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INITIATIVES FOR ACCOMPLISHING THE TIMSS 500 CENTERPOINT THROUGH CURRICULA, TEACHERS' DEVELOPMENT AND INSTRUCTIONAL STRATEGIES

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ABSTRACT

The Trends in International Mathematics and Science Study (TIMSS) is one of the most influential assessments of student achievement conducted every four years. It provides reliable data on mathematics and science achievements in grade 4 and grade 8 as well as information about instructional curricular and teaching-learning process. This helps to make decisions on policy development and identify areas of progress. This research delivers evidence on factors that influence the improvement in the scores of TIMSS examination in 2015 compared to 2011 in the Kingdom of Bahrain. Since the Kingdom experienced a major reformation in mathematics and science education, this research analyzes the improvement in students' skills and knowledge by comparing the same cohort results in 2011 and 2015 in mathematics as well as science. This research is also trying to identify other factors, as benchmarked by the Bahrain Numeracy Strategy (BNS) such as school environment, teacher education, teacher's professional development, and classroom contexts for learning and instructional support which backed the improvement. This research provides initiatives to be taken to accomplish TIMSS Center Point 500 in the coming TIMSS examination in 2019 or later.

Contribution/Originality: This research provides initiatives to be taken to cross TIMSS Center Point 500 in the coming TIMSS examinations in the Kingdom of Bahrain by analyzing the factors such as curriculum development, instructional strategies, school infrastructure, teacher's education and professional development, classroom contexts for developing a learning environment.

1. INTRODUCTION

The Trends in International Mathematics and Science Study (TIMSS) has been measuring student achievement in mathematics and science at fourth and eighth grades every four years since 1995. TIMSS assessment and questionnaire data provide an authentic report on how the students are currently performing in mathematics and science, and what changes have occurred in curriculum, instruction, and other aspects of education that influence learning of mathematics and science (Mullis *et al.*, 2016).

Bahrain participated in the Trends in International Mathematics and Science Studies (TIMSS) in 2003 and in 2007 with only Grade 8 students but in 2011 and 2015 both Grade 4 and Grade 8 participated in TIMSS. Bahrain's average score in TIMSS improved in mathematics Grade 4 from 436 in 2011 to 451 in 2015 by 15 scale points. The

average score in mathematics Grade 8 also improved from 409 in 2011 to 454 in 2015 by 45 scale points (Martin *et al.*, 2016). Bahrain still stays under the TIMSS scale CenterPoint (500).

In order to suggest initiatives for joining the CenterPoint, this research examined factors such as supportive school environment, teacher education, professional development, classroom contexts for learning and instructional support which backed the improvement. These factors were explored in addition to other factors such as curriculum and learning environment that are key determinants of academic achievement of students. (Ado, 2015). Besides, teachers also play a critical role in foregrounding and integrating higher order thinking skills, and so does content and representation in the context of teacher education to register achievements in the domain of mathematics(Tajudin and Chinnappan, 2016).

The introduction of Bahrain Numeracy Strategy contributes towards the increase in student performance on the TIMSS. In September 2012, the Bahrain Numeracy Strategy (BNS) was launched and introduced into the mathematics curriculum in Bahrain. The strategy mainly aimed at increasing numeracy standards and raising student performance in Mathematics. It utilizes a structured approach in improving teaching, learning and assessment of mathematics instruction in Bahraini public schools. According to the BNS introductory guide, these goals can be achieved through:

- Providing a framework and guidance that exemplifies the mathematics that should be taught in each grade.
- Providing a framework, guidance, training and support for principals and teachers on how mathematics should be taught and assessed.
- Involving everyone in the system to ensure a consistent approach to teaching and learning mathematics in Bahrain. (Introductory Guide, Bahrain Numeracy Strategy, 2012)

2. LITERATURE REVIEW

In 2015 Bahrain ranked 26th out of 41 countries with a score of 454 points in mathematics for eighth grade and ranked 41st out of 51 countries with a score of 451 points for fourth grade (Bahrain Education and Training (BQA), 2017). TIMSS science achievement in fourth grade was a score of 459 and in eighth grade, the score was 466 (BQA, 2017). It is important that Bahrain should achieve the CenterPoint (500) in both mathematics and science in the next assessment. This section explores factors that have influenced the TIMSS scores in different situations and put on record in previous studies.

Supportive school environment, for instance, is one of the factors that can affect TIMSS results. According to Mullis *et al.* (2016) "the Safe and Orderly Schools scale was one of the most important variables related to achievement over and above the effects of home background in about half the countries" (p. 39). According to the report '20 years of TIMSS': there was an increase in safe and orderly schools from 47 fourth grade and 36 eight grade in 2007 to 69 fourth grade and 63 eight grade schools in 2015 (Mullis *et al.*, 2016).

A high-quality learning environment in a school is another important factor in encouraging a positive attitude towards academic excellence and facilitating classroom instruction. Several studies have identified resources such as the use of computers in the teaching of mathematics and science having a positive impact on student achievement (Lay and Chandrasegaran, 2016; Tas and Balgalmis, 2016). Furthermore, these studies also suggested that most successful schools tend to have students who are economically advantaged and share a common language of instruction.

