THE FUNDAMENTAL ABILITIES OF INQUIRY IN THE ELEMENTARY SCIENCE WORKBOOKS: THE CASE OF UAE NORTHERN SCHOOLS

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ABSTRACT_*This research investigated the elementary (grades 1 to 4) science workbooks in the UAE for the degree to which they promote fundamental scientific inquiry abilities. A content analysis technique was applied to conduct the evaluation. After scrutinizing 108 workbooks investigative logs, the findings revealed that investigative activities did not give students real opportunities to formulating questions, planning for simple investigations, writing conclusions, or communicating investigations. However, there are evidences that these activities provided opportunities for students to use scientific skills such as observing, measuring, and displaying results. Students were sometimes allowed to manipulate tools and instruments such as rulers, watches, beam balances and spring scales, magnifiers, and scaled tubes. At this level of elementary education, students were not provided with real opportunities to use computers or calculators and they were rarely asked to use mathematics. Recommendations for further investigation are presented.*

KEYWORDS*: United Arab Emirates, elementary education, workbook evaluation, fundamental inquiry abilities.*

I. INTRODUCTION

The importance of the curriculum in school setting shows that the definition of curriculum as a "plan for learning" [1] is still supportive. Moreover, the history of science education reform has primarily rotated around science curriculum and its implementation [2]. Based on personal experience as a science teacher at different school levels for almost 10 years in the United Arab Emirates (UAE), teachers heavily rely on textbooks and workbooks for their instruction. Students must use these educational materials to be promoted to the next class level. According to Elizabeth and Roberts [3], due to the dominant role of textbooks in science curricula, it is important that science educators evaluate them carefully by paying close attention to the images of science they present. Because of the important roles that curriculum materials play in school teaching and learning, careful works should be applied in developing, selecting, and evaluating these texts to accomplish the nation educational goals.

In the United Arab Emirates (UAE), science education becomes one of the nation priorities. The Ministry of Education (MOE) has been providing significant efforts to apply inquiry-based instruction in the national schools. The United Arab Emirates (UAE) has taken considerable reform initiatives since the beginning of the 21st century with regard to teaching science in Emirati schools. The MOE stresses the inclusion of inquiry-based science teaching and learning into public school science curriculum and programs. Seven wide ranging goals for science education are stated in the UAE. These seven goals draw on themes of the nature of science; scientific knowledge; processes of science; scientific inquiry; the interaction of science, technology, and society; scientific literacy; and scientific values, attitudes, habits of mind, and dispositions [4]. These goals are similar to those that are recommended by the contemporary international science education community (see for example, Bybee & Ben-Zvi, [5]; Carin, Bass, & Contant, [6]; National Research Council [7,8]. For example, goal one states that the learner should apply scientific inquiry in a way that could lead the student to develop his/her science thinking skills. Goal seven is oriented towards providing the learner with scientific skills that support more advanced learning opportunities [4]. Moreover, the National Science Curriculum Framework (NSCF) includes educationnal standards for all school science domains for different school levels as well as standards for scientific inquiry which are similar to those emphasized by National Science Education Standards [4,7,9]. Thus, NSCF was developed according to the science education trends that were emphasized by the contemporary international reform documents such as the National Science Education Standards [7] and Benchmarks for Science Literacy [10]. The NSCF is being used as a main source in developing science textbooks and workbooks for all grades in the public school system. Thus, the structure and the components of the textbooks and workbooks must represent goals and standards that were stated in the NSCF. Although researchers in the area of science curriculum argue that science educators periodically should examine goals and their representation in science programs [5], research is very limited on how these and other goals and standards have been implemented in Emirates' classrooms. The research reported in this paper is the first of its kind in investigating science inquiry in the UAE's elementary public schools. This study developed an inquiry framework to assess the elementary (grades 1 to 4) science textbooks and workbooks in the UAE for the degree to which they promote fundamental scientific inquiry abilities.

Curriculum material descriptions.

Grades 1 and 2

The grade one science textbook includes five units namely: They are Plants and Animals All Around; About the Earth; Weather and Seasons; Matter Around Us; and Forces and Motion. The grade two science textbook includes six units namely: Living Things Grow and Change; Living Together; Exploring Earth's Surface; Space and Weather; Exploring Matter; and Energy and Motion. For both grades each unit is divided into two chapters and each chapter includes two, three, or four lessons. Each lesson includes an investigative activity; the total number of these activities is 27. Each investigative activity includes materials that students need to do during the activity and easy procedural steps for students to follow. At the beginning of each unit the unit's project is located. Each unit's project has a paragraph describing it. The workbook contains Science Skill Practices that serve the investigative activities and concept review. Grade one and two students report their investigative tasks via science skill practices. The science skill practices in the student's workbook were all scrutinized for inquiry abilities.

