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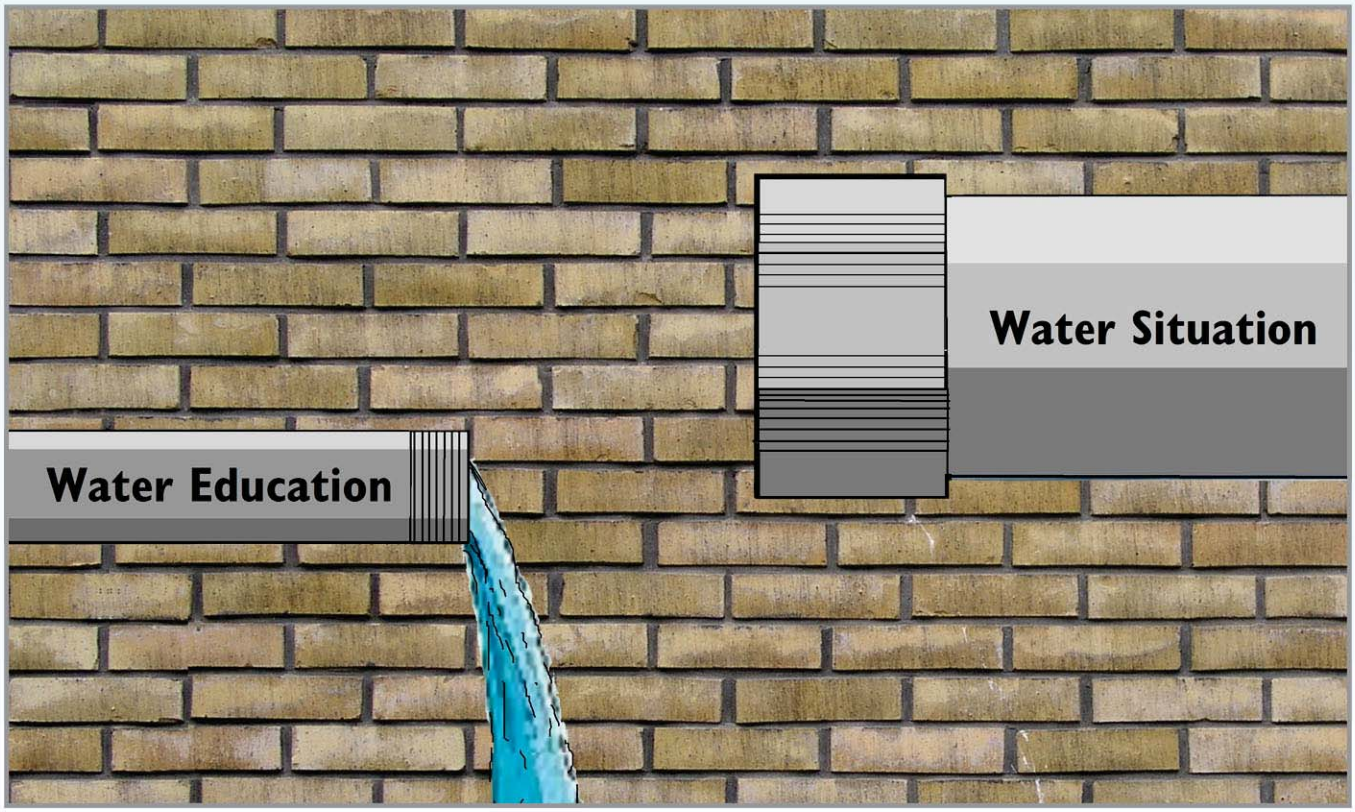
Water Education in Yemen

Baseline Assessment Study for Water Concepts in Primary and Secondary Education

Abdulkhaleq Qannaf Shaif Alwan



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WATER EDUCATION IN YEMEN

BASELINE ASSESSMENT STUDY FOR THE WATER CONCEPTS IN THE PRIMARY AND SECONDARY EDUCATION

By

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COMMITTEE DECISION

This Thesis/Dissertation (Water Education in Yemen (Baseline Assessment Study for the Water Concepts in the Primary and Secondary Education)) was Successfully Defended and Approved on 20/1/2013.

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تعتمد كلية الدراسات العليا
هذه النسخة من الرسالة
التوقيع ..... التاريخ .....

