Analysis of Cycle-1 Primary Science Textbooks in the Kingdom of Bahrain for Reflection of Reform

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Abstract

This research paper is the product of a research grant project (27/2012) that was approved and supported by the Deanship of Scientific Research at the University of Bahrain. Research papers in the field of Science education and educational reform documents have always emphasized the important role of analyzing the contents of science textbooks in improving the science teaching, learning and assessment processes. The broad objective of our analysis is to explore the effectiveness of Cycle-1 Primary Science textbooks and workbooks in terms of their reflection of the Bahrain Ministry of Education's school and curriculum reforms. When analyzing textbook contents, researchers examine the readability level, gender distribution, questioning cognitive levels and location, and graphical representations of concepts. The purpose of this paper is to quantify the type, quality and pedagogical functions of the graphical representations of the newly developed Cycle-1 primary science textbooks and the accompanying workbooks and to quantify the nature, location and cognitive levels of the texts questions as well. Twelve Science textbooks and workbooks were examined using an author-developed graphical analysis grid was used to examine the graphical representations. Descriptive statistical analysis was performed. Results showed domination of the non-analytic form of graphics. Maps and scale diagrams were almost absent and most of the graphs were of static nature. Analysis also showed that indigenous graphics were dominant over foreign graphics. About a third of the graphics served a specific cognitive function and were connected to the text, and most of them were captioned and indexed. An author developed questions analysis grid was used to examine the in-chapter and end-of-chapter questions and problems of 6-cycle-1 science textbooks. Analysis showed the following distribution of categories of questions and problems: knowledge, 29%; comprehension, 30.5%; application, 12.7%; analysis, 15.2%; synthesis, 7%, and evaluation, 5.5%. Further research is undergoing to establish a connection between graphical representations and students' achievements and attitudes towards science and to analyze the cognitive level of questions in relation to their respective objectives.

1. Introduction

Educators have always emphasized that textbooks play a vital role in the teaching and learning processes and in promoting specific curriculum vision and type [1] [2]. For this reason, various research studies have been conducted on science- textbook analysis in the past several decades. Since textbooks are being used as major sources of information in teaching the particular subject, therefore, the quality and accuracy of the content of those texts are crucial to their educational effectiveness and to students' learning and attitudes towards science.

International organizations, such as UNESCO formulated comprehensive strategies and guidelines for analyzing texts and modes of presentations; such as the use of illustrations, photos, maps, and tables and exercises in textbooks [3].

Researchers look at the following when analyzing the science textbooks: balance between theoretical and practical knowledge, portrayal of minorities, women and gender fairness, distribution of graphical information, vocabulary load, readability, the role of textbook questions, dealing with misconceptions, and cultural and religious sensibility. A number of analytical tools have been constructed in recent years in the form of survey questionnaires, rubrics, grids, criteria, rating schemes, and image analysis protocols.

The type and quality of the graphical representations and how they interacted with the textual material in middle school science texts in the United States were quantified by Slough et al., using a developed research instrument Graphical Analysis Protocol (GAP) [4]. They reported that analytic forms of graphics were dominated in the text and one third of all graphics were decorative in nature, most graphics were static, and approximately one third were not connected to the text.

Aikenhead, stated that textbooks are mostly developed in western countries and they primarily serve their own education system and tend to carry western perspectives and culture [5]. Ninnies stated the need to promote indigenous knowledge and local culture of the society in order to make these textbooks effective in other contexts [6].

Lee, reported that the visual representations are commonly found in science textbooks and how they have been used is the focus of discussion among educators [7]. The author examined the extent to which changes in representations in textbooks published in the US over the past six decades. It was found that photographs are more often used than the schematic and explanatory images to promote the familiarization to students.

Ajda Kahveci, quantitatively analyzed the effectiveness of Turkish chemistry and science textbooks [8]. The author applied content analysis procedure to investigate gender equity, questioning level, science vocabulary load, and readability level and concluded that the textbooks included unfair gender representations, a considerably higher number of input-level and processing than output level questions, and high load of science terminology.

Nakiboglu et al, analyzed grade-10 school chemistry textbooks' questions in Turkey [9]. They found that most of the questions did not enable students to develop conceptual understanding and gain higher-order cognitive skills.

