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THE INCLUSIVITY OF TIMSS' PHYSICAL SCIENCE STANDARDS IN THE FOURTH GRADE SAUDI SCIENCE CURRICULUM

Abstract:

This study aims at analyzing the fourth grade Saudi physical science curriculum in light of TIMSS standards. A modified version of Mousa's multitude measurement tool was implemented after being checked for validity and reliability. Five teachers who have at least 15 years of experience were participated in conforming the analysis according to a sequence of legitimate steps.

It has been shown that the Saudi fourth grade science curriculum has tackled TIMSS content and cognition dimensions adequately on the Physical science area. At the content paradigm, all topical areas on force, electricity and magnetism, and matter and properties were targeted. Yet, subjects on light were entirely discarded.

The cognition paradigm has been targeted variously; the factual knowledge came on the top list, followed by conceptual understanding, and reason and analysis. The less rated standards were drawing reflective models or diagrams of understanding, and the formulation of questions based on depicted information.

Keywords:

TIMSS, Curriculum, Content, Cognition

Introduction:

The advancement in science has been amazedly accelerating over the last century. Science information is rapidly growing, and evolving in different domains. With the same token, the educational strategies of corresponding to the increase body of knowledge have witnessed a dramatic change. More focus has become on pathways leading to these information and applications; rather than an absolute attainment.

The call of an educational reform to encompass all these changes has been always considerable. The pathway to adapt a reform in science education has come through six movements since the nineties of the last century: 1) The megatrend of science-technology-society (STS) 2) Project 2061 3) Project on scope, sequence, and coordination (SS &C) 4) National Science Education Standards (NSES) 5) National Education Goals : America 2006) Trends in International Mathematics and Science Study (TIMSS).

The accumulate reform effort may lead to a progress in the science education field; yet, the measure of such success should always be determined by what students know and be able to do. The TIMSS is a study that reflects the quality of science education from two perspectives: content and cognition. The content dimension covers life, physical, and earth sciences. While cognition dimension tackles primarily knowledge applying and reasoning.

The TIMSS is a valuable benchmark to look at science education in general, and science curricula in particular. Therefore, this study falls in a solidarity with other studies that tend to view intended science curricula from the TIMSS mirror.

Background:

TIMSS is an International study that is carried out every four years under the supervision of the International Association for the Evaluation of Educational Achievement (IEA). The history of the first International study in Mathematics was carried out in 1964, while students performance in science was firstly assessed within six other disciplines in 1971 FIMS. The assessment in math and science was under investigation by many studies between 1970 -1984, and between 1982-1983 a mega study was conducted and followed by the second international study in science in 1984. In 1990, the general meeting of the International Society to evaluate educational performance decided to assess students' performance in math and science together on a regular basis. That decision was extended, and has been implemented for the first time in 1995 under the study of TIMSS, and carried out consecutively in 1999,2003,2007, and 2011 (Arora and others, 2008).

TIMSS focuses on educational policy and practice to improve the teaching and learning of science and math. It provides an integrated base needed to support the developmental process, and to setout policies of educational strategies. The driven data is a rich source of each participating country to conduct concrete analysis of the educational math and science as benchmarked to the performance of other countries. It is also a study that comes cross different educational systems to reflect the math and science status with respect to diverse cultural, economical, and social backgrounds.

In Saudi Arabia, the government directs a great budget of its gross domestic product to develop education. The elevation of education has dramatically witnessed considerable movements that impacted the level of literacy. "Yet in a recent set of standardized global math tests, the Trends in International Mathematics and Science

Study (TIMSS), under half of Saudi 13-year-olds reached the lowest benchmark, compared with 99 percent in South Korea and 88 percent in England." (Jiffry, 2013)

The overall Saudi students' performance in TIMSS has become under the lens of all proponents that are concerned with the quality of education. It had been one of these factors that has driven The Ministry of Education to launch a prosperous science and math curriculum development. Science textbooks were adopted according to McGraw-Hill series, along with teacher guides, supplementary materials, and a complete professional development solution for teachers. In addition, the math and science core has stroke the attention of many researchers to investigate the quality of teaching and learning process. For example, Dodeen, Abdelfattah, Shumrani, & Abu Hilal (2012) conducted a study comparing Saudi Arabia and Singapore in terms of the effects of teachers' qualifications, practices, and perceptions on student achievement in TIMSS mathematics. Furthermore, Al-bursan and Tighezza (2013) assessed the practices of Saudi science teachers, and implied that 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.