Grades 3 and 4

The grade three science textbook includes six units namely: Plants and Animals; Plants and Animals Interacts; Earth's Land; Cycles on Earth and in Space; Investigating Matter; and Exploring Energy and Forces. The grade four science textbook also includes six units namely: A world of Living Things; Environmental Systems; Earth's Surface; Motion on Earth and in Space; Matter and Light; and Electricity, Force, and Motion. For both grades, each unit is divided into two chapters and each chapter includes two lessons with one exception for chapter two which has three lessons in unit one. Each lesson includes an investigative activity; the total number of these activities in grade three is 25 and 29 in grade four. Each investigative activity specifies its purpose, materials, procedure, and conclusion. The grade three and four students also use a workbook to do the activities and other writing works. The workbook contains investigative logs, concept review, process skills practice, vocabulary review, and concept maps. Grade three and four students report their investigative tasks via instigative logs. The workbook investigative logs were all scrutinized for inquiry abilities.

Scientific inquiry

The international science education reform efforts have emphasized inquiry as an approach that is of major importance to teaching and learning science (DeBoer & Bybee, [5]; Germann, Aram, & Burke, [11]; Keselman, [12]; NRC, [7,9]; Schwab, [13]; Tamir, [14]). As early as the beginning of the second half of the twentieth century, Schwab [13] suggested that teaching of science as inquiry should be a priority in science education. He advocated that teachers should teach students how to conduct investigations by viewing science as a process of inquiry.

In the USA, since the 1960s, science curricula have emphasized the inquiry approach as a way to create literate citizens of today's society [7,9]; Project 2061, [15]; Yager & Lutz, [16]. The national science education standards [7] focus clearly on inquiry. In those standards inquiry refers to the abilities students should develop to be able to design and conduct scientific investigations and to the understanding they should gain about the nature of scientific inquiry. Moreover, it also refers to the teaching and learning strategies that enable scientific concepts to be mastered through investigations.

Referring to the definition of scientific inquiry in the standards documents [7,9], Cuevas, Lee, Hart, and Deaktor [17] claim that scientific inquiry occurs when students formulate questions, plan procedures, design and carry out investigations, analyze data, draw conclusions, and report findings. The NRC [7] also states that "scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" (p. 23). Therefore, students who exercise inquiry to learn science engage in many of the same activities and thinking processes as scientists who are seeking to expand human knowledge of the natural world. Moreover, the standards documents [7] recommend that "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments" (p. 105).

Marshall [18] found that several research results indicate that if there is appropriate scaffolding, grade one students will be capable of inquiry-based learning. Generally, students at the first level of schooling are capable of independent experimental investigations [19]. Therefore, inquiry in this manner is said to be an active learning process and 'something that students do, not that is done to them' [7] According to McConnaughay, Welsford, and Stabenau [20], current research suggests that students should be educated through methods of inquiry and investigation. These methods will enhance recruitment and retention as well as improve knowledge generation and acquisition skills in sciences. Research revealed that students have better attitudes toward science when they are more actively engaged in the learning process [21]. In this present study, inquiry is considered to be any combination of the following activities described as inquiry by the National Science Education Standards [7,9] and Lee, Buxton, Lewis, and LeRoy [22]: identifying or refining questions, planning investigations, implementing investigative plan, proposing explanations and comparing proposed explanations with scientific knowledge (concluding), and communicating report.

International science education reform efforts have emphasized inquiry as an approach which has a major importance to curriculum development and teaching and learning science (Bryant [23]; DeBoer & Bybee [5]; Germann, Aram, & Burke [11]; Germann, Haskins, & Auls, [24]; Jorgenson, [21]; Keselman [12]; Lord & Orkwiszewski [25]; Marx et al. [26]; NRC [7,9]; Nuangchalern & Thammasena, [27]; Wolf & Fraser, [28]; Wu & Hseih, [29]).

Kızılaslan, Sözbilir, and Yaşar [30] state that well-prepared science curriculum should describe students' role as self-directed learner; they are at the central of learning and they process information; they interpret and explain data; they design their own activities; and they form their own interpretations of data. According to them, well designed curriculum provides students with opportunities to explore scientific phenomena, practice problem solving and scientific skills, and refining their critical thinking and working with others in a cooperative and collaborative ways.