Davila et al, classified the end-of-chapter questions and problems of selected general chemistry textbooks in USA [10]. They found that about 70% of the questions covered low-cognitive levels, while about one third only covered the high-order thinking skills.

2. Rationale and Purpose of the Study

As part of the Bahrain Educational reform ourselves, we needed to perform this whole critical review of cycle-1 primary science textbooks and workbooks in order to reflect on how they are aligned with the principles and standards of the science curriculum reform and with the guiding principles of the Bahrain MOE education reform as a whole. This study is considered of a benefit to curriculum developers and teachers in producing reform-oriented science textbooks, which would help in improving the quality of science textbooks used in Bahrain.

Textbook quality has been correlated directly and indirectly to the success of education reforms and to the enhancement of students' understanding [1] [11] [12] [13]. Well designed and written textbooks are shown to help students to understand the difficult concepts and overcoming scientific misconceptions. They are also expected to raise students' interests in learning science topics and improve students' achievements in science.

According to Holliday, low-level cognitive questions reduce learning effectiveness of concepts and ideas [14]. On the other hand, Watts et al stated that higher level cognitive questions broaden students' attention [15].

Leonard highlighted the role of in-text questions in assessing students' learning [16].

In this study, we utilize an authors' developed grid to quantitatively explore the type, function and quality of the graphical representations in cycle-1 primary science textbooks. In addition, an author developed questions analysis grid is used to examine the in-chapter and end-of-chapter questions and problems of 6-cycle-1 science textbooks.

3. Process of Developing Science Textbooks in Bahrain- Context of Study

The school Science and Mathematics curricula reform in Bahrain was triggered by the (TIMSS) results.

As described in Abdel-Hameed, F., a Science and Mathematics curriculum development team was formed [17]. The team's job was to develop a new improved 1-12 Science and Mathematics curriculum that adopts inquiry and critical and creative thinking-based approaches. Development included the content of textbooks, workbooks, teachers' instruction manuals as well as other learning and instructional materials.

The team started to examine various science and mathematics textbooks and accompanying

Table 1. List of textbooks under study

No	Level	Part	Title	Pages
1	Primary 1	I	Students' Text Book	128
2	Primary 1	I	Students' Work Book	40
3	Primary 1	II	Students' Text Book	126
4	Primary 1	II	Students' Work Book	33
5	Primary 2	I	Students' Text Book	120
6	Primary 2	I	Students' Work Book	52
7	Primary 2	II	Students' Text Book	126
8	Primary 2	II	Students' Work Book	53
9	Primary 3	I	Students' Text Book	138
10	Primary 3	I	Students' Work Book	54
11	Primary 3	II	Students' Text Book	148
12	Primary 3	II	Students' Work Book	54

materials from international publishing companies, looking for high quality learning materials in which the content addresses the ideas students are intended to learn, as described in the modified curriculum, and the instructional modes support effective teaching and student achievement of a learning goal. McGraw-Hill Science and Mathematics K-12 package was chosen. A team of Science consultants and specialists performed, supervised and reviewed the adaptation and alignment of the Arabic versions of all learning materials with the Bahraini curriculum, with the aid of Obeikan publishing of Saudi Arabia.

Science: A Closer Look, from McGraw-Hill Science for primary 1, 2 and 3 offers students' exciting and accessible standards-based lessons,

Table 2. Graphic types with description

Graph Type	Description
I - Topic Area	
Plant	A plant photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arabic world)
Animal	An animal photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arabic world)
Human	A human photo or drawing, female or male
Environmental Science	An environmental photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arabic world)
General	A general-science photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arabic world)
Earth Science	An earth science photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arab world)
Physical Science	A chemistry or physics photo or drawing of indigenous (local Arabic –from the Gulf – or Bahraini) or foreign origin (outside the Arabic world)
II – Form	
Photograph	Photograph only
Drawing	All features are shown in details
Map	Geographical features with spatial relation to other objects
Table	Cells, rows and columns
Flow chart	Arrows or numbers indicating stages
Graph	Relationships, statistical bar or pie graphs
III - Ethnic representation	
Indigenous	Local photograph (gulf states or Arabic) or drawing
Foreign	Non-local photograph or drawing
IV - Gender representation	
Female	Female human photograph or drawing
Male	Male human photograph or drawing
V- Indexing	
None	Photograph or drawing is not mentioned in text
indexed	Photograph or drawing is mentioned in text
VI- Captioning	
No caption	No title or description under graph or drawing
captioned	A title or description is written under graph or drawing
VII- Quality	
Dynamic	Use series of images to show change over time in graph or drawing
static	No change with time in graph or drawing
VIII- Function	
Decorative	Does not support text, if taken out does not cause any difference in understanding of the written text
Related to Text	Important to text written, if taken out will affect understanding of text