Lay and Chandrasegaran (2016) in a comparative study of resource availability and TIMSS grade in Malaysia and Singapore however found that school resource shortage was positively and significantly associated with student science achievement in Malaysian schools. In a similar correlation study between school quality and family socioeconomic background with students' mathematics achievement in the Middle East, Kareshki and Hajinezhad (2014) found that some variables such as parents' education and family economic status, show a weaker correlation

with academic achievement but school resources, educational climate, and the number of enrolments of school show a stronger correlation with academic achievement.

An important factor that contributes to the students' achievement is the teacher education. According to Mullis *et al.* (2016) "the fourth and eighth grade mathematics and science teachers in TIMSS 2015 reported that they were better educated than their counterparts in TIMSS 2007." There was an increase of seven percent in grade 4 teacher education in 2015 with a bachelor's degree and five percent increase in teachers with an advanced degree. In 2011, for eighth grade there was an increase of three percent in teachers' education with a bachelor's degree and five percent increase in teachers with an advance degree as compared to 2007 (Mullis *et al.*, 2016).

The impact of the principal's leadership style also played an important role in students' achievement. In the context of TIMSS, Al-Safran *et al.* (2014) conducted a comparative study of principals' leadership style in the USA and Kuwait and found that principal's leadership style was statistically associated to student achievement in mathematics and science, in spite of the fact that the principal's leadership style of both countries was entirely different. Another factor that affects students' achievement is teachers' professional development. In England, a teacher must pass one year teacher's training program in order to be qualified to achieve the teaching standard while in Finland the Ministry has introduced a new program of two years duration to train 50,000 teachers (Mullis *et al.*, 2016). Hong Kong has set up a committee for professional development of teachers and principals; in 2015 they introduced 810 programs for 60,000 teachers and principals (Mullis *et al.*, 2016). A high-quality professional development program for teachers fosters teachers' job satisfaction and changes their attitudes and beliefs. Such modification in teachers' attitudes and beliefs are also important in implementing the school curriculum and improve students' learning outcomes.

The classroom context for learning is another factor that affects the student achievement. According to Mullis *et al.* (2016) "differences in expenditures and class size play a limited role in explaining cross-country achievement differences, but that teacher quality and instructional time matter". According to Farbman (2015) "Both research and practice indicate that adding time to the school day and/or year can have an expressive positive impact on student proficiency and, indeed, upon a child's entire educational experience "(p.1). Based on 2011 TIMSS data from 14 European countries of 4th grade students, Li and Konstantopoulos (2017) have analysed the relationship between class size and mathematics achievement.

International benchmarking too plays an important role in educational achievement and interpreting the results of an assessment. At a high Benchmark score– 550, students can apply their understanding and knowledge in mathematics in a wide variety of complex situations. They can solve algebraic problems, compute with fractions and decimals to solve word problems, find areas and volumes of simple geometric shapes and solve probability problems and interpret data in tables and graphs. In science, students can communicate and apply knowledge about the human life, physical sciences, and the Earth sciences in their everyday contexts. Students can communicate their knowledge of characteristics of plants, animals, and their life cycles, and apply knowledge of ecosystems and of humans' and organisms' interactions with their environment. Students can communicate and apply knowledge of states and properties of matter, and of energy transfer in practical contexts, as well as show some understanding of forces and motion. Students can also apply knowledge of Earth's structure, physical characteristics, processes, and history and show basic understanding of the Earth-Moon-Sun system. Students can compare, contrast, and make simple inferences using models, diagrams, and descriptions of investigations, and provide brief descriptive responses using science concepts, both in everyday and abstract contexts.

This research aimed to identify the factors that influenced the improvement in the scores of mathematics and science in grade four and grade eight TIMSS examination in 2015 compared to 2011 in the Kingdom of Bahrain. It attempted to find whether there was also a significant improvement in students' skills and knowledge in mathematics and science as a result of the improvement in the scores. This study has looked into the factors in school instruction that might have contributed to achieve this improvement such as supportive school environment,

teacher education, and professional development, classroom contexts for learning and instructional support and to examine whether they can potentially contribute in crossing the CenterPoint 500 in the coming TIMSS examination in 2019. It is expected that this research will contribute to the development of a better educational framework in the Kingdom for the improvement of the teaching-learning process and to achieve Center Point 500.

3. RESEARCH METHOD

This research used a descriptive approach method comprising the mean, standard deviations, and frequencies. The Context questionnaire adapted from the TIMSS was used to collect data from mathematics and science teachers of grade four and grade eight and school principals in order to gather information about their perceptions on the improvement materialized in 2015. This tool was collected data from participants about variables such as supportive school environment, teacher education, professional development, classroom contexts for learning instructional support and curriculum change information in mathematics and science which can cause further improvement. The collected data was analyzed using SPSS, version 25.

3.1. Sample

The sample consisted of 462 Mathematics teachers (237 at primary schools and 225 at intermediate schools) with a 49% response rate, 349 Science teachers (170 at primary schools and 179 at intermediate schools) with a 28% response rate, and principals were 228 (143 at primary schools and 85 at intermediate schools)[1].