Many factors determine what a student learns in school, but TIMSS clearly demonstrated that one important factor is the curriculum to which students are exposed. For example, each nation performed more and less well in particular areas of mathematics and science emphasized in that country. U.S. 13 year olds scored second among TIMSS countries in the area of "life cycle and genetics"—topics that tend to be highlighted in middle school and junior high school curricula. But they scored near the bottom of TIMSS countries in the area of "physical changes," reflecting the lower emphasis in U.S. curricula on the physical sciences (Schmidt and McKnight, 1998).

Statement of the Problem:

Solid science curricula are not determined as if they are a mile wide, and an inch deep, or if they suffer a splintered vision , but by the quality of their outcomes, which reflect an integrative and balanced scientific base. Hence, the assessment of any science curriculum should be endeavored from well recognized International benchmarks to mirror their essences.

TIMSS is a substantial reference that many countries look to assess their science education accordingly. Saudi Arabia ranked in 2011 below the International average for the fourth grade science according to IEA' s report. Therefore, it is vital to examine how Saudi science curricula are lined up with TIMSS trends. In addition, it is important to look at these curricula in a comparison with curricula from other countries.

Consequently, this study is raising this question:

To what extent do science curricula in Saudi Arabia and some other countries correspond to TIMSS trends for the fourth grade in Physics?

Methodology:

Descriptive analysis demonstrates patterns in the studied phenomena, and makes judgments based on quantitative measures. Accordingly, Toimah (2004) asserts that the descriptive analysis approach reveals profound indicators when it is used to draw judgments on the compliance of a curriculum material against a set of criterion.

In this study, all physics subjects that are encompassed in the Saudi fourth grade science textbooks, and teacher guidance will be descriptively analyzed against the content and cognition strands of TIMSS' trends at the same level. The results of this analysis will then be compared against each other and discussed on light of Mousa's study (2012) which has looked at the fourth grade Palestinian science curriculum.

The Instrument:

Mousa (2012) developed a multitude measurement tool to analyze the Palestinian science curriculum according to TIMSS' trends. The measurement was profoundly designed through the adaption of legitimate process, and referring to related studies such as Jung-Chih & Wang-ting (2009), and Karousi (2010). The validity of the instrument was checked, and a high reliability of 0.96 was reported.

This study will adapt a modified version of Mousa's instrument through the administration of 48 items associated with the physical educational aspects; 25 items are related to physical education subjects, while 23 items are reflecting cognition.

The modified version of Mousa's instrument was assessed for reliability. The test-retest technique was conducted by the researcher, and the interval time between the two measurements was 17 days. The coefficient correlation between the test-retest scores is 0.78, which indicated that the modified version is reliable.

Process:

The instrument was discussed with the analyzing team which is compiled of five science teachers whom experiences exceeded 15 years. All items were clarified, and the analysis procedures went through the following order:

1- Acquiring the latest version of the fourth grade science textbook in Saudi Arabia, and teacher guidance book.
2- Selecting all pages tied with physics subjects including graphs or figures, and lesson/unit assessments.
3- Identifying all the standards stressed out in the instrument and pinpointing to associated items.
4- Reading through the transcript, and making marginal brief notes of each theme.
5- Filling out the instrument based on recorded thematic notes.
6- Re-reading through the transcript, and refilling a new copy of the instrument.
7- Comparing the two filled versions and ascertaining quoting.

Results:

The physics content has revealed that TIMSS standards are presented fairly in the Saudi fourth grade science curriculum. Eighty percent of the physics content standards are indicated as being targeted in the Saudi fourth grade science curriculum; while twenty percent of the standards are discarded. Overall, the Saudi fourth grade science curriculum has best stressed the physics content standards comparing to the Palestinian fourth grade science curriculum, which only targeted 33.8 % of these standards.

Looking more precisely on these standards, subjects on light are significantly neglected in the fourth grade Saudi science curriculum, while the fourth grade science curriculum in Palestine encompassed light standards by 20.9 %. In contrast, standards on force have been stressed closely across the Saudi fourth grade science curriculum, while the Palestinian curriculum neglected all standards on force.