engaging activities which promote curiosity and foster the development of science inquiry skills. Through a consistent and structured learning cycle (Engage, Explore, Explain, Evaluate and Elaborate), students confidently build upon their experiences to develop a lifelong understanding of science concepts in the following fields: Life sciences, Physical sciences, Earth sciences and Environmental sciences.

4. Methodology

4.1. Sample

The sample consisted of all Cycle 1 Science Students' Text-Books and Workbooks adopted in all government schools in the Kingdom of Bahrain for the graphical representations analysis. For questions

nature & cognitive levels analyses, only 6-textbooks were considered. Table 1 lists the titles that were covered in this study.

4.2. Research Tools

All graphics in the selected books were coded and analyzed with the researchers' developed Graphical Analysis grid.

Table 3. Classifying End-of-Chapters and In-Chapters Questions

Unit	Objectives	Type / level of question											
		Formative (in-chapter)						Summative (end-of-chapter)					
		K	U	Ap	An	E	C/S	K	U	Ap	An	E	C/S
1													
Total													

K= Knowledge, U= Understanding, Ap = Applications, An= Analysis, E= Evaluation, C/S= Creativity/Synthesis

We looked for the graphs' form, function, topic area, quality, ethnic representation, gender representation, type and relation to text. Table 2 lists the categories of graphics with clear descriptions, as was described in Abdel-Hameed, F. [17].

For analysis of questions, the six Science textbooks were examined using an author-developed questions analysis grid, shown in Table 3.

4.3. Analysis Procedures

As described in Abdel-Hameed, F., following the development of the graphical analysis instrument, a coding key was used to establish a common understanding among the researchers [17]. The data for each category were tabulated for each chapter in each textbook and workbook on a paper matrix. The data were then entered into an excel file and descriptive statistics for each variable were calculated. The grid was validated previously as described in Abdel-Hameed, F., by two science education specialists [17]. In order to enhance the validity and reliability of the analysis procedure, two well experienced science curriculum specialists helped in performing the initial classification of the graphical representations, then the main author reviewed and re-entered the data into the excel grid for descriptive statistical calculations.

Questions were classified using the original and revised Bloom's taxonomies of educational objectives, as it is based on a clear hierarchical cognitive framework from simple to complex and

from concrete to abstract [18] [19]. Our analysis focused on the in-chapter and end-of-chapter questions and problems. In order to ensure the reliability of our classification of questions, we did the following: agreed upon an initial scheme based on the analysis of randomly selected questions, then both authors and an assistant independently analyzed one randomly selected chapter questions and classified them. Results were then compared, cases of disagreements were discussed, and a final category code was agreed upon. We repeated this process until we reached about 90% agreement. Then each researcher analyzed and categorized the assigned chapters/texts questions independently.

5. Results and Data Interpretation

5.1. Graphical Representations' Analysis

In the following section, overall statistics regarding the number of pages and graphics analyzed, as well as results by research question according to the overall categories of: form, function, quality, ethnic representation and gender representation are reported for every grade level of cycle1's science texts and workbooks.

About 2,551 graphical representations were analyzed in the 12- textbooks and workbooks (two parts for every grade level). Illustrations covering all science topic areas were examined to answer the first research question in this study;

(1)What are the frequencies of the graphics among the science topic areas?