4. RESULTS

This section presents the results of a survey carried out on the three targeted participants (Principals, Mathematics teachers, and Science teachers) in response to items such as supportive school environment, teachers' education, professional development, classroom context for learning and instructional support which backed improvement. The survey consisted of three parts (in addition to the personal information): supportive school environment, teaching strategies, and professional development.

4.1. Supportive School Environment

Table-1. School's instruction affected by a shortage or inadequacy of resources.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Computer technology for teaching and learning (e.g., use of computers or tablets for student use)	2.90	1.009	2.91	0.881
Technologically competent staff	2.96	0.985	2.88	0.870
Resources for students with disabilities	2.84	1.092	2.85	0.970
Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors)	2.90	1.016	2.80	0.910
Instructional space (e.g., classrooms)	2.81	1.173	2.56	1.128
Heating/cooling and lighting systems	2.57	1.154	2.49	1.031

Source: TIMSS Survey Questionnaire for School Principals.

The items in Table 1 show the extent to which the school's instruction was affected by the shortage or inadequacy of resources. The results reveal that the school's instruction was somewhat affected at both primary and intermediate schools by shortage or inadequacy of computer technology for teaching and learning and technologically competent staff. School instruction was also somewhat affected by audio-visual resources for delivery of instruction. Physical necessities like instructional space and heating/cooling and lighting systems do not

[1] The principal's population was unknown at the time the data were collected

seem to highly affect school instruction compared to resources for students with disabilities, technology and audio and visual resources.

Table-2. Principal's perception on factors influencing academic achievement.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Teachers' degree of success in implementing the school's curriculum	4.16	0.691	3.78	0.697
Teachers' working together to improve student achievement	4.23	0.769	3.68	0.658
Students' ability to reach school's academic goals	3.98	0.791	3.33	0.679
Students' desire to do well in school	4.01	0.829	3.16	0.652
Parental support for student achievement	3.68	0.888	2.88	0.762
Parental involvement in school activities	3.70	0.930	2.72	0.825

Source: TIMSS Survey Questionnaire for School Principals.

Table 2 shows primary and intermediate principal's responses to their perception on factors influencing academic achievement of students. They were asked to indicate their choice for the items as either very high, high, medium, low, or very low. Both primary and intermediate principals rated teachers' degree of success in implementing the school's curriculum and teachers working together to improve student achievement as high. Students' desire to do well in school, Parents support for student achievement and involvements in school activities were rated between medium and high.

Table-3. Problem among students in schools.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Absenteeism (i.e., unjustified absences)	2.15	1.066	2.37	0.929
Physical fights among students	2.14	1.205	2.27	0.993
Intimidation or verbal abuse among students (including texting, emailing, etc.)	2.06	1.273	2.15	1.114
Arriving late at school	1.99	0.985	2.08	0.824
Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.)	1.99	1.291	2.02	1.225

Source: TIMSS Survey Questionnaire for School Principals.

Table 3 shows the principals' response to the items related to students' behaviors in school, suggesting to what extent the students behavior causes a problem in school: major problem, medium problem, simple problem, not a problem. All of them agreed that such behaviors are considered between simple to medium problem (Means ranged from 1.99 – 2.37). The students' behaviors are not considered as major problems, nor are they an issue that needs to be investigated.

Related to the supportive school environment, the principals were asked if schools provided a place where students can do their schoolwork before or after school. 57% of them indicated that they do provide the place; but 60% of them stated that they cannot provide someone to assist them with their schoolwork.

4.2. Instructional Strategies

All the primary schools participated in this study were equipped with an average of 34 computers (including tablets) available for use by students whereas intermediate schools were equipped with an average of 58 computers (including tablets). Responses of primary school principals showed that 90% schools have a science laboratory that can be used by students; intermediate school principals indicated that 83% schools have a science laboratory that can be used by students. Nevertheless, 73% of primary school principals stated that there was no assistance available when students conducted science experiments. On the contrary, 67% of intermediate school principals indicated that assistance was available when students conducted science experiments. These responses showed that all primary and intermediate schools were equipped with a library in their schools.

Table-4. Incompetent laboratories and libraries.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Science equipment and materials for experiments	2.69	1.122	2.76	0.895
Concrete objects or materials to help students understand quantities or procedures	2.62	1.102	2.47	0.765
Library resources relevant to science instruction	2.40	0.956	2.47	0.853
Computer software/ applications for science instruction	2.45	0.967	2.45	0.764
Library resources relevant to mathematics instruction	2.29	0.968	2.42	0.792
Computer software/ applications for mathematics instruction	2.21	0.930	2.41	0.776

Source: TIMSS Survey Questionnaire for School Principals.

Both primary and intermediate schools principals were found in agreement that there was a moderate impact of the inadequacy of science equipment and materials for experiments, concrete objects or materials to help students understand quantities or procedures, library resources relevant to science instruction, computer software/ applications for science instruction, library resources relevant to mathematics instruction, and computer software/applications for mathematics instruction (Table 4).

4.3. Professional Development

Table-5. Principals and their professional development in the past two years.