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To my Nation

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Abbreviations

- EE-Environment Education
- ERDC-Education Research and Development Center
- EMPPC-Educational Means and Programs Production Center
- GCGD-General Curricula and Guidance Department
- GEIP-General Education Improvement Program
- GIZ-German International Cooperation
- GW-Ground Water
- IHP-International Hydrological Program
- IWRM-Integrated Water Resources Management
- LCs-Local councils
- MAI-Ministry of Agriculture and Irrigation
- MENA-Middle East and North Africa
- MOE-Ministry of Education
- MWE-Ministry of Water and Environment
- NWRA-National Water Resources Authority
- NWRA-SB-National Water Resources Authority – Sana’a Branch
- WEC-Water and Environment Center
- WUAs-Water Users Associations

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Abstract

This study sheds light on what and how Yemeni students are educated with respect to water. In a hand, it aims to assess the water concepts presence in the national school textbooks in primary and secondary education, and teaching aids. On the other hand, it proposes how both can be developed so that they ultimately induce a holistic and integrated water education that interactively socialize learners of today improving the deteriorating critical water situation, and prepare effective water managers for future. The collective methodology to evaluate the water concepts is applied through textbooks content mapping by which water concepts are identified and analyzed against different analyses based on some water and educational criteria of evaluation. The mapping and analyzing matrix is developed and Excel Spreadsheet is used to achieve mapping and assessment purposes. The identified concepts are mainly evaluated vertically on subjects' level with relevance to their cognitive depth determined by vertical sequence and development, delivery and representation forms. Further, horizontally they are assessed according to their experiential depth, and scope and alignment under the water six main principles besides their relevance to Yemen. Concepts map for each subject is drawn illustrating concepts' location, cognitive and experiential depth, misalignment, and vertical sequence. The study shows that the majorities of water concepts have poor cognitive and experiential depth, limited vertical sequence and development, quit significant presence of misalignment, and mainly focusing on principles of water characteristics, and importance while water problems, management and sustainability principles have the less presence. Teaching aids relevant to water are absent and visualization is either poor, mis-selected or absent. Finally, mutual ignorance between officials in both sectors of water and education appears significantly.

Keywords: Water Education, Primary and Secondary Education, Yemen, Curricula Mapping, Assessment, Experiential Learning, IWRM, Behaviors Change.

1. Introduction

1.1. General Background: Water and Education

Water and education have mutual interdependences and impacts on each other. In one hand, having sufficient safe access to drinking water services and adequate sanitation provision has significant impacts on education quantitative and qualitative outcomes. For instance, students' enrollment in schools is strongly and adversely affected in areas that lack adequate water and sanitation services (Watkins et al, 2006). This because three main reasons; i) students in those areas have the task of drinking water fetching from far water sources which either prevents them from schools attendance or affects their home study (Al-Hamdi 2006), ii) having unsafe drinking water results in diarrhea that attacks students losing 443 million study-days every year, and iii) lacking adequate sanitation services in schools is one of the main drivers by which girls drop out of schools (Watkins et al, 2006). On the other hand, education plays a very important role on conserving and sustaining water resources. *"Water education is key to achieve the water related Millennium Development Goals"* (International Hydrological Program IHP, 2009). IHP emphasized that water education is a vital entry point to develop ethics for water management shaping a new generation of water managers who are able to act in a holistic multidisciplinary approach toward water. The human values-based initiative for water education in Africa stated that water wastages in cities can be maintained by promoting water education in schools and communities (UN-Habitat 2003). *"I believe that water education is crucial to managing the water crisis in Yemen. There is no a magic bullet to solve this problem and, hence, it requires community engagement in conservation and management. Water is everyone's business, so everyone should participate in the solution"* Dr. Al-Eryani[i], Former MWE Minister (Email communication on 06 Sep, 2012).