Table 4. Frequencies of graphics in various topic areas for Cycle-1 primary Science textbooks and workbooks

Grade	Topic Area									
	Life Sciences (Plant + Animal + Human)		Physical Sciences		Earth Sciences		Environ Science		General	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1 textbook	276	45	21	3.5	22	3.6	70	11.5	218	36
1 workbook	80	38	19	9	1	0.5	3	1.5	106	51
2 textbook	210	36	27	5	35	6	79	13.5	229	39.5
2 workbook	61	32	4	2	5	2.5	7	3.6	114	60
3 textbook	232	32	27	4	19	2.6	75	10.3	371	51
3 workbook	49	20	10	4	3	1	2	1	176	73
Total	908	35.5	108	4	85	3.3	236	9	1214	47.5

As shown in Table 3, for grade 1 students' text books: 45% of the graphics covered life sciences, followed by 36% for general sciences, 11% for environmental science, and 3.5% for both earth and physical sciences. The largest percentage of graphics covered life sciences, as it is the most common topic

area in this age and grade level. For grade 1 work books, general sciences graphics represented the highest percentages (51%), followed by life science (38%), then physical science (9%) and environmental sciences (1.5%), and earth sciences came last with a percentage of (0.5%). For grade 2 students' text books, the same trend was found, as shown in Table 3, with 39.5% of the graphics covering general sciences, 36% life sciences, 13.5% environmental sciences, 6% earth science and 5% physical sciences. For grade 2 work books, the trend was as follows: 60% of the graphics covered general sciences, 32% life sciences, 3.6% environmental sciences, 2.5% earth science and 2% physical sciences. Finally, for grade 3 students' text books: 51% of the graphics covered general sciences, 32% life sciences, 10.3% environmental sciences, 2.5% earth science and 2% physical sciences. For grade 3 work books: 73% of the graphics covered general sciences, 20% life sciences, 4% physical sciences, 1% environmental and earth sciences.

To answer the second research question:

(2)What is the distribution of the various forms of graphical representations?

The graphics in the 12 cycle-1 primary textbooks and workbooks were examined and broken down to photographs, drawings, maps, tables, flow charts, graphs and hybrids, the results are shown in table 5 for grades 1, 2 and 3 textbooks, and in Table 6 for workbooks.

Table 5. Distribution of the forms of graphical representations for grades: 1, 2 and 3 textbooks

Form	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Photograph	568	93.6	532	91.7	647	89.3	1747	91.5
Drawing	29	4.8	32	5.5	49	6.7	110	5.7
Table	3	0.5	5	0.9	12	1.7	20	1
Map	1	0.15	2	0.35	6	0.85	9	0.5
Flow chart	1	0.15	2	0.35	3	0.45	6	0.3
Graph	0	0	1	0.2	2	0.35	3	0.16
hybrid	5	0.8	6	1	5	0.6	16	0.84
Total	607	100	580	100	724	100	1911	100

Table 6. Distribution of the forms of graphical representations for grades: 1, 2 and 3 workbooks

Form	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Photograph	201	96.2	183	96	211	88	595	93
Drawing	3	1.5	5	2.5	17	7	25	4
Table	5	2.4	3	1.5	6	2.5	14	2.1
Map	0	0	0	0	0	0	0	0
Flow chart	0	0	0	0	3	1.25	3	0.45
Graph	0	0	0	0	0	0	0	0
hybrid	0	0	0	0	3	1.25	3	0.45
Total	209	100	191	100	240	100	640	100

Results showed that: in grade 1 textbooks, both part I and II, photographs were the most common form of graphics at 93.6%, while drawings came second at 4.8%, tables at 0.5%, hybrids at 0.8%, maps at 0.15%, flow charts at 0.15%, and graphs at 0%. In grade 1 work-books, both part I and II, photographs were the most common form of graphics at 96.2%, with tables at 2.4%, drawings at 1.5%, flow charts at 0%, maps at 0%, hybrids at 0%, and graphs at 0%. In grade 2 textbooks, both part I and II, the same trend was observed, photographs were the most common form of graphics at 91.7%, with drawings at 5.5%, hybrids at 1%, tables at 0.9%, flow chart at 0.35%, maps at 0.35%, and graphs at 0.2%. In grade 2 work-books, both part I and II, photographs were the most common form of graphics at 96%, with tables at 2.5%, drawings at 1.5%, flow charts at 0%, and maps, graphs and hybrids at 0%. In grade 3 textbooks, both part I and II, photographs were the most common form of graphics at 89.3%, with drawings at 6.7%, tables at 1.7%, maps at 0.85%, hybrids at 0.6%, flow charts at 0.45%, and graphs at 0.35%. In grade 3 work-books, both part I and II, photographs were the most common form of graphics at 88%, with drawings at 7%, tables at 2.5%, flow charts and hybrids at 1.25%, and maps and graphs at 0%.