Items	Participation	Primary		Intermediate	
		Frequency	Percent	Frequency	Percent
Mathematics content	Yes	42	30.4	12	14.5
	No	96	69.6	71	85.5
Mathematics pedagogy/instruction	Yes	56	40.6	29	34.9
	No	82	59.4	54	65.1
Mathematics curriculum	Yes	36	26.3	11	13.3
	No	101	73.7	72	86.7
Integrating information technology into mathematics	Yes	62	44.9	37	44.6
	No	76	55.1	46	55.4
Improving students' critical thinking or problem solving skills	Yes	57	42.2	21	25.3
	No	78	57.8	62	74.7
Mathematics assessment	Yes	56	40.6	33	39.8
	No	82	59.4	50	60.2
Addressing individual students' needs	Yes	78	56.5	52	62.7
	No	60	43.5	31	37.3

Source: TIMSS Survey Questionnaire for School Principals.

Table 5 shows participation of principals in professional development in the past two years. The data reveal that intermediate school principals seemed to show less participation compared to primary school principals. The participation in professional development was also mostly related to addressing individual students' needs, as 56.5% of primary school principals and 62.7% of intermediate school principals participated. This was followed by integrating information technology into mathematics, in which 44.9% of primary school principals and 44.6% of intermediate school principals participated. In the field of mathematics assessment, 40.6% of primary school principals and 39.8% of intermediate school principals participated. In the area of improving students' critical thinking or problem-solving skills, 42.2% of primary school principals and 25.3% of intermediate school principals participated. Very few participated in other topics like Mathematics content, Mathematics pedagogy/instruction, and Mathematics curriculum.

Table-6. Mathematics teachers' and their professional development programs.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
How often does your school provide professional development programs for mathematics teachers in a year?	6.11	7.669	12.56	10.662
How many times does your school provide professional development programs for science teachers per year?	5.78	7.935	12.54	11.051
Over the past two years, how many mathematics teachers have you sent to professional development programs?	5.17	4.426	8.32	3.831
Over the past two years, how many science teachers have you sent to professional development programs?	3.40	4.525	5.89	4.388

Source: TIMSS Survey Questionnaire for School Principals.

Table 6 shows Mathematics teachers' participation in professional development programs. Over the past two years, primary school principals sent, on average, 5.17 mathematics teachers to professional development programs. In addition, they provided, on average, 6.11 professional development programs for mathematics teachers in a year. An average of 3.40 science teachers was sent for professional development programs. In addition, they provided on average 5.78 professional development programs for science teachers in a year.

4.4. Mathematics Teachers

4.4.1. Supportive School Environment

Table-7. Characterization of mutual support within schools.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Teachers working together to improve student achievement	4.16	0.782	4.21	0.783
School leadership's support for teachers' professional development	4.08	0.823	4.07	0.729
Collaboration between school leadership and teachers to plan instruction	4.01	0.827	3.95	0.771
Teachers' expectations for student achievement	3.58	0.671	3.41	0.736
Students' desire to do well in school	3.47	0.860	3.05	0.777

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

Table 7 exhibits characterization of mutual support within schools. Their rate for teachers working together to improve student achievement, school leadership's support for teachers' professional development, collaboration between school leadership and teachers to plan instruction, and teachers' expectations for student achievement is shown from high to very high (*Means ranged* from 4.21 – 3.41). The students' desire to do well in school was rated as medium by intermediate mathematics teachers (*Mean* = 3.05, *SD* = 0.777).

Table-8. The extent of disciplinary measures.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
This school's security policies and practices are sufficient	3.55	2.638	3.20	0.569
I feel safe at this school	3.46	0.620	3.33	0.544
The students behave according to the school rules	2.99	0.731	2.98	2.048
The students are respectful of the teachers	2.97	0.760	2.87	0.707

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

Table 8 indicates the extent of disciplinary measures. The participants, primary mathematics teachers and intermediate mathematics teachers, indicated that they felt safe in their school accepting that school's security policies and practices were sufficient. Both primary and intermediate school teachers showed their agreement that students behaved according to the school rules and that students were respectful to teachers.

Table-9. The severity of insufficient facilities.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
The school building needs significant repair	1.89	0.955	1.92	1.014
Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students)	1.85	0.907	1.63	0.792
Teachers do not have adequate technological resources	1.81	0.875	1.68	0.794
Teachers do not have adequate instructional materials and supplies	1.69	0.847	1.66	0.805
Teachers do not have adequate support for using technology	1.60	0.757	1.53	0.732

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

Table 9 shows the severity of insufficient facilities. Factors like inadequate technological resources, insufficient instructional materials and supplies, and inadequate support for using technology do not seem to be a big problem to both primary and intermediate mathematics teachers. That the school building needs significant repair also does not seem to be a major problem.

4.5. Classroom Contexts for Learning

Table-10. The extent of teachers' workload.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
There are too many students in the classes	3.12	0.880	3.20	0.748
I need more time to prepare for class	2.84	0.904	2.87	0.735
I have too many teaching hours	2.61	0.837	2.60	0.755
I have to do too many administrative tasks	2.49	0.865	2.43	0.761

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

As indicated in Table 10, participants were asked about the nature of their work. They agreed that there were too many students in classes and that they needed more time to prepare for class. They also agreed about having too many teaching hours, and that they were made to perform too many administrative tasks. On average, primary teachers indicated that, in a typical week, they spent 5.74 hours whereas intermediate teachers spent 5.65 hours teaching mathematics to students in the classroom.