The relationship between the curriculum materials and science teaching and learning is obviously recognized. According to Zhang et al. [31], accumulated research findings show that inquiry-based curriculum and instructional methods can improve students' understanding of the content knowledge. Teachers too, can also influence student learning. They are not only implementers of the curriculum but they can also influence the way the curriculum is implemented. It is therefore teachers who are viewed in this research as an active part in the review of curriculum implementation. Although the focus of this study is the curriculum materials; the role of teachers cannot be ignored.

Examples of previous studies

During the last few decades several studies in USA and other countries have been conducted to examine to what degree junior and high school workbooks support students to implement inquiry-based school science curriculum-related activities (see for example, Elizabeth & Roberts, [3]; Eltinge & Roberts, [32]; Germann, Haskins, & Auls, [24]; Shepardson, [33]; Tamir & Lunetta, [34,35]). Tamir and Lunetta [34,35] used Laboratory Structure and Task Analysis Inventory to analyze high school science textbooks' laboratory investigations. The results indicated that these curriculum materials did not provide students with real opportunities to investigate and inquire. Germann, Haskins, and Auls [24] used a modification of Tamir and Lunetta's inventory to analyze nine high school biology laboratory manuals to find out how well these manuals promote science processes that are involved in scientific inquiry. They found that although some manuals made efforts to include a few science process skills, they rarely asked students to use their experiences and knowledge to formulate questions, solve problems, study natural phenomena, or construct answers or generalizations.

Shepardson [33] analyzed science textbook for junior high/middle school students and found that activities tended to stress lower level skills such as information gathering, remembering, and organizing rather than higher level skills such as classifying, inferring, predicting, and hypothesizing. Elizabeth and Roberts [3] developed and used linguistic content analysis method to assess the degree to which science was portrayed as a process of inquiry within a high school biology textbook series. The results indicated that in the textbook series studied, the frequency of the portrayed of science as a process of inquiry increased from 1956 to 1965, and then demonstrated a pattern of decline in 1977 and 1985. Moreover, the results showed that the frequency of portrayal of science as a process of inquiry was higher in introductory chapters of the textbooks and in chapters dealing with the topic of genetics and lower in chapter dealing with leaf structure.

In the UAE, Al-Naqbi [36] used a document review technique to scrutinize a total of 58 investigative logs in order to investigate grades 5 and 6 science workbooks for the degree to which these educational materials promote students scientific inquiry abilities. Findings showed that while the activities allowed students to use appropriate tools and techniques to collect and interpret data, and use their inquiry abilities related to implement investigation plan, they did not allow students real opportunities to formulate questions, plan for simple investigations, write conclusions, or communicate investigations.

II. SIGNIFICANCE OF THE STUDY

It seems from the literature review that most studies that were concerned with the assessment of the process of the inquiry and the degree to what extent science is portrayed as a process of inquiry (Elizabeth & Roberts, [3]; Eltinge & Roberts, [32]; Germann, Haskins, & Auls, [24]; Shepardson, [33]; Tamir & Lunetta, [34,35] have mostly analyzed high school curriculum materials, not elementary school materials. The present study was designed to examine the range of science inquiry abilities in the elementary grades science education workbooks in the UAE. The inquiry framework that was developed and used in the current study could be used in many situations with or without modifications to assess the degree to which grade one, two, three, or four science workbooks promote inquiry abilities. The findings will assist in the planning and preparation of future textbooks and curriculum and instruction decisions in UAE. Moreover, the results of this study could provide suggestions to promote the quality of school science curricula which could lead to increase the effectiveness of hands-on and practical activities as Dagher and BouJaoude [37] recommend for science education in Arab states.

Research Questions

The research aimed to answer the following five main questions:

1. Do elementary grades science workbooks in the UAE public schools provide students with opportunities to formulate questions about objects, organisms, and events in the environment?
2. Do elementary grades science workbooks in the UAE public schools provide students with opportunities to plan for simple investigations?
3. Do elementary grades science workbooks in the UAE public schools provide students with opportunities to implement their plans using scientific skills and employ simple equipments and tools to gather and record data?
4. Do elementary grades science workbooks in the UAE public schools provide students with opportunities to use data to construct reasonable explanations?
5. Do elementary grades science workbooks in the UAE public schools provide students with opportunities to communicate investigations and explanations?