The third question stated that:

(3) What is the distribution of the forms of graphical representations in the topic areas in the sampled primary science textbooks and work-books for cycle1?

Summaries of the distribution results for this research question are given in Tables 7 and 8 for cycle-1 textbooks and workbooks respectively, which show that photographs dominate all topic areas in all grade levels.

Table 7. Distribution of the forms of graphical representations in topic areas for textbooks

Topic Area	Grade											
	1				2				3			
	Photograph		Drawing		Photograph		Drawing		Photograph		Drawing	
	I	F	I	F	I	F	I	F	I	F	I	F
Life sci	134	111	5	3	65	111	11	2	63	135	7	6
Phys sci	26	1	1	0	4	2	1	0	0	3	0	0
Earth sci	20	2	0	0	10	18	3	0	5	16	0	0
Envi Sci	26	52	0	0	19	50	5	0	11	59	0	6
Gen Sci	206	5	6	2	221	10	5	0	244	15	11	2
Total	412	175	12	5	319	191	25	2	323	228	18	14

(a) Grade 1 textbooks

Form	Grade 1											
	Life Sciences		Physical Sciences		Earth Sciences		Environ Science		General		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Photog.	77	99	18	100	1	100	3	100	102	98	201	98.5
Draw.	1	1	0	0	0	0	0	0	2	2	3	1.5
Total	78	100	18	100	1	100	3	100	104	100	204	100

(b) Grade 2 textbooks

Form	Grade 2											
	Life Sciences		Physical Sciences		Earth Sciences		Environment al Science		General		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Photog	189	92	18	78	30	97	74	96	221	97	532	94.3
Draw.	17	8	5	22	1	3	3	4	6	3	32	5.7
Total	206	100	23	100	31	100	77	100	227	100	564	100

(c) Grade 3 textbooks

Form	Grade 3											
	Life Sciences		Physical Sciences		Earth Sciences		Environment al Science		General		Total	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Photog.	206	93	22	88	15	88	65	94	342	95	647	93
Drawing	16	7	3	12	2	12	4	6	19	5	49	7
Total	222	100	25	100	17	100	69	100	361	100	696	100

Table 8. Distribution of the forms of graphical representations in topic areas for workbooks:

Topic Area	Grade											
	1				2				3			
	Photograph		Draw		Photograph		Drawing		Photograph		Drawing	
	I	F	I	F	I	F	I	F	I	F	I	F
Life sci	48	22	2	0	22	27	0	0	16	29	0	0
Phys sci	19	0	0	0	0	0	0	0	0	0	0	0
Earth sci	1	0	0	0	5	0	0	0	0	0	0	0
Envi Sci	3	0	0	0	0	7	0	0	0	0	0	0
Gen	106	0	0	0	107	0	1	0	172	2	2	0
Total	177	22	2	0	134	34	1	0	188	31	2	0

(a) Grade 1 workbooks

Form	Grade 1											
	Life Sciences		Physical Sciences		Earth Sciences		Environ. Science		General		Total	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Photogr	255	93.5	17	85	18	90	66	97	212	98	568	95
Drawing	18	6.5	3	15	2	10	2	3	4	2	29	5
Total	273	100	20	100	20	100	68	100	216	100	597	100

(b) Grade 2 work-books

Form	Grade 2											
	Life Sciences		Physical Sciences		Earth Sciences		Environ. Science		General		Total	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Photog.	57	95	4	100	5	100	7	100	110	98	183	97.3
Draw	3	5	0	0	0	0	0	0	2	2	5	2.7
Total	60	100	4	100	5	0	7	100	112	100	188	100

(c) Grade 3 work-books

Form	Grade 3											
	Life Sciences		Physical Sciences		Earth Sciences		Environ. Science		General		Total	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Photog.	39	87	6	75	0	0	0	0	161	94	211	92.5
Draw.	5	23	2	25	0	0	0	0	10	6	17	7.5
Total	44	100	8	100	3	0	2	0	171	100	228	100

The fourth question deals with the gender representations:

(4) What is the distribution of the gender representations of graphics in the sampled primary science textbooks and work-books for cycle1?