In addition, electricity and magnetism standards are well represented in the Saudi curriculum by the inclusion of all the sub-standards. In contrast, the Palestinian fourth grade science curriculum has only targeted 12.9 % of the sub-standards; however, this percentage looks apparent among other standards arenas.

Overall, the Evaluation of Educational Achievement (IEA) has specified that TIMSS content domains and topic areas of the physical science assessment are targeted by 35 %. Accordingly, the Saudi fourth grade science curriculum has targeted the content and topic areas of the physical science significantly by the inclusion of 21 sub-standard out 25 standards.

The above results fall in line with a previous study conducted by Al-shai and Shinan (2006) reporting that elementary Saudi science curricula have considered fairly force topics, and moderately topics on matter and energy. With the same token, these results are backed by Al-fahidi study (2013) which has indicated that the first four series of the Saudi science curricula books have taken great paces on subjects of force and movement , and an intermediate inclusion of strands on energy sources and impacts, as well as, matter's properties and classifications. According to its measurement tool, TIMSS physics content standards were accumulatively ranked 3.51 out of 4 in the Saudi fourth grade science curriculum revealing a very high degree of consideration.

While the two studies share the same results inclining to the prominent inclusion of the subjects of force, energy, and matter in the Saudi science elementary curriculum, they did not pinpoint to the topic of electricity and magnetism. It could be that topics of interest in these two studies were determined to meet certain aims that electricity and magnetism was not among them.

The standard deviations of all sub-standards have revealed that there is a high consistency among evaluators. In the Saudi curriculum, only two items were slightly diverted among the evaluators' rankings. One item coded with a standard deviation (11.18), which has been rated "strongly agree" by four evaluators, while one evaluator chose the "agree option". In addition, another item was more diverted among evaluators' rankings; the standard deviation was coded (17.7), which reveals a discrepancy among evaluators response. The item was looking at the identification of different energy sources; it could be possible that some evaluators correlated its availability with a minimum number, while others were looking for more sources.

The cognition dimension has been represented significantly across the two science curricula. Mousa's study (2012) recorded that the fourth grade science curriculum (including physics, life science, and Earth science) in Palestine has targeted 56.6 % of the cognition skills. Nonetheless, the analysis of the physics subjects in the fourth grade Saudi science curriculum has shown that cognition skills were targeted comprehensively on some perspectives. Eighty percent of the physics cognition standards are indicated as being targeted; while twenty percent of the standards are discarded.

In the Saudi curriculum, the conceptual understanding dimension was weighted 79% showing that 21% of its sub-dimensions was neglected. Primarily, drawing reflective understanding models was marginally considered, and Yet, sub-dimensions such as representing data into tables and figures, drawing models that reflect understanding, constructing hypotheses, and inducing expectations of physical impacts are less considered.

The standard deviations have revealed that there is a high consistency among evaluators in considering as many as sub-standards. One item was apparently diverted among the evaluators' rankings, and was coded with a standard deviation (30.5). The item is tied with the manifestation of inductive and deductive reasoning to solve problems. It is a possibility that some evaluators have overviewed inductive reasoning (drawing conclusions from evidence), and deductive reasoning (finding evidence to support or disprove conclusions) as being inclusive in preceded standards.

Another item was also apparently diverted among evaluators' rankings; the standard deviation was coded (17.7), which reveals a discrepancy among the evaluators' responses. The item was looking at the identification of different energy sources; it could be possible that some evaluators correlated its availability with a minimum number, while others were looking for more sources to show this standard as being accountable.

Conclusion:

The identified list of physical science standards has shown that the Saudi fourth grade science curriculum has tackled TIMSS content and cognition dimensions adequately. At the content paradigm, all topical areas on force, electricity and magnetism, and matter and properties were targeted. Yet, subjects on light were entirely discarded. In contrast,

The cognition paradigm has been targeted variously; the factual knowledge came on the top list, followed by conceptual understanding, and reason and analysis. The less rated standards were drawing reflective models or diagrams of understanding, and the formulation of questions based on depicted information.

Recommendations:

1- Analyzing third grade and fifth grade science curriculum to look at how these standards are complimented over different stages.
2- Analyzing implemented, and achieved fourth grade Saudi physical science curriculum to look how they are corresponding to these standards.

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Appendix

Table 1.