Background framework for the analysis

The analytical framework of this study is based on the work of Brandon, Taum, Young, and Pottenger III [38], Cuevas et al. [17], Lee, Buxton, Lewis, and LeRoy [22], Nowak et al. [39], the NRC [7,9] and Wellnitz, Hartmann, and Mayer [40] on the inquiry-oriented curriculum materials. The NRC [7,9] suggests fundamental abilities of inquiry for grades K to 4, grades 5 to 8, and grades 9 to 12. The current study is one in a series of three studies aimed at finding out to what extent the fundamental inquiry abilities are included in grades K to 4, grades 5 to 8, and grades 9 to 12 [as suggested by NRC [7,9] science workbooks in the UAE. For grades K-4, the NRC proposes five essential inquiry abilities which are: 1) Asking question about objects, organisms, and events in the environment; 2) planning and conducting a simple investigation; 3) employing simple equipment and tools to gather data and extend to the senses; 4) using data to construct a reasonable explanation; and 5) communicating investigations and explanations. Cuevas et al. [17] and Lee et al. [22] suggest an inquiry framework that includes five fundamental abilities which are: 1) Questioning; 2) Planning; 3) Implementing; 4) Concluding; and 5) Reporting abilities.

For the purpose of this study and as results of the previous review, an inquiry framework that includes the five fundamental inquiry abilities which are questioning, planning, implementing, concluding, and communicating was developed and used to scrutinize the elementary science workbooks investigative logs (hereafter referred to as WBILs) regarding these fundamental inquiry abilities. The items of each fundamental inquiry ability in the framework that were used to code the curriculum materials can be found in the NRC [9] and Lee et al. [22]. For example, in the process of implementing inquiry plan, students develop simple skills such as how to observe measure, cut, connect, switch, pour, tie, hold, and hook. Beginning with simple instruments, students learn to use rulers, thermometers, watches, spring scales, and balance beams to measure important variables. They learn to use magnifiers and microscope to see finer details of objects and organisms. Students also begin to develop skills in the use of computers and calculators in investigations [9].

The framework includes 4 abilities for questioning, 6 for planning, 28 for implementing, 5 for concluding, and 12 for communicating inquiry abilities. The study does not expect that all these items can be found in a single WBIL. However, the objective is to draw a picture regarding the availability of all these inquiry abilities throughout all 108 WBILs. Tables 1 through 5 at the result section of this study include the five essential inquiry abilities and their components.

III. METHODOLOGY

Design and procedures

This is a descriptive study using a content analysis technique (Krippendorff, [41]; Tamir, [42]). Unit of analysis were specifically WBILs. For the purpose of this study, the WBILs were used for scrutinizing the five fundamental inquiry abilities as they proposed in the framework. A procedure was followed to develop a framework that used to identify the inquiry abilities included in the elementary science WBILs. Tables 1 through 5 show the framework that included the five inquiry fundamental abilities and their elaborations. The framework was used to examine inquiry abilities in 108 WBILs in four elementary grades (1 to 4).

The inquiry framework includes the fundamental inquiry abilities in elementary education as mentioned above with the details abilities was developed. The validity of this Inquiry Framework was determined by content-related and face-related evidence. For this purpose, a panel of experts from the College of Education in the United Arab Emirates University (UAEU) and Ministry of Education was established to review the guideline. The panel was chosen based on their knowledge of elementary science education, elementary science curriculum and textbook development, science teaching and learning, and content evaluation. The panel included professors, elementary school supervisors, elementary science curriculum and textbook developers, and practitioners. Another team of four (including the author) was established to scrutinize 108 WBILs for inquiry abilities and their aspects as they appear in the Inquiry Framework. Other members of the team included an elementary science teacher, an elementary science supervisor, and a science curriculum developer from the Ministry of Education. To answer the research five questions, the 108 WBILs were scrutinized using content analysis techniques for five fundamental abilities, of questioning, planning, implementing, concluding, and communicating. The evaluation team members attended a training session which focused on content analysis technique and how to use it to scrutinize the selected workbooks using the Inquiry Framework.

Sample

The sample of this research focused on the elementary (1-4) science workbooks that were developed based on the standards that were stated in the National Science Curriculum Framework (NSCF). These curriculum materials are being used in the general education elementary schools at the northern Emirates (Dubai, Sharjah, Ras Al khaimah, Ajman, Al Fujairah, & Umm Al Qaiwain) in the UAE as major resources for both students and teachers and all were published by the Ministry of Education during the 2011-2012 school year and they are still in use completely in schools of six districts of education. The sample included four science workbooks which are Science For All: Workbooks for first, second, third, and fourth Year Elementary Students (2011-2012).