The answer to the above question is summarized in Table 9, which shows that male representations dominated both photographs and drawings, ranging from 50% to 70% as shown in the Table below:

Table 9. Distribution of the gender representations of graphics for textbooks and work-books

Grade	Gender			
	Photograph		Drawing	
	M*	F**	M*	F**
1 (textbook)	83	31	5	2
2 (textbook)	63	17	6	3
3 (textbook)	99	27	8	3
1(workbook)	13	10	5	2
2(workbook)	21	6	4	3
3(workbook)	31	19	3	1

* M= Male, ** F = Female

Question 5 stated that:

(5) What was the ethnic representation (indigenous, foreign) of the graphics in the newly developed cycle-1 primary science textbooks and workbooks?

Ethnic representation data for both research questions are given in tables 9 and 10 for cycle-1 primary science textbooks and workbooks, respectively. We can see that the indigenous graphics dominated all grade levels in all topics of textbooks, making 60 - 70% of photographs and 60 – 90% of drawings, as can be seen from Table 10. For workbooks, indigenous graphics dominated all grade levels in all topics, making 80 - 90% of photographs and almost 100% of drawings, as can be seen from Table 11.

Table 10. Distribution of ethnic representations in textbooks (I= Indigenous, F = Foreign)

Topic Area	Grade											
	1				2				3			
	Photograph		Drawing		Photograph		Drawing		Photograph		Drawing	
	I	F	I	F	I	F	I	F	I	F	I	F
Life sci	134	111	5	3	65	111	11	2	63	135	7	6
Phys sci	26	1	1	0	4	2	1	0	0	3	0	0
Earth sci	20	2	0	0	10	18	3	0	5	16	0	0
Envi Sci	26	52	0	0	19	50	5	0	11	59	0	6
Gen Sci	206	5	6	2	221	10	5	0	244	15	11	2
Total	412	175	12	5	319	191	25	2	323	228	18	14

Table 11. Distribution of ethnic representations in workbooks (I= Indigenous, F = Foreign)

Topic Area	Grade											
	1				2				3			
	Photograph		Draw		Photograph		Drawing		Photograph		Drawing	
	I	F	I	F	I	F	I	F	I	F	I	F
Life sci	48	22	2	0	22	27	0	0	16	29	0	0
Phys sci	19	0	0	0	0	0	0	0	0	0	0	0
Earth sci	1	0	0	0	5	0	0	0	0	0	0	0
Envi Sci	3	0	0	0	0	7	0	0	0	0	0	0
Gen Sci	106	0	0	0	107	0	1	0	172	2	2	0
Total	177	22	2	0	134	34	1	0	188	31	2	0

The sixth research question stated that:

(6) What were the functions (decorative- doesn't support text, representational- illustrating a concept, organizational- places text within a greater scheme e.g. scale diagram, related to text) of the graphical representations in the newly developed cycle-1 primary science textbooks and workbooks?

The answer to that question is clear from table 12 and table 13, which show that the majority of the graphics were decorative in nature, while a small percentage were representational and organizational (related to text). It can also be seen from Tables 12 and 13 that the number of representational and organizational graphics increases as we go to higher grades. This trend was also seen by Abdel-Hameed, F. et al., for cycle 2 Science textbooks and workbooks [17].

Table 12. Distribution of the functions of graphical representations for workbooks

Function	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Decorative	501	82.5	424	73	496	68	1421	74.3
Representational	58	9.5	92	16	124	17.7	274	14.3
Organizational	48	8	64	11	104	14.3	216	11.3
Total	607	100	580	100	724	100	1911	100

Table 13. Distribution of the functions of graphical representations for textbooks

Function	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Decorative	143	68.4	111	58	132	55	386	60.3
Representational	37	17.7	43	22.5	71	29.5	151	23.5
Organizational	29	13.8	37	19.4	37	15.4	103	16
Total	209	100	191	100	240	100	640	100

Regarding questions 7,

(7)What was the quality (dynamic, static) of the graphical representations in the newly developed cycle-1 primary science textbooks and workbooks?

