have the lessons	Some lessons	Never	
Observe natural phenomena & describe what they see	24.4	18.9	53.3	2.4	7.3	10.2	77.4	5.1	50.7*
Watch me demonstrate an experiment or investigation	46.4	16.3	36.7	0.6	1.0	15.5	80.9	2.7	210.9*
Design or plan experiments or investigations	6.6	14.4	62.9	16.2	1.7	2.9	58.4	37.0	51.5*
Conduct experiments or investigations	11.4	22.2	57.6	8.9	5.8	30.8	61.2	2.2	20.7*
Work together in small groups on experiments or investigations	19.8	21.0	49.7	9.6	6.1	22.3	65.9	5.8	30.0*
Read their textbooks or other resources materials	22.4	17.6	48.5	11.5	15.7	16.0	54.2	14.0	4.5
Have students memorize facts and principles	50.9	21.8	25.5	1.8	6.6	16.7	59.0	17.7	171.6*
Use scientific formulae and laws to solve routine problems	34.9	24.9	38.5	1.8	5.6	25.5	60.7	8.3	91.9*
Give explanation about something they are studying	46.7	18.6	31.7	3.0	34.1	35.8	29.3	0.7	21.4*
Relate what they are learning in science to their daily life	72.8	14.2	12.4	0.6	36.8	33.7	29.5	0.0	65.8*

* $p \leq .01$ 

Comparison of Teachers' Participation in Professional Development

Teachers were asked to indicate the frequency of their participation in professional development in specific areas of science teaching and learning. In order to examine the differences in participation of teachers in the two countries a frequency counts were calculated for each country and the (χ^2) tests were performed to test any significant differences between the two countries. Table 10 showed that the participation in professional development was significantly higher for Singapore sample than their Saudi counterparts in all categories of professional development.

Table 10. Percentage of teachers' participating in professional development programs on the previous two years and it is significant.

Professional development topic	Saudi Arabia	Singapore	Absolute Difference	(χ^2)
Science content	41.3	77.3	36.0	69.6
Science pedagogy/ instruction	43.0	85.5	42.5	69.3
Science curriculum	21.3	77.3	56.0	155.2
Integrating information technology into science	31.9	70.3	38.4	70.7
Improving students' critical thinking or inquiry skills	41.6	71.7	30.1	46.3
Science assessment	29.2	64.0	34.8	58.4

* $p \leq .01$

The Saudi sample reported that participations in professional development that can be described as low and ranging from (29.2% for participation in professional development activities related to science assessment to 43.0% on science pedagogy/ instruction). According to table 10, the Singapore sample reported highest participations in science pedagogy/ instruction(85.5%), science content, and science curriculum (77.3% each), professional development related to critical thinking or inquiry skills directed towards improving student thinking (71.7%), and science assessment (64.0%). The absolute differences ranged between (30.1% and 56%) in favour of the Singapore sample. The average absolute difference between the two countries in each category was found to be statistically significant at ($p < 0.01$). These findings could very well explain the apparent differences in student achievement in science in the two countries as will be discussed later.

Discussion

Although findings related to teacher effectiveness research are conclusively difficult to interpret in the context of student achievement, it is now possible to identify those characteristics that could be linked to student achievement. We made an attempt in this study to identify the differences in teacher characteristics that could explain the differences in achievement between Saudi Arabia and Singapore. TIMSS findings showed that Grade 8 Singapore science students achieved significantly higher average score (567) compared to only an average score of (403) achieved by the Saudi Arabia Grade 8 students. Would it be these differences as a result of differences in teacher characteristics? Teachers are one of the factors that influence student learning, though their impact on student achievement has been debated frequently over the years. The debate is motivated by the fact that schools and teachers can indeed make a real difference in the student achievement. The results of this TIMSS secondary analysis suggest differences in teacher characteristic background, preparation, classroom practices, and professional development attended might have been responsible for the differences in student achievement in the two countries.