IV. RELIABILITY OF THE ANALYSIS

Reliability for the fundamental inquiry abilities framework was established by following a series of steps. First, the inquiry framework was formed and explained for the team that scrutinized the elementary grades science WBILs. Second, as explained in the previous section, the scrutinizing procedures were carried out by expert reviewers including the author, grade one, two, three, and four science teachers, and a science textbook developer from the Ministry of Education. Third, all WBILs (n = 108) for elementary grades (1 to 4) were analyzed by three of the reviewers. Fourth, all WBILs were scrutinized in elementary grades. Dukes and Kelly [43] recommended sampling 10% of the text for readability studies. Finally, it was decided that agreement rates of 95% or above would provide acceptable levels of reliability for the analysis of the TBIs and WBILs, which above the 87% agreement rate recommended by Kesidou [44].

Objectifying the data

In the inquiry framework that identified the inquiry abilities in each workbook exercise, a scale was used to indicate the degree to which the inquiry abilities included or addressed in the WBILs. In the scale, "1" means that the inquiry ability was given in the WBILs (labeled as “Given”). For example, Given-WBIL was selected when the students did not implement the inquiry ability because it was ‘implemented’ by WBILs. For example, in the cases that WBILs provided students with scientific questions and identified the hypothesis and materials and tools, (Given) was selected. The scale "2" means the WBIL was asking the students to implement the inquiry ability (labeled as “Open”). For example, (Open) was selected when the WBILs asked students to make systematic observation, collect evidences to support explanations, or discuss their results. Inquiry is agreed upon as open when students generate a question and carry out an investigation [9]. Germann, Haskins, and Auls, [24] stated that "the open inquiry laboratory gives students even more independence in conducting inquiry” (p. 482). For each WBIL, every inquiry ability was counted once even if it appeared again in the same activity.

V. RESULTS

The results related to the research questions are displayed in five tables (Table 1 to 5). Each table contains the components of one of the five fundamental inquiry abilities and their frequencies in the elementary grades 1 to 4 science WBILs.

TABLE 1
Inquiry Questioning Abilities Across Four Elementary Grades WBILs

Inquiry Questioning Abilities	Given-WBILs Grades				Open-WBILs Grades			
	1	2	3	4	1	2	3	4
1. Asking a question about objects in the environment	0	2	3	1	0	0	0	0
2. Asking a question about organisms in the environment	0	3	0	0	0	0	0	0
3. Asking a question about events in the environment	0	1	3	2	0	0	0	0
4. Formulating Hypothesis	0	0	0	0	0	0	1	2
Total 4	0	6	6	3	0	0	2	1

Table 1 shows the inquiry questioning abilities included in the framework and their frequencies in elementary grades science WBILs. As presented in Table 1, the grade one science WBILs did not allow students to ask questions about objects, organisms, and events in the environment. The grade two students were not allowed to pose scientific questions. The grade two students were given questions in several times to guide their investigations (total of Given-WBILs = 6). The grade three students were also not given opportunities to pose scientific questions. Several times those students were given questions to answer (total of Given-WBILs = 6). The grade four students were also not asked to pose scientific questions. Students in these grades were given questions several times to facilitate their inquiry (total of Given-WBILs = 3). Although grade two, three, and four students in several exercises were given at least one question to guide their investigation, this opportunity has decreased from 6 in grade two and grade three to 3 in grade four. Table 1 also shows that students in grade one and grade two were not given opportunities to formulate hypotheses and this opportunity is rarely provided to grade three (Open-WBILs = 2) and to grade four (Open-WBILs = 1).

The evidence from table 1 suggests that students in elementary grades were not provided with opportunities to pose scientific questions about objects, organisms, and events in the environment. Despite that some activities provided questions for students to guide their investigations, the majority of the WBILs included no questions to be investigated. The results reveal that elementary students have been given little chance by WBILs to formulate hypotheses when they come to leave grade four.