As shown in Tables 14 and 15, the static graphics dominated in all grade levels and topic areas, with more in the lower grade levels.

Table 14. Distribution of the quality of graphical representations for textbooks

Quality	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Static	505	83.2	451	77.7	514	70.9	1470	76.9
Dynamic	102	16.8	129	22.3	210	29.1	441	23.1
Total	607	100	580	100	724	100	1911	100

Table 15. Distribution of the quality of graphical representations for workbooks

Quality	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Static	178	85	144	75.4	176	73.3	498	77.8
Dynamic	31	15	47	24.6	64	26.7	142	22.2
Total	209	100	191	100	240	100	640	100

The last research question in this study dealt with the indexing and captioning of the graphics in various grade levels;

(8)What was the connection of the graphics, in the newly developed cycle-1 primary science textbooks and workbooks, to the written text (indexing, captioning)?

Tables 16 and 17, show the data regarding the connection of the graphics to the written text (indexing, captioning) in the newly developed cycle-1 primary science textbooks and workbooks, respectively. We can see that about 65-70% of the graphics are captioned and indexed in textbooks and workbooks.

Table 16. Distribution of the indexing and captioning of graphics in textbooks

Indexing and Captioning	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Indexed	421	69.3	415	71.5	451	62.3	1287	67.3
Not-indexed	186	30.7	165	28.5	273	37.7	624	32.7
Captioned	389	64	401	69.2	524	72.3	1314	68.7
Not-captioned	218	36	179	30.8	200	27.6	597	31.3

Table 17. Distribution of the indexing and captioning of graphics in workbooks

Indexing and Captioning	Grade						Total	
	1		2		3			
	Freq	%	Freq	%	Freq	%	Freq	%
Indexed	148	70.8	139	72.7	172	71.6	459	71.7
Not-indexed	61	29.2	52	27.3	68	28.3	181	28.3
Captioned	132	63.2	125	65.4	159	66.2	416	65
Not-captioned	77	36.8	66	34.5	81	33.7	224	35

5.2. In-Chapter and End-of-Chapter Questions Analysis

The objective of this part of the study was to quantify the nature, location and cognitive levels of the questions of the newly developed Cycle-1 primary science textbooks. The data for the questions categories listed in Table 3 were tabulated for each text-book on a paper matrix

The data were then entered into an excel file and descriptive statistics for each cognitive level and location of questions were calculated for each grade level.

5.3. Research questions

(1) What are the frequencies of the questions in the cycle-1 science textbooks, by cognitive level and chapter location?

(2) Are the percentages of high level cognitive questions consistent with the science reform expectations?

About 1584 questions were analyzed in 6-textbooks in order to answer the research questions. The following tables show the analysis results:

Table 18. Classifying End-of-Chapters and In-Chapters Questions- Grade 1-Parts 1 + 2 - Student's Textbook

Unit	Type / level of question											
	Formative (in-chapter)						Summative (end-of-chapter)					
	K	U	Ap	An	E	C/S	K	U	Ap	An	E	C/S
1	12	14	9	9	2	1	4	3	1	2	0	0
2	11	7	12	11	4	1	6	1	2	4	0	0
3	7	13	4	7	3	9	9	2	1	1	2	2
4	6	13	15	3	4	4	8	3	1	2	1	0
5	11	8	8	5	4	5	9	4	1	0	2	1
6	15	9	16	4	4	4	8	3	2	2	1	0
Total	62	84	64	39	21	24	44	16	8	11	6	3

Table 19. Classifying End-of-Chapters and In-Chapters Questions- Grade 2-Parts 1 + 2 - Student's Textbook

Unit	Type / level of question											
	Formative (in-chapter)						Summative (end-of-chapter)					
	K	U	Ap	An	E	C/S	K	U	Ap	An	E	C/S
1	8	22	2	14	2	2	18	5	2	7	2	1
2	5	13	6	15	2	3	13	4	5	8	2	3
3	6	18	1	16	5	1	11	4	2	7	2	7
4	6	18	2	12	2	2	14	4	2	4	1	5
5	7	15	11	11	5	2	17	3	5	6	2	1
6	6	13	3	10	6	1	12	14	3	2	1	3
Total	38	99	25	78	22	11	85	34	19	34	10	20