4.6. Instructional Strategies

In the area of instructional strategies, primary and intermediate teachers showed that they found their work full of meaning and purpose. They often felt content with their profession as teachers and felt almost satisfied with being teachers at their school (See Table 11).

Table-11. Participant's feeling of being school teachers.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
I find my work full of meaning and purpose	3.58	0.645	3.54	0.695
I am content with my profession as a teacher	3.13	0.899	3.22	0.837
I am satisfied with being a teacher at this school	3.07	0.954	3.26	0.779

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

To shed light on the accessibility the students have to computers in their schools, 74% of primary school teachers indicated that each student is provided a computer in their schools, 86.9% of them indicated that the classes have computers that students can share, and 73.7% of them indicated that the schools have computers that the class can use. Similarly, 68.6% of intermediate school teachers indicated that each student has a computer in their schools, 94.2% of them indicated that the classes have computers that students can share, and 72.2% of them indicated that the schools have computers that the class can use.

Table-12. Students activities on computer during mathematics lessons.

Items		Primary		Intermediate	
		Frequency	Percent	Frequency	Percent
Explore mathematics principles and concepts	Rarely	66	28.2	50	22.4
	Once or twice a month	78	33.3	81	36.3
	Once or twice a week	54	23.1	50	22.4
	Almost every day	36	15.4	42	18.8
Practice skills and procedures	Rarely	40	17.1	39	17.5
	Once or twice a month	77	32.9	66	29.6
	Once or twice a week	51	21.8	45	20.2
	Almost every day	66	28.2	73	32.7
Look up ideas and information	Rarely	53	22.6	38	17.0
	Once or twice a month	92	39.1	93	41.7
	Once or twice a week	55	23.4	55	24.7
	Almost every day	35	14.9	37	16.6

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

In terms of exploring mathematics principles and concepts using a computer, Table 12 shows that 33.3% of primary mathematics teachers asked students once or twice a month, 28.2% rarely, 23.1% once or twice a week, and 15.4% almost every day. 36.3% of intermediate teachers asked students to explore mathematics principles and concepts using the computer once or twice a month, 22.4% rarely and same percentage once or twice a week, and 18.8% almost every day. Furthermore, 39.1% of primary mathematics teachers asked students to look up ideas and information once or twice a month, 23.4% once or twice a week, 22.6% rarely, and 14.9% almost every day.

4.7. Curriculum Change in Mathematics

Table-13. Mathematics teachers' confidence in the curriculum and instruction.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Inspiring students to learn mathematics	3.57	0.575	3.53	0.559
Showing students' a variety of problem solving strategies	3.36	0.627	3.37	0.552
Improving the understanding of struggling students	3.32	0.642	3.18	0.649
Assessing student comprehension of mathematics	3.26	0.674	3.16	0.688
Developing students' higher-order thinking skills	3.26	0.699	3.13	0.691
Providing challenging tasks for the highest achieving students	3.23	0.700	3.10	0.729
Improve low-achiever students' understanding	3.08	0.709	2.86	0.760

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

The responses in Table 13 show that primary and intermediate teachers' confidence for all the items exhibited ranged between high and very high.

Table-14. Mathematics teachers' interactions with other teachers.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Collaborate in planning and preparing instructional materials	3.14	0.911	3.57	0.680
Work together to try out new ideas	3.03	0.938	3.37	0.748
Visit another classroom to learn more about teaching	2.76	0.902	2.89	0.787

Source: TIMSS Survey Questionnaire for Mathematics Teachers.

Table 14 indicates that both primary and intermediate mathematics teachers collaborate in planning and preparing instructional materials; they work together to try out new ideas and visit one another's classroom to learn more about teaching.

4.8. Professional Development

In the past two years, almost similar percentage of primary and intermediate teachers participated in Mathematics content and Mathematics pedagogy/instruction. They also participated in programs like Integrating information technology into mathematics, improving students' critical thinking or problem-solving skills, and addressing individual students' needs. However, their least participation was in Mathematics curriculum and Mathematics assessment.

For the participation in professional development activities 91.8% of primary and 97.6 of intermediate schoolteachers indicated that participation in professional development activities had increased, 5.3% of primary teachers thought there was no change, and 2.9% opined that it had become less than before. Also, both primary and intermediate schoolteachers agreed about changes that have improved students' achievements. Another question was about the extent to which the changes in mathematics curriculum (Introducing the Bahrain Numeracy strategy) helped in improving TIMSS 2015 results in Bahrain. Their responses showed that they agreed that the changes improved students' achievements on TIMSS 2015.

4.9. Science Teachers

4.9.1. Supportive School Environment

Table-15. Characterization of mutual support within schools.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Teachers working together to improve student achievement	4.16	0.782	4.21	0.644
Collaboration between school leadership and teachers to plan instruction	4.10	0.833	4.12	0.736
School leadership's support for teachers' professional development	4.08	0.890	4.10	0.858
Teachers' expectations for student achievement	3.62	0.653	3.47	0.706
Students' desire to do well in school	3.51	0.879	3.22	0.838

Source: TIMSS Survey Questionnaire for Science Teachers.