Content Analysis (Average Percentage and Standard Deviation)

Standard		S. A. Average Percentage	S. A. Standard Deviation.
Count the three states of matter.	matter and properties	% 100	0
Identify that matter transfers from state to another through: heating, cooling, evaporating, and condensing.	matter and properties	% 100	0
Clarify the transformation of matter with concepts of melting, freezing, heating, evaporating, and condensing)	matter and properties	% 100	0
Describe matters based on physical properties.	matter and properties	% 100	0
Recognize metals' properties and usages.	matter and properties	% 0	0
Recognize water properties and usages in three forms: solid, liquid, and gas.	matter and properties	% 95	11.18
Distinguish between a pure substance and a mixture.	matter and properties	% 100	0
Explain physical methods to resolve a mixture to components.	matter and properties	% 100	0
Recognize chemical and physical changes occur on a matter.	matter and properties	% 100	0
	(85 %)		
Identify different energy sources.	Energy	% 75	17.7
Identify some energy applications.	Energy	% 75	0
Recognize heat transformation from a hot object to a cold object.	Energy	% 100	0
	Energy	% 100	0

Compare between different substances in terms of heat conductivity.		(83 %)	
Recognize normal light resources (light, candle, the Sun).	Light	% 0	0
Discover some light properties.		% 0	0
Correlate between eminent physical phenomenon and light properties (reflection, rainbow, shadow).		% 0	0
		(0 %)	
Explain a close circuit necessity to electrical machines.	electricity and magnetism	% 100	0
Classify electrical conductive and nonconductive materials.		% 100	0
Recognize a magnet bar with north and south poles.		% 100	0
Discover attraction of different magnet poles and repel of same poles.		% 100	0
Explain a magnet ability to attract materials and objects.		% 100	0
		100 %	
Recognize forces acting on a moving object.	Force	% 100	0
Comparing the impact of small and large force acting on an object.		% 100	0
Explain a change in an object position due to a force.		% 100	0
Count the general forms of force.		% 100	0
		% 100	
		% 80	

Table. 2

Cognition Analysis (Average Percentage and Standard Deviation)

Standard		S. A.	
		Average Percentage	Standard Deviation.
Factual	Recall accurate statements about: science facts, relationships, processes,	100 %	0

Knowledge	concepts, and specific materials' properties.		
	Define Scientific terms using Scientific terminologies, abbreviations, symbols, units in relevant contexts.	100 %	0
	Describe substances by demonstrating knowledge of properties, structure, operations, and correlations.	100 %	0
	Provide examples reflecting understanding of scientific concepts.	100 %	0
	Support scientific statements with reflective examples.	100 %	0
	Demonstrate Knowledge associated with science apparatus, and measurement tools.	100 %	0
		100 %	
Conceptual Understanding	Compare and classify substances based on properties.	100 %	0
	Clarify scientific facts and concepts through examples.	100 %	0
	Draw Models or diagrams to reflect understanding of scientific concepts, correlations, and processes.	25 %	11.18
	Correlate physical concepts with observed or inferred properties.	75 %	17.67
	Exhibit data associated with a scientific concept or a principle into appropriate tables and graphs.	75 %	0
	Explain Physical phenomenon or observations in light of Physical concepts and/or, principles , and/or laws, and/or theories.	100 %	0
		79 %	
	Analyze	100 %	0

Reasoning and Analysis	contextual problems based on relevant concepts, relationships, and scientific approaches.		
	Use inductive and deductive reasoning to solve problems.	75 %	30.5
	Synthesize Variables or related concepts to propose a solution.	100 %	0
	Integrate mathematical concepts and procedures into the solution of problems.	100 %	0
	Propose an understanding of unified concepts and themes across the domains of science.	50 %	17.67
	Formulate questions based on acquired concepts and recorded observations.	25 %	11.18
	Construct testable hypotheses that can be answered by observations or conceptual understanding.	50 %	0
	Make expectations of physical changes in light of scientific evidence and understandings.	50 %	0
	Design investigations to test hypotheses by pinpointing to variables and cause-and-effect associations.	75 %	0
	Record measurements demonstrating applications of apparatus or tools.	100 %	0
	Detect patterns in recorded data and interpolate or extrapolate a conclusion.	50 %	11.18
		61 %	
		80 %	