1.1.1. Water Situation in Yemen: Brief Overview

The current water situation in Yemen is one of the most critical and complex challenges Yemen has ever faced. The country is characterized by arid to semi-arid climatic conditions resulting in rainfall average of 200mm/year only (Bashuaib 2009) and less than 100 m^3 of available water per capita per year (Qassim, 2012). Its capital city "Sana'a" is ranked as the first city overall the world expected to run out of the water (The Stimson Center, 2010). The high population growth of 3% (USAID, 2010) and agriculture expansion with very low efficiency of 35% have induced in a high gap of 1100 MCM between the annual water demand (3500MCM) and recharge (2.5MCM) (Qassim, 2012). Five basins are considered as very critical basins in terms of ground water (GW) depletion where GW table drops by 4 to 8 meter annually (Bashuaib, 2009). Qat a mild simulating tree Yemeni chew every day (Lichtenthaler, 2010) consumes around 40% of the 90% of agriculture water consumption (NWSSIP, 2012). Furthermore, climate change impacts on water resources, agriculture and national economy is considered as one of the main drivers expected to worsening the critical water situation in Yemen (Wiebelt et al, 2011). Access to drinking water supply and sanitation services are still very poor with coverage percentages of (56 and 31) and (45 and 21) for urban and rural areas respectively (NWSSIP, 2012). Finally, laws non-applicability, limited official capacities, low level of public awareness and participation, and mis-behaviors towards water and its uses are within the main drivers deteriorating the water situation in Yemen (Ward et al. 2011).

1.1.2. Water Education in Yemen

Formal water education in schools remained embedded tacitly within environmental education between 1990 and the late of 1998 when the National Water Resources Authority (NWRA) took the initiative to incorporate water issues officially in primary and secondary system. After holding some bilateral meetings between NWRA and ERDC, a cooperation contract was signed on 13.09.1998 to incorporate the water concepts within the national curricula (NWRA, 1998). The contract scope was confined to four educational subjects: Islamic Education, Science, Arabic and Social Studies. The contract assigned ERDC to include water issues and other concepts within the mentioned subjects during three main phases summarized below.

Phase I: in this phase ERDC is committed to:

- Survey school textbooks of the mentioned four subjects identifying the already existed water concepts.
- Prepare new water concepts within the four subjects' textbooks for different grades.
- Insert water awareness photos and drawings on textbooks in-side front and out-side back covers and in any empty suitable spaces within the textbooks.
- Print the prepared textbooks in 1999 and provide NWRA with five samples.

Phase II: in this phase ERDC is committed to prepare and insert new water topics within the four subjects as follows:

- Collecting the scientific content and review experiences of the countries with relevance to water education in schools.
- Designing and inserting new water topics taking in consideration age alignment and in line with General Curricula Document determiners.

- Printing the designed water topics between 2000 and 2001 and providing NWRA with five samples of each textbook

Phase III: in this phase ERDC is committed to develop structured water concepts and topics, and to insert them in the developed curricula and textbooks as endorsed part of the Education Strategy for any future curricula development as follows:

- Revise water concepts of the first phase and water topics of the second phase according to educational principles and goals of education curricula development.
- Prepare general developed water education goals and behavioral objectives for the four subjects and in line with the coming developed curricula mainstream.
- Prepare scientific content that reflects the stated objectives and design it in lessons.
- Prepare in-class and out-class activities, and projects that serve designed lessons.
- Print the new developed textbooks and provide NWRA with five samples

NWRA commitment was stated in two articles as follows:

- To provide ERDC with the required information and photos that forms as technical base for the planned three phases.
- To pay to ERDC a total amount of 5,000,000YR as installments of 2,800,000YR; 1,000,000YR, and 1,200,000YR for the first, second and third phases respectively.

One focal point for coordination purposes was assigned in each party to follow the implementation. In 12.07.1999, a team from NWRA was assigned by NWRA chairman to evaluate the achieved work by ERCD. According to the evaluation report, water concepts were mentioned by 130 times mainly as photos and insertions. The report evaluated first phase implementation by 77.2 % of the agreed work for this phase (NWRA 1999). The second and third phases were disregarded by ERDC upon the

financial fund lack of both phases provided NWRA according to Um Al-Saad Abdulhai, Curricula Expert at GCGD and former coordination focal point by ERDC (interviewed on 22 Oct, 2012). After that, textbooks were exposed to many changes that deal with technical matters of printing and layouts only (Dr. Al-Hothi, ERDC vice chairman, interviewed on 22 Oct, 2012).

In 2006, NWRA Sana'a Branch (NWRA-SB) organized a workshop and invited the national curricula experts. The water situation and main issues in Sana'a Basin were presented to the audience. Groups work was established to discuss best ways of making people aware about water problems and issues in the basin and the possibility to insert them in school textbooks. As principle, participants welcomed the idea but they raised the difficulty to localize textbooks content on a specific basin issues and discussed the prospect to include the general awareness messages (NWRA-SB 2006).