In this study, teacher's gender was looked at as a factor that is difficult to discuss and compare whether it has a profound effect on student achievement. For the fact that in Saudi Arabia schools



are completely segregated by gender at both student and teacher levels (single sex classrooms), and therefore comparing the impact of gender in the two countries may not be appropriate. Teacher certificate and education showed differences between the two countries. In fact teachers' subject area certification is one of the teacher qualifications most consistently and positively associated with improved student achievement (Betts, Zau, & Rice, 2003; Cavalluzzo, 2004; Carr, 2006), particularly those teachers who have had full certification status. Findings showed that more teachers from Singapore held or obtained educational certification and as such it can be said they are more qualified than their counterparts in Saudi Arabia, and as such this may very well contribute to their positive impact on student achievement as suggested by Cavalluzzo (2004), Carr (2006), and Darling-Hammond (2000). On the other hand, in Saudi teacher certification is not a necessary or a required condition to join the teaching force and thereby teachers can easily join the profession as long as they have first degrees in school disciplines. This could very well explain the high percentage of teachers with first degree in Saudi Arabia sample. Although the Saudi Arabia sample showed that more teachers have held first degree, the superiority of Singapore sample in contributing to student achievement can be explained by the fact that more teachers are educationally certified than simply holding first degrees. With regard to the possession of advanced or higher degrees, the findings contradict with Goe & Stickler (2008) who found that the majority of studied reviewed indicated no or minimum impact of teacher with advanced degrees on student achievement that could be neglected. Unlike the review of Betts et al. (2003) who reported a significant effect for teachers who held advanced degrees. Whatever the size of difference between Saudi Arabia and Singapore samples, the issue of educational certification and qualification should be given due attention for its contribution to student achievement (Dodeen, et. al., 2012).

Differences in the Level of Preparation to Teach Science at Grade 8

We looked at the preparation of teachers in the two countries and their perceptions of how well they felt prepared to teach scientific topics identified in TIMSS. Findings indicated significant differences between the two countries with higher percentages of Saudi Arabia teachers who felt very well prepared in Biology and Earth Science and higher percentages of Singapore teachers who felt very well prepared in Chemistry and Physics.

Regard to biological topics, (67.4%) of the Saudi teachers felt that were very well prepared to teach biological topics compared to only (37.2%) of the Singapore teachers. These findings are consistent with how much biological topics been covered in Saudi Arabia compared to the Singapore curriculum. The fact that more biological topics were covered in the Saudi Arabia curriculum may point to an indication that more Saudi Arabia teachers might have better training in and certification in biology than Singapore teachers. Nevertheless their impact on student achievement still remains below that of the Singapore sample.

Findings related to the level of preparation for teaching Chemistry showed significant differences emerged between the two samples in favour of Singapore teachers. The majority of Chemistry teachers in Saudi Arabia felt that they were not very well prepared to teach Chemistry. In contrast, the majority of Singapore teachers felt they were very well prepared to teach Chemistry, and as such they have better impact on student achievement. The same trends emerged in the Physics subject whereby only (45.3%) of the Saudi Arabia teachers felt that they were very well prepared compared to (56.2%) of the Singapore sample. Subject matter preparation is among the critical contributing factors to the achievement of students (Dodeen, et. al., 2012; Goe, 2008; Hill, Rowan, & Ball, 2005; Wayne & Youngs, 2003). In order to achieve the stated curriculum goals teachers need to have the right preparation of content and pedagogy so that they can influence the achievement of students. Teachers in both countries have indicated low level of preparation with regard to the Earth Science topics. The fact that teachers of both countries were not prepared to teach Earth Science topics identified by TIMSS can be traced by to the curriculum emphasis in the two countries whereby Earth Science topics were only minimally covered in the curricula of the two countries (only 15.96% were covered in the curriculum in case of Singapore).



Differences in the Science Teaching Practices

Research studies dealing with science teachers' instructional practices focused on the relationship between instructional quality used by teachers to interact and engage students in learning and student outcomes suggested that teachers indeed make a difference in the achievement of students (Anderson, 1997; Von Secker & Lissitz, 1999). Findings emerged from this secondary analysis suggested that most Saudi Arabia teachers did not use inquiry oriented practices. Instead, they relied heavily most of the time on traditional practices such as helping students to memorize factual information and providing them with explanations and readymade experimentation in the form of teacher demonstration. In contrast, the Singapore sample seemed to use balance approaches to engage students more on inquiry oriented practices such as student experimentation whenever is needed. The value of active inquiry oriented learning has been well documented (Furtak, Seidel, Iverson, & Briggs, 2012; Luft, 2001), and highly recommended by researchers as a desirable approach that influences student achievement. Professional agencies such as the National Research Council (NRC, 1996) suggested specific instructional practices related to how science should be taught. Most of these instructional practices are similar to those examined in the present TIMSS secondary analysis such as providing opportunities for students to conduct evidence based experiments, encouraging students to conduct further study to test and elaborate explanations, and emphasizing the importance of relating scientific knowledge to everyday life (NRC, 1996). The findings presented in this study in relation to teachers' instructional practices indicated that at least from the point of view of science teachers in the Saudi Arabia, they appear to describe their science instruction in ways similar to those suggested by the NRC (1996) than their Singapore counterparts. Unfortunately, this was not evident in terms of student achievement and could not help keep them out of the bottom of the international ranking, especially, Saudi Students achievement on the applying and reasoning domains were very low, and most of students' scores come from the knowing domain. It will be a challenge therefore for educators and policy makers in Saudi Arabia to help teachers adopt a balance approach to active learning and inquiry oriented practices that could really influence student achievement.