Table 20. Classifying End-of-Chapters and In-Chapters Questions- Grade 3-Parts 1 + 2 - Student's Textbook

Unit	Type / level of question											
	Formative (in-chapter)						Summative (end-of-chapter)					
	K	U	Ap	An	E	C/S	K	U	Ap	An	E	C/S
1	6	29	7	21	6	2	14	9	6	6	2	8
2	4	27	17	10	0	3	8	16	13	1	0	0
3	3	36	12	3	0	1	15	17	8	3	1	3
4	11	40	10	7	3	3	24	7	6	4	1	5
5	15	52	13	9	4	1	23	16	9	2	3	11
6	4	63	6	7	1	0	16	11	6	5	0	12
Total	43	247	65	57	14	10	100	76	48	21	7	39

Table 21. Summary of the cognitive levels of questions in Cycle-1 primary science textbooks

Cognitive categories	Percentage of total number of questions by textbook and location					
	In-chapter			End-of-chapter		
	Grade1	Grade2	Grade3	Grade1	Grade2	Grade3
K= Knowledge	22%	14%	10%	50%	42%	34.5%
U= Understanding	28.6%	36.3%	56.7%	18%	17%	26%
Ap = Applications	21.8%	9.2%	15%	4%	9.5%	16.5%
An= Analysis	13.3%	28.6%	13%	12.5%	17%	7.2%
E= Evaluation	7.2%	8%	3.2%	7%	5%	2.4%
C/S= Creativity/Synthesis	8.2%	4%	2.3%	3.5%	10%	13.5%

Using the data given in Tables 18 to 21, the average percentages of the categories of questions for Cycle-1 Science textbooks are shown in Figure 1:

Figure 1. the distribution of questions according to their cognitive level

Analysis of school science textbooks showed that low-cognitive level questions predominate, about 73% of the questions.

Higher order thinking questions (analysis, creativity & evaluation) make up to 27% of the questions.

Science textbook analysis, according to Kahveci Davila and Pizzini showed that:

- The input questions (knowledge & understanding) predominate (40-45%), which was 60% in our study;
- The processing questions (application & analysis) come second (35-40%), which was 28% in our study;
- The output questions (synthesis, creativity & evaluation) come last, (15-20%), which was 12% in our study [8] [10] [20].

From our findings, about a quarter of the questions belong to higher order thinking questions, one eight belong to output questions. Therefore, the answer to our second research question is that: science textbooks are consistent with the science reform expectations to a low extent.

6. Discussion and Further Research

In this study, a descriptive statistical analysis of the type, function and quality of the graphical representations in 12-Bahrain cycle-1 primary science textbooks and workbooks was performed. The results of this study suggest that all graphic forms were represented.

Most forms of graphics are represented across all from topic areas of both textbooks and workbooks. About 45% of the graphics in the textbooks covered life sciences, followed by 36% for general sciences, 11% for environmental science, and 3.5% for both earth and physical sciences.

Results also showed that less than one third of the graphics were of the more analytic forms; more than one third served a specific cognitive purpose; 27%

were well connected to the text; 60-70 % were indexically referenced. Two third of the graphics were decorative; 76% were static representations; 30% were not indexically referenced and did not have captions.

This summation shows that graphics were primarily added to the text to make it more appealing to the teachers and students. There was an absence of maps and scale diagrams. Analysis also showed that indigenous graphics represented about 60-70% of the photographs and 60-90% of drawings. Male representations made 50-70% of the graphics.

Our study also focused on the nature, location and cognitive levels of the science textbooks questions. Results showed that 27% of the questions belong to higher order thinking questions; which indicates the newly developed science textbooks are consistent with the science curriculum reform expectations in the Kingdom of Bahrain to a certain extent.

Future work is underway, taking into account the gender equity issues, the readability level and the scientific vocabulary loads. Research is being performed in order to examine the connection between graphical representations and students' achievements and attitudes toward science, as well as analyzing the cognitive level of the questions in relation to their respective objectives.

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