Out of what is mentioned above the water education remains subjected to the informal efforts and programs. During the 2000s NWRA and its branches have their annual public awareness programs implemented in schools, local communities, water events, workshops and media however timely, scattered and limited upon fund availability. In 2008, a public awareness study has been prepared but it is still unimplemented due to the lack of financial fund required. According to Ward et.al (2011), informal water education sector which is mainly leaded by NWRA and its branches is still highly hampered by many constrains as; i) limited geographic outreach, time and continuity, ii) very low technical and financial capacities allocated for awareness activities, iii) lack of awareness specialist staff, iv) very limited space allocated by media means, and v) lack of required fund on time.

Both formal and informal water education sectors are important. Water education in schools can form the base for a holistic and integrated perception and action reinforced by informal water education programs according to Pro. Abdullah Babaqi, Water and Environment Center Chairman (WEC) (Interviewed on 06 Aug, 2012).

1.2. Study's Problem Statement, Scope, Importance and Objectives:

1.2.1. Study's Problem Statement and Main Research Questions:

End users, mainly farmers, represent the significant element of the worsening water situation in Yemen; meanwhile, they are the key effective stakeholder for improvement and management (Ward et al, 2011). Their roles became much more influential in absence of the effective water management by the official water sector (NWSSIP update, 2012). Water education, both formal and non-formal sectors have a significant influence in shaping attitudes and behaviors of people. As mentioned before, that water informal education is still striving and has very limited impact. The formal water education as introduced in the introduction was initiated and partially incorporated in 1999; however, is still not assessed up to date. Therefore, it is highly praiseworthy to conduct research on what and how Yemeni students are educated with respect to water? To what extent are the different water concepts covered within the national primary and secondary school textbooks? Does water concepts presence match to the critical water situation Yemen faces? Are concepts related to water conservation and management in line with integrated water resources management mainstream? What are the main gaps and weaknesses? Are they vertically sequenced within respective subjects? How are they delivered within textbooks? What are main representation forms by which water concepts are presented? To what cognitive and experiential depth are the presented concepts covered? What side teaching aids and materials exist to support teachers

teaching water stuff? Are they adequately prepared and provided? How can current water concepts and teaching aids be developed?

1.2.2. Study Scope:

To begin with, it is helpful to mention that around 74% (4,190,719 students) of the total Yemeni students in the whole education systems are enrolled in basic education from grades one to nine, and 34 % (560,907 students) within secondary education from grades ten to twelve as shown in figure 1. Only does 13% continue to finish the higher education stage. In other words, the great majorities of enrolled students finish the school education only and then leave to labor market where 50% are working in agriculture the main water consuming sector in Yemen (USAID, 2010). Putting that in mind and recognizing the fact that textbooks are the main curricula mean available for schools (World Bank, 2010), the study scope is confined to the water concepts assessments and improvement proposals in the national primary and secondary school textbooks. However, it does neither assess the informal water education system for communities nor the students or communities' behaviors.