As shown in Table 15, science teachers were also asked to rate some items related to supportive school environment. The responses of primary and intermediate science teachers seemed too close to each other. For example, the mean for Teachers working together to improve student achievement is 4.16 (SD=0.78) for Primary science teachers and 4.21 (SD=0.644) for intermediate science teachers.

Table-16. The extent of disciplinary measures.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
I feel safe at this school	3.41	0.620	3.39	0.621
This school's security policies and practices are sufficient	3.37	0.563	3.31	0.647
The students behave according to the school rules	3.03	0.638	2.83	0.715
The students are respectful of the teachers	3.06	0.681	2.80	0.698

Source: TIMSS Survey Questionnaire for Science Teachers.

In response to the safety issue in their schools, Table 16 indicates that all participants, primary science teachers and intermediate science teachers, felt safe in their school. The school's security policies and practices were found to be enough, and they agreed that students behaved according to the school rules and that they showed respect for the teachers.

Table-17. The severity of the insufficient facilities.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
The school building needs significant repair	1.96	0.944	2.08	1.038
Teachers do not have adequate technological resources	1.81	0.917	1.89	0.920
Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students)	1.75	0.891	1.81	0.982
Teachers do not have adequate instructional materials and supplies	1.89	0.846	1.75	0.898
Teachers do not have adequate support for using technology	1.59	0.869	1.60	0.871

Source: TIMSS Survey Questionnaire for Science Teachers.

Table 17 presents that primary and intermediate science teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students), nor do they have adequate instructional materials and supplies, nor support for using technology, but this does not seem to be a big problem to them . The school building that needs significant repair also does not seem a major problem.

4.10. Classroom Contexts for Learning

Table-18. The extent of teachers' workload

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
I need more time to prepare for class	3.12	0.739	3.09	0.739
There are too many students in the classes	3.14	0.824	3.09	0.901
I have too many teaching hours	2.61	0.872	2.71	0.824
I have to do too many administrative tasks	2.54	0.816	2.54	0.895

Source: TIMSS Survey Questionnaire for Science Teachers.

Table 18 presents the extent of teachers' workload. Both primary and intermediate science teachers provided almost similar responses in terms of the items in this variable. They agreed that they needed more time to prepare for their classes, that there were too many students in each class, that they have too many teaching hours, and that they have to do too many administrative tasks. On average, primary teachers indicated that, in a typical week, they spent 4.37 hours and intermediate teachers spent 4.48 hours teaching science to students in a classroom.

4.11. Instructional Strategies

In the area of instructional strategies, both primary and intermediate teachers agreed that they found their work full of meaning and purpose. They often felt content with their profession as teachers and felt satisfied with being teachers at their school (Table 19).

Table-19. Participant's feeling of being school teachers.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
I find my work full of meaning and purpose	3.53	0.664	3.54	0.737
I am content with my profession as a teacher	3.21	0.920	3.26	0.926
I am satisfied with being a teacher at this school	3.21	0.844	3.21	0.922

Source: TIMSS Survey Questionnaire for Science Teachers.

Furthermore, the accessibility of students to computers in schools was also highlighted in this study. The responses of 71% of primary school teachers show that each student has a computer in their schools, 84.6% of them indicate that the classes have computers that students can share, and 65.9% of them indicate that the schools have computers that the class can use. Similarly, 53.7% of intermediate school teachers indicate that each student has a

computer in their schools, 95.5% of them indicate that classes have computers that students can share, and 67.0% of them indicate that the schools have computers that the class can use.

Table-20. Students activities on computer during science lessons.

Items		Primary		Intermediate	
		Frequency	Percent	Frequency	Percent
Practice skills and procedures	Rarely	25	14.9	21	11.8
	Once or twice a month	57	33.9	60	33.7
	Once or twice a week	61	36.3	61	34.3
	Almost every day	25	14.9	36	20.2
Do scientific procedures or experiments	Rarely	24	14.3	19	10.6
	Once or twice a month	48	28.6	78	43.6
	Once or twice a week	79	47.0	76	42.5
	Almost every day	17	10.1	6	3.4
Look up ideas and information	Rarely	1	.6	7	3.9
	Once or twice a month	7	4.2	49	27.4
	Once or twice a week	37	22.2	83	46.4
	Almost every day	90	53.9	40	22.3
Study natural phenomena through simulations	Rarely	43	25.6	52	29.1
	Once or twice a month	52	31.0	64	35.8
	Once or twice a week	51	30.4	46	25.7
	Almost every day	22	13.1	17	9.5

Source: TIMSS Survey Questionnaire for Science Teachers.

In terms of making students practice skills and procedures, Table 20 indicates that 33.9% of primary science teachers ask students to practice once or twice a month, 14.9% rarely, 36.3% once or twice a week, and 14.9% almost every day. Similarly, 33.7% of intermediate teachers ask students to practice skills and procedures once or twice a month, 11.8% rarely, 34.3% once or twice a week, and 20.2% almost every day.