TABLE 2
Inquiry Planning Abilities Across Four Elementary Grades WBILs

Inquiry Planning Abilities	Given-WBILs Grades				Open-WBILs Grades			
	1	2	3	4	1	2	3	4
1. Planning a simple investigation	0	0	2	3	0	0	1	0
2. Designing simple experiment to answer the questions	0	0	22	5	0	0	3	0
3. Identifying the materials and tools needed to conduct the investigation	2	27	25	29	0	0	0	0
4. Identifying the procedures to collect information	1	27	25	24	0	0	0	0
5. Identifying how to use the systematic observation to record results	4	27	22	29	0	0	0	0
6. Identifying how to Investigation record the results	12	27	25	27	0	0	0	0
Total 6	19	108	121	117	0	0	0	0

Planning items of the inquiry framework are presented in Table 2. As summarized in this table, science workbooks in just three WBILs asked grade three students to design simple experiments and in just one activity asked students to plan a simple investigation. As shown in this Table, the planning items such as designing simple experiment, identifying the materials and tools needed to conduct the experiment, identifying the procedures to collect information, identifying how to use the systematic observation to record results, and identifying how to record the results were given to students though the WBILs with little variation among the grade four (total ranged from 19 to 121 for Given-WBILs). Therefore, elementary students were not provided with opportunities by WBILs to design investigations, observations, and tables; and identify materials and tools to conduct experiments.

TABLE 3
Inquiry Implementing Abilities Across Four Elementary Grades WBILs

Inquiry Implementing Abilities	Open-WBILs Grades			
	1	2	3	4
Developing and using simple skills such as how to:	-	-	-	-
1. Observe	27	24	24	27
2. Measure	0	1	14	1
3. Cut	3	0	7	6
4. Connect	0	0	2	3
5. Switch	0	0	0	0
6. Turn on and off	0	0	2	2
7. Pour	0	0	11	11
8. Hold	1	2	15	6
9. Tie	1	0	4	7
10. Hook Using simple instruments:	-	-	-	-
11. Rulers or other measurement of length of (objects and materials)	0	0	3	3
12. Rulers or other measurement of height of (objects and material)	0	0	2	1
13. Rulers or other measurement of depth of (objects and materials)	0	0	0	0
14. Thermometers to measure the temperature	0	0	1	0
15. Watches to measure time	0	0	4	5
16. Beam balances and spring scales (measure weight and forces)	0	0	5	3
17. Magnifiers to observe objects and organisms	0	0	3	3
18. Microscopes to observe the finer details of plants	0	0	0	1
19. Microscopes to observe the finer details of animals	0	0	0	0
20. Microscopes to observe the finer details of rocks	0	0	0	0
21. Microscopes to observe other materials	0	0	0	0
22. Computers for conducting investigation	0	0	0	0
23. Calculators for conducting investigation	0	0	0	0
24. Scaled tube to measure volumes	0	0	2	1
25. Using chart to display results	0	0	1	3
26. Using graph to display results	5	0	0	0
27. Using tables to display results	1	7	10	5
28. Using other ways to display Results	20	23	25	25
Total 28	58	57	141	130

Table 3 displays the inquiry implementing abilities included in the framework and their frequencies in elementary grades science WBILs. This table summarizes the frequencies of 28 inquiry implementing abilities used in the framework. As shown in Table 3, WBILs provided elementary students with opportunities to extensively implement wide range of scientific processes and apparatus (total of open-WBILs = 58, 57, 141, & 130 for grades 1, 2, 3, & 4 respectively). The most scientific skills that students were highly asked to apply were observation, measurement, pouring, and holding objects. Students sometimes used ready-made tables or other forms to record or display the results. Students were sometimes provided opportunities to manipulate tools and instruments such as rulers, watches, beam balances and spring scales, magnifiers, and scaled tubes. At this level of elementary education, students were not provided with opportunities to use computers or calculators and were rarely asked to use mathematics.

TABLE 4
Inquiry Concluding Abilities Across Four Elementary Grades WBILs

Inquiry Conclusion Abilities	Open-WBILs Grades			
	1	**2**	**3**	**4**
1. Collecting evidences to support explanations	0	2	0	3
2. Using information and evidences to provide reasonable explanations	0	0	0	3
3. Judging the merits or strength of the data and information that will be used to make explanations	0	0	0	0
4. Checking the explanations against scientific knowledge, experiments, and other observations of others	0	0	0	0
5. Recording the finding	2	22	25	28
Total 5	2	24	25	34

Table 4 displays the inquiry conclusion abilities included in the framework and their frequencies in elementary grades science WBILs. Frequencies indicated that students in the elementary grades were not asked to judge the merits or strength of the data and information that they used to make explanations and check the explanations against scientific knowledge, experiments, and some other observations. Moreover, students were seldom asked to collect evidences to support the explanations and to use information and evidences to provide reasonable explanations. However, students in grade two, three, and four were asked in WBILs to record what was found in existing tables or in other recording formats (Open-WBILs were 22, 25, & 28 for grade 2, 3, & 4 respectively).