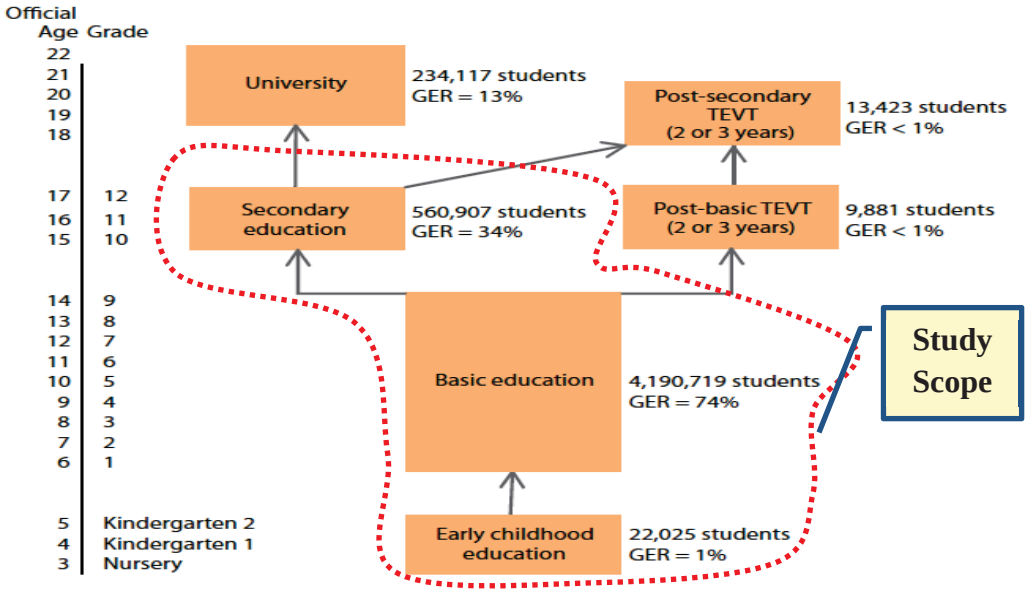


Figure 1. Yemeni Education System Structure, Number of Students and Gross Enrollment Ratio (GERs) (%), 2007-08 . *(Source: MOE, 2008 in World Bank, 2010)*

1.2.3. Study Importance and Justifications

Mainly, this is the first baseline assessment study evaluating the water concepts presence in the national school textbooks from multidisciplinary perspective. In a hand, it assesses the existed concepts against some water and educational cross criteria identifying the gaps and weaknesses and it propose on how Yemeni water education in schools can be improved in a comprehensive and integrated manner on the other hand. Besides, it investigates the underlying elements determined the ultimate presence of the water concepts in current school textbooks. Furthermore, wider importance and benefits beyond this work can be obtained in future once its outcomes being considered for school water education development such as i) creating a holistic understanding for the critical water situation and main issues in Yemen and how it can be improved in an integrated manner of action, ii) Encouraging students to take actions at present and in future to change mis-behaviors and mis-practices exist within their communities, iii) educating learners how best modern and indigenous practices can save water and money, and sustain the water resources, and iv) aware Students and teachers can serve better teaching others in their areas, and v) knowledgeable students will be in the near future the effective water managers in the field.

1.2.4. Study Objectives:

The main objective of this study is basically to assess the water concepts within the primary and secondary national textbooks and propose how they can be improved. To address this overall objective, this research will focus on the specific following goals:

- Investigating and mapping the current national textbooks of Primary and Secondary education system with respect to the water concepts and issues,
- Assessing the water concepts according some educational and water evaluation criteria such as cognitive depth (delivery and representation forms), vertical

sequence and development, alignment, experiential depth, and scope extent covering the main water principles. Further, identifying gaps and weaknesses.

- Evaluating present teaching aids and materials used to support teachers transmitting the water concepts to the learners,
- Propose how water concepts and teaching aids can be developed.

1.3. Literature Review

The study concerns mainly to explore, mapping and evaluate the water concepts in the national Yemeni textbooks finding out how they can be promoted. Further, the research area itself lies within cross areas of water education, concepts mapping and assessment, and experiential education. Hence, the main focus during the literature review was to investigate and recognize the basic aspects of curricula, curricula mapping, and experiential education in a hand, and to explore what have been done in water education arena on the other hand. Since water is non-separable element of environment, it was not avoidable to go through literatures that cope with environmental education.

1.3.1. What is “Curriculum”?

According to Munazza (2004), people socialization is one of education major goals, school is the agency delegated to transmit values to generations, and the curriculum is the tool used by schools attaining that goal.

Curriculum is sticky word that has plenty of definitions. "Curriculum is often taken to mean a course of study. When we set our imaginations free from the narrow notion that a course of study is a series of textbooks or specific outline of topics to be covered and objectives to be attained, broader more meaningful notions emerge. Curriculum is the plan for learning Taba (1962, as in Bloom 2006). Another definition is *"The planned and guided learning experiences and intended outcomes, formulated through the*

systematic reconstruction of knowledge and experience, under the auspices of the school, for the learner's continuous and willful growth in person-social competence" (Tanner and Tanner, 1975 as in Bloom, 2006). A third one, It is the whole body of courses given to learners by an educational institution (Munazza, 2004). *"A curriculum can become one's life course of action. It can mean the paths we have followed and the paths we intend to follow. In this broad sense, curriculum can be viewed as a person's life experience"* (Connelly and Clandinin, 1988 as in Bloom, 2006).

Much important than the vast styles of defining the term of curriculum is what is the main determiner of the curriculum to the learning process? Munazza (2004), points out that in countries such as Pakistan the textbook especially for the elementary schools is the main determiner for the curriculum since it is almost the sole source used by teachers to deliver the learning experiences to the learners.