Asking students to do scientific procedures or experiments, it is found that 28.6% of primary science teachers do that once or twice a month, 10.1% almost every day, 47.0% once or twice a week, and 14.3% rarely. Similarly, 3.4% of intermediate teachers ask students to do scientific procedures or experiments almost every day, 43.6% once or twice a month, 42.5% once or twice a week, and 10.6% rarely. When asked about looking up ideas and information, it is discovered that 4.2% of primary science teachers do that once or twice a month, 53.9% almost every day, 22.2% once or twice a week, and 0.6% rarely. On the other hand, 27.4% of intermediate schoolteachers ask students to look up ideas and information once or twice a month, 46.4% once or twice a week, 3.9% rarely, and 22.3% almost every day.

4.12. Curriculum Change in Science

Table-21. Science teachers' confidence in the curriculum and instruction.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Inspiring students to learn Science	3.56	0.615	3.54	0.620
Assessing student comprehension of science	3.30	0.730	3.35	0.632
Showing students', a variety of problem solving strategies	3.42	0.678	3.34	0.688
Providing challenging tasks for the highest achieving students	3.32	0.657	3.28	0.697
Improve students' understanding of science	3.38	0.588	3.25	0.679
Developing students' higher-order thinking skills	3.32	0.719	3.23	0.689
Teaching science using inquiry method	3.25	0.707	3.11	0.787
Improving the understanding of struggling students	3.11	0.745	3.01	0.717

Source: TIMSS Survey Questionnaire for Science Teachers.

For asking student to study natural phenomena through simulations, the data reveals that 31.0% of primary school teachers ask students to look up ideas and information once or twice a month, 30.4% once or twice a week,

25.6% rarely, and 13.1% almost every day. Likewise, 35.8% of intermediate schoolteachers ask students to study natural phenomena through simulations once or twice a month, 25.7% once or twice a week, 29.1% rarely, and 9.5% almost every day.

Table 21 shows that in all the items stated in this variable, the confidence level of both primary and intermediate school teachers ranges between high to very high.

Table-22. Science teachers' interactions with other teachers.

Items	Primary		Intermediate	
	Mean	SD	Mean	SD
Collaborate in planning and preparing instructional materials	2.98	0.988	3.37	0.764
Work together to try out new ideas	2.96	0.938	3.25	0.787
Visit another classroom to learn more about teaching	2.76	0.890	3.01	0.854

Source: TIMSS Survey Questionnaire for Science Teachers.

The interaction between participating teachers and their colleagues too was investigated in this study. Table 22 presents responses of both primary and intermediate science teachers which show that they collaborate in planning and preparing instructional materials, work together to try out new ideas, and visit one another's classroom to learn more about teaching.

4.13. Professional Development

This study also investigated whether teachers participated in professional development related to science in the past two years. It was revealed that both primary and intermediate teachers participated in Science content (65.5% and 77.7%, respectively) and science pedagogy/instruction (65.5% and 77.7%, respectively). They also participated in integrating information technology into science (80.4% and 88.1%, respectively), improving students' critical thinking or problem solving skills (60.7% and 67.2%, respectively), addressing individual students' needs (67.3% and 72.2%, respectively), integrating science with other subjects (71.4% and 79.0%, respectively), and science assessment (48.8% and 65.3%, respectively) . However, their least participation was in science curriculum (26.8% and 33.7%, respectively).

In terms of integrating ICT in science lessons or activities, 92.5% of primary and 95.0% of intermediate schoolteachers seem to agree that it has increased since last time. Only 6.8% of primary school teachers think nothing has changed and 0.8% think that integrating ICT in science lessons or activities has decreased since last time. Of intermediate schoolteachers, 5.0% think that nothing has changed, and none feels that integrating ICT in science lessons or activities has decreased since last time.

For participation in professional development activities (attending workshops, courses, etc.), 75.2% of primary and 81.6% of intermediate school teachers respond that participation in professional development activities has become more than before, 17.3% of primary teachers think there is no change, and 7.5% think that the participation in professional development activities has become less than before. However, 14.9% of intermediate schoolteachers think that there is no change in the participation of professional development activities thinks and 3.5% think that this participation has become less than before.

Participants were also asked two direct questions. The first one was to what extent they agree, on a five-point Likert scale, that changes in science curriculum have helped in improving students' performance in science. Both primary and intermediate schoolteachers agreed that there have been changes which improved students' achievements. The second question was about the extent to which changes in science curriculum helped in improving TIMSS 2015 results in Bahrain. Their responses reveal that such changes did improve students' achievements on TIMSS scores.

5. DISCUSSION

Data collected from the Principals and Mathematics and Science teachers of both primary and intermediate schools were analyzed statistically. The statistical analysis revealed many facts, which can be considered as quality indicators having influenced the performance and achievement of students in the TIMSS exams. Of these quality indicators, school environment and organization hold an important position and play an effective factor in achieving curricular goals. The school context questionnaire used in this study contained many aspects such as school characteristics, shortage of instructional resources and lack of facilities, safety and security and a sense of belonging to school. Adequate working conditions and facilities, as well as enough instructional resources, were also considered important for maintaining a favorable learning environment in schools (Cohen *et al.*, 2009). Instructional resources include teaching materials, supplies, school buildings, classroom space, technology-based equipment such as smartboards, computers and tablets, and Internet access. Besides, there may be subject-specific resources for mathematics and science like specific software/applications, calculators, laboratory equipment, and instructional materials; besides, having a good well-equipped library, a science laboratory and computers.