Differences in Professional Development Participation

With regard to professional development, the findings indicated that the Singapore science teachers differed significantly in the amount of professional development attended. The majority of Saudi Arabia science teachers did not participate adequately in professional development activities compared with their Singapore counterparts. The value of participation in professional development programs for teachers has been well researched and documented for its positive effect on the professionalism and consequently the performance of teachers (Goe, 2008; Luft, 2001; Rockoff, 2004; Wenglinsky, 2002). It is therefore a challenge for Saudi educators to encourage teachers to attend and participate in professional development activities in order to bring about the needed influence on student achievement. The findings related to the participation of Saudi teacher in Professional development activities suggest that schools and the Ministry of Education in Saudi Arabia should engage teachers more in planning and implementation of professional development programs that focus on inquiry approach and hands-on-minds-on activities. Such training not only attract science teachers but also contribute significantly to their instructional practices so that they adopt strategies and approaches similar to those used by the Singapore sample. On other words, Professional development programs for science teachers in Saudi Arabia need to be redesign and structure to focus more on inquiry-based practices as a main strategy to improve science learning and students' achievement.

Conclusions

The focus of this study was to examine similarities and differences of Saudi Arabia and Singapore science teachers' experience, and teaching learning practices as measured by TIMSS's teacher ques-



tionnaire. In so doing the study was designed as causal comparative study in which attempts were made to determine the cause or reason for the existing differences in the achievement of the students of the two countries. Data analysed in this study were the responses of Grade 8 science teachers to TIMSS's 2007 Teacher Background Questionnaire. Responses of 552 grade 8 science teachers (175 from Saudi Arabia and 377 from Singapore) were analysed and compared. The comparison between two countries reveals that there were significant differences in teachers' preparation for teaching science topics (Biology, Chemistry, Physics, and Earth science), teachers' license, teaching experience, professional development programs, and teaching practices. The findings suggest that the Grade 8 science teachers in Saudi Arabia and Singapore differed significantly in most characteristics related to their background, perception of their preparation, and the way they teach science.

The findings also suggest that in most of the comparisons the Singapore sample was found to be better qualified, teach less content, balanced in their perceptions of how well they prepared, participated more in professional development programs and have had classroom practices close to or resemble those identified as inquiry oriented practices. The identified differences between the teachers in the two countries might very well explain the differences between student achievement in the two countries. Although it is possible to rightly relate differences in student achievement in TIMSS assessments to differences in professional practices as measured in the Teacher Background Questionnaire, it appears that Saudi teachers tended to overstate their perceptions regarding the assessed areas of professional practices. For example, in general the Saudi biology teachers felt better prepared to teach topics related to biology than the Singaporean sample, and yet they were unable to impact their student achievement in the same way as their Singapore counterparts. Similar trends can be seen in the responses of the Saudi earth science teachers. Teachers in Saudi also reported frequent use of teaching strategies that are related to inquiry teaching in the same way as Singapore sample. It can be concluded that these contradictory trends might well be explained by the overestimation of the perceptions that were reflected in the responses to how well teachers felt prepared to teach science to grade 8.

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Qasim M. Al Shannag

Ph.D., Associate Professor, College of Education, P.O.Box 66921, United Arab Emirates University, Al-Ain, UAE.
E-mail: qalshannag@uaeu.ac.ae
Website: <http://www.cedu.uaeu.ac.ae>
Phone: +971504483551.

Hassan H. Tairab

Ph.D., Associate Professor, College of Education, P.O.Box 17551, United Arab Emirates University, Al-Ain, UAE.
E-mail: tairab@uaeu.ac.ae
Website: <http://www.cedu.uaeu.ac.ae>

Hamza Dodeen

Ph.D., Associate Professor, College of Humanities & Social sciences, P.O.Box 17551, United Arab Emirates University, Al-Ain, UAE.
E-mail: hdodeen@uaeu.ac.ae
Website: <http://www.chss.uaeu.ac.ae>

Faisal Abdel-Fattah

Ph.D., Associate Professor, P.O.Box 2458, Excellence Research Centre of Science and Mathematics-King Saud University, Riyadh, KSA.
E-mail: fattahf@hotmail.com
Website: <http://ecsme.ksu.edu.sa>