TABLE 5
Inquiry Communicating Abilities Across Four Elementary Grades WBILs

Inquiry Communicating	Open-WBILs Grades			
	1	**2**	**3**	**4**
1. Using spoken communication	0	0	1	3
2. Using written communication	1	2	0	0
3. Using drawing communications	10	1	0	1
4. Using other forms of communications	1	0	0	2
5. Discussing their questions	0	0	0	1
6. Discussing their plans	0	0	0	0
7. Discussing their results	0	0	0	2
8. Discussing their explanations	0	0	0	1
9. Giving opinions on inquiry questions	0	0	0	0
10. Giving opinions on inquiry plan	0	0	0	0
11. Giving opinions on inquiry results	0	0	0	0
12. Analyzing each other Results	0	0	0	1
Total 12	12	3	0	11

Table 5 summarizes the inquiry communication abilities included in the framework and their frequencies in elementary grades WBILs. Table 5 shows that grade one students were provided opportunities by WBILs to communicate their investigation tasks 12 times in the workbooks while grade four students were asked to perform these tasks just 11 times in the workbook. The grade two students were asked to communicate their inquiry tasks 3 times in the workbook, respectively. Grade three students were surprisingly never asked to perform any forms of inquiry communication abilities. Students in grade 1, 2, and 4 were given chances to communicate their findings through spoken, written, and drawing forms. However, WBILs seldom provided elementary students with opportunities to apply other forms of communications; to discuss their questions, results, and explanations; or to analyze each other results. Moreover, students were never given chances to give opinions regarding the inquiry questions, the inquiry plan, and the inquiry results.

VI. DISCUSSION

The findings of this study indicate that all the activities did not give students real opportunities to formulate scientific questions about objects, organisms, and events in the environment; to plan by themselves a simple investigation or designing simple experiment; or use data to construct reasonable explanations; and generally to apply all communication abilities suggested in framework. The results showed with some variations that activities allowed students use scientific and personal skills such as observation, holding things, measuring, pouring liquids, tying things, cutting materials, connecting things, turning things on and off, and hooking objects. The results revealed that elementary science activities were highly structured in that they allow students to follow a step-by-step detailed direction. This study reported findings similar to studies that were conducted in other contexts particularly USA, such as studies carried out by Elizabeth and Roberts [3], Germann, Haskins, and Auls [24], Shepardson [33]. For example, Germann, Haskins, and Auls [24] found that school science manuals rarely asked students to identify a question to guide investigation, formulate a hypothesis to be examined, or use their experiences and knowledge to design investigation to study natural phenomena.

The findings indicated that for the elementary grades nothing was found within the WBILs that students before doing the investigation or within the investigations posed any questions about objects, organisms, or events by themselves. As indicated in the results before, students in grade two, three, and four were sometimes provided with hints about questions to guide the investigations. The literature review stresses the importance of providing students with ample opportunities to ask questions or to select questions from provided lists of questions. As Carin, Bass, and Contant [6] stated that "the starting place for inquiry is well-formed questions about the natural world that arise from students' own experiences" (p. 65). Asking good questions for initiating inquiry lead to obtain new knowledge about the world, to a clear understanding of the scientific inquiry and nature of science, and to use a variety of science processes [6]. Cuevas et al. [17] believed that science inquiry encourages the development of communication, problem solving, and thinking skills as students pose questions about the natural world and then seek evidence to answer their questions. According to Wallace and Kang [45], current research indicates that inquiry-based learning can be a very successful practice for students if their teachers posing interesting questions for students to answer or by facilitating students to pose their own questions practice. Therefore, it is wildly accepted that when students practicing asking questions this will allow them to have positive attitudes toward inquiry. Learners usually have the intention to involve in asking questions and finding path to answer their questions (Crawford, Krajcik, & Marx, [46]; Gibson & Chase, [47]; Hand, Wallace & Yang, [48]). Furthermore, if learners familiarize themselves with inquiry activities they will gain progress in their ability to ask investigable questions and to associate with evidences and scientific knowledge (Crawford et al., [46]; Hand et al., [42]). According to the NRC [7], "different kinds of questions suggest different kinds of scientific investigations".

Generally, the finding revealed that elementary grades WBILs did not allow students to plan by themselves a simple investigation. Elementary science WBILs identified materials and tools needed to conduct the activities, the procedures or steps that students would take to collect information, and how to use the systematic observation to record results. Students' duties were to follow steps and procedures that were already prepared for them. Thus students were not provided with any opportunities to plan for their observations and measurements or to design experimental procedures.