Teachers and principals were asked to express their assessment on school safety and discipline because previous researches had revealed that there was a positive relationship between academic achievement and school effectiveness. Respondents agreed that lack of discipline and a feeling of insecurity can lead to lower academic achievement. It was also agreed that students with a strong sense of belonging felt safe at school, enjoyed school, and maintained good relationships with teachers and classmates. Data collected on teacher preparation and professional development and teaching experience shed light on the amount of time devoted for professional development through seminars, workshops and conferences that helped to broaden their knowledge on subject matter and learning the latest pedagogical trends in teaching mathematics and science. These types of professional development opportunities helped teachers to be aware of the recent trends, technology and curricular changes.

Respondents also agreed that the amount of instructional time allotted for each subject, and the number of students in each classroom (class size) were also factors that affected their performance. If teachers have excellent classroom management skills, they can utilize the instructional time effectively to teach the curricular content by employing clear instructions. Teachers can also provide a supportive classroom environment by giving positive feedback, by responding to students' ideas and being concerned about their needs. The data also revealed that investing on technological resources would also accelerate learning and hence contribute to academic excellence. In teaching science, technology can also be used to simulate learning experiments and encourage enquiry-based learning. It was also agreed upon by a majority of respondents that students gain experience in taking tests on their digital devices and online tests in the classroom as well as at home. This boosts students' confidence. Teachers also face many challenges in fulfilling their responsibilities such as heavy workload, additional administrative tasks to be accomplished which consume most of their lesson preparation time.

6. CONCLUSION

School is generally the main establishment across the world for teaching and learning, sharing information and knowledge and imparting training skills. This research has examined School Principals' and teachers' responses to questions in school's context, about school management, instructional resources and about the learning environment in the school as well as in the classroom. This study has provided vital viewpoints from which educational reforms and improvements can emanate. Even though some factors analyzed may not be able to be modified by teachers or principals, they still lead to some important findings that might influence students' achievement and if addressed positively can lead to achieve the TIMSS CenterPoint in the coming examination.

The purpose of curriculum planning in mathematics is to develop high quality, well-coordinated teaching and learning programmes that help children to learn, understand and use appropriate mathematical facts, skills and concepts to ensure that children become numerate, based on the curricular goals and vision of the Kingdom. This

mathematics curriculum is used to plan what is taught to the students in each grade rather than the textbooks. The learning objectives are also used as the basis for assessing the attainment and progress of children, including through end-of-grade examinations along the six domains: Number and Operations, Algebra, Geometry, Measurement, Data Analysis and Problem Solving. Even though the domains and strands are described separately, mathematics has many connections within and across topics. Problem solving is identified as a separate domain, but the approach of the Bahrain Numeracy Strategy suggests that problem solving should not be taught separately but integrated into all teaching and learning.

The following efforts are already in practice:

Bahrain Teachers College – aiming at development in teachers' pedagogical content knowledge, building confidence, devising innovative classroom management skills, and improving quality of teaching to improve students' basic mathematics/science skills in a student-centered learning environment.

Leadership: Arranging leadership training, courses, seminars for leaders to enhance their leadership skills.

School management and Hours of instruction: Teacher is one of the most important components of teaching and learning process (Anderson, 2004). Apart from their regular teaching loads teachers are loaded with various administrative tasks.

Teachers' satisfaction on their job/responsibilities: Professional development trainings/seminars/workshops for teachers/principals are organized to improve content knowledge and teaching skills.

School resources: There is a lack of well-equipped science lab or related resources. The BNS insists upon to provide latest resource materials for both teachers and students especially in Science. The BNS has already revised the Mathematics curriculum and provided schools with various teaching materials and sample lesson plans. Many teachers already use textbook as the main/only source for teaching.

Use of computers and effective technologies in learning: The BNS insists to integrate new or updated technologies to foster learning.

School/Climate for learning: The authorities emphasizes upon reducing rate of absenteeism, arriving late to school and skipping classes which influence instructional continuity and consequently academic achievement. Teachers should work hard to motivate students to be regular, punctual and help building a good learning climate.

Interaction/collaboration with other teachers: It is also important to create opportunities for teachers to collaborate with other teachers in order to exchange ideas.

Bahrain Numeracy Strategy: BNS has specified benchmarks about class size, infrastructure requirements, instructional time for each class, limitations to conduct various classroom activities, integrating computers with latest technology. Such instructional approaches about structure and pace of lessons are essential to monitor students' progress and provide effective feedbacks, analyze and address misconceptions, help or encourage students to use technology. All these will help to create a positive attitude towards mathematics. Besides, it is also important to adopt disciplinary measures in the school.

Security policies and practices: Policies related to school Safety and student behaviors that would make a difference in the level of students' achievement are already in place in the system. This will help in creating an enabling learning environment for acquiring knowledge and skills in Mathematics as well as Science. It is also important that students feel secure and comfortable since achievement in mathematics and science is positively related to what safety standards the schools follow to help students excel in learning.

Students' attitude and beliefs about Mathematics/Science: Lastly, those who like or value mathematics and are confident seem to be successful and good achievers.

It is hoped that the findings of this study will help the school authorities, the Principals and teachers, to achieve these BNS benchmarks and accomplish TIMSS 500 Centerpoint in the next exam.

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