It is evident from the results that almost all the WBILs asked students to use their observation skills. Other simple skills that elementary students were allowed to perform were measuring, holding materials, pouring liquids, tying things, connecting materials, hooking things, and turning things on and off. These findings are consistent with the findings of Al-Naqbi [36] who found that grades 5 and 6 students were given opportunities by their workbook activities to make systematic observations and accurate measurements. Regarding using simple instruments, the results show that elementary students were given little opportunities to use rules, beam balances, scale tubes, time measure, and magnifiers. The results indicate that elementary students were not given opportunities to use microscopes, computers, and calculators. They used thermometer once or twice during their elementary school years. Moreover, second graders were not given any opportunities to use simple tools and instruments when they conduct WBILs. When elementary students displayed their investigation results, they could use charts, graphs, and tables or they could select other ways to display the results. One possible explanation for the rise level of usage of observation ability could relate to the nature of the ability. Scientific observation supposed to be used at the start point of any scientific investigation. Since the results reveal that the elementary science WBILs to some extents gave more opportunities for students to use their senses to observe and use instruments to expand the influence of their senses "students are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe " [49].

The results reveled that WBILs did provide students with real opportunities to use data to construct reasonable explanations. It appears from the findings that WBILs did not give students opportunities to collect evidences to support their explanations; use information and evidences to provide reasonable explanations; judge the merits or strength of the data and information that they used to make explanations; and check the explanations against scientific knowledge, experiments, and the observations of others. The developers of the examined workbooks should use the recommendations of science education community (see for example, NRC, [7,9]; National Science Foundation (NSF), [50]; National Science Teacher Association (NSTA), [51] to provide students when they engage in inquiry with context to collect and records data; use other resources such as books, videos, and the expertise or insights of others; and interpret scientific explanations; generate and evaluate scientific evidence and explanations; and participate productively in scientific practices and discourse.

Generally, the results revealed that WBILs in the elementary science did not provide students with opportunities to apply all inquiry communication abilities included in the framework. There were little opportunities provided for students to communicate using different forms of communications such as oral, writing, drawing communications. For applying this essential inquiry abilities there were also some apparent problems. For example, students were given only little opportunities to communicate with each other or with the whole class to share the results of their investigation and to discuss their questions, plans, and explanations; give opinions regarding the inquiry questions; give opinions regarding the inquiry plan, opinions regarding the inquiry results, or analyze each other results. "Inquiry is a powerful strategy through which children can communicate the state of their knowledge" [50]. According to NSF [50], doing inquiry requires conversations. Moreover, when students involve in inquiry, they exchange ideas and thoughts through different forms of communications such as speech, writing, numbers, drawings or they might. Classrooms discussions and communications increase students' social skills and provide teachers with accurate knowledge about their students' abilities and level of understanding.

Educational implications

The present study offers four major educational implementations. First, the current UAE Northern Emirates elementary workbooks need to be reconsidered in order to realize the stated National Science Curriculum Framework goals that related to inquiry and scientific processes. In order to include fundamental inquiry abilities within the science workbooks activities these educational materials should be redeveloped and reorganized.

Second, inquiry abilities should gradually increase in quality and quantity through elementary curriculum materials. Third, science curriculum materials should facilitate the development of students' inquiry basic scientific processes and skills through help them practicing questioning, planning, implementing, concluding, and communicating abilities. Fourth, science curriculum materials in the elementary schools should sometimes give students opportunities to use computers and calculators as well as other technological instruments such as microscopes when the students are engaged in investigative activities. In conclusion, this study showed that science workbooks in the elementary grades in the UAE northern Emirates schools allowed students use scientific and personal skills such as observation, holding things, measuring, pouring liquids, tying things, cutting materials, connecting things, turning things on and off, and hooking objects. However, the results revealed that elementary science activities were highly structured in that they allow students to follow a step-by-step detailed direction. Moreover, major changes should take place in the elementary educational materials to allow elementary grade students to identify or refine questions that could be answered via inquiry investigation; to plan by themselves a simple investigation or designing simple experiment; or use data to construct reasonable explanations; and generally to apply all communication abilities appropriate to their ages. This study covered all northern Emirates school systems that are part of the Ministry of Education and did not cover Abu Dhabi, Al-Ain, and Western districts because these three districts are part of the Abu Dhabi Educational Council which implements different science educational materials for elementary schools.

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