1.3.1.1. Curriculum Mapping

"Curriculum mapping is a systematic process for gathering and analyzing data on what is taught within our curriculum. Data gathered include content, teaching methods, assessment methods and where specific competencies are addressed in individual courses and the program as a whole" (Mazurat, 2008). Rahimia et al. (2010) argue that curriculum mapping was introduced in the 1980s as an important scheme to develop education quality, culture of participation and collaboration in educational institutions. Curriculum mapping have many benefits. In a hand, it identifies the seams; gaps, repetition within the scope, and the concepts vertical sequence and development within the subject. On the other hand, it allows evaluating the concepts alignment, delivery and the experiential depth (Sky-McIlvain 2003).

Curricula can be evaluated from two main standpoints. For first, an assessment can be conducted to assess what is included in the curricula. The other one is carried out to evaluate what is executed in the field. The first one might happen on its own during the regular change and reform while the second one reveal the education situation that has ascended on the ground (Rahimia et al. 2010).

According to Sky-McIlvain (2003), some problems accompanied the concepts transmission as summaries below:

- **Contents do not achieve outcomes:** There are many cases when the number of subjects contributing to the planned concept outcome is plenty, but the outcome is actually not being addressed adequately. In other words, the concept is repeated many times in different subjects and grades but with no crucial cognitive development that achieve the planned result.
- **Problems with alignment:** This issue happens when the given content and aids do not achieve the intended learning outcomes. *"For example, to teach the swimming in class lecture"*.
- **Under- or Over-Represented outcomes:** this takes place when students are given too many opportunities to 'get knowledge' but too little chance to learn to apply the knowledge and develop the skills that are relevant to their professions.

Finally, it is worthy to state that it is often not preferable by providers to conduct educational evaluation due to the following causes raised by Tao (2011); i) A Lack of proper perception about evaluation, ii) A failure to give evaluation sufficient priority, iii) Concerns of gaining negative consequences of evaluation, and iii) Lack of incentives V.s penalties for evaluation conducting and avoidance respectively. He also added, *"The possibility of negative outcomes can be reason enough to avoid evaluation"*.

1.3.1.2. Yemeni School Education System and Curriculum

Yemeni school education system consisted of two main stages; the primary and secondary stages including a total of 12 grades. The primary stage includes grades of 1 to 9 while the secondary stage contains grades of 10 to 12 (Smart, 2005). "*In general, during the last 30 years, Yemen has impressively expanded education, halving the illiteracy rate from 90 percent to 45 percent. From 2000–01, growth in basic education enrollments continued at a rate of 22 percent to over 4 million in 2007–08* (World Bank, 2010)". The General Curricula and Guidance Department (GCGD) is responsible for the curricula detailed planning and management, the Education Research and Development Center (ERDC) is in charge of preparing, developing and even designing the textbooks till they reach the printing-house. Even the roles and responsibilities of the ERDC is stated clearly by its creation decree, implementation overlapping between the ERDC and GCGD (SMART, 2005). Currently, seventeen subjects are given to the students from grad 1-12 (World Bank, 2010). The new textbooks were designed as methodology-based materials unlike the former ones which were informational content based. According to (Smart, 2005), *"the textbook is considered as an extension of the teacher's guide, and assumes that the real learning will come in the classroom as a result of the interactions between teacher and student as well as between the students"*. Furthermore, the teacher's guidelines books on the whole are detailed lesson plans providing background information, statements of learning objectives, and lists of materials and teaching methods required. Nevertheless, according to World Bank (2010), teachers' guiding books do not match with the textbooks and the majority of schools are still lack the guides books. Besides that, the vast number of students in the classes that reach sometimes more than 70 students and the low academic qualification of teachers especially for grades 1 – 6 and rural areas as illustrated below do not support

the inter-active learning methodology. For instance, teachers below university qualification form 86% of the total teachers over the country and represent 91% of the teachers in the rural areas as illustrated in red color in Table 1.

Table 1. Teachers' academic qualification in basic and secondary education.
Source: *modified from MOE AES 2005–06 as in World Bank (2010).*

	Below secondary	Secondary	Post-secondary diploma	University and above	Total	Qualified teachers	Total no. of teachers
No. of grade 1-6 teachers	45,850	18,094	21,018	13,803			98,765
% of grade 1–6 teachers	46	18	21	14	100	35	98,765
Male teachers	52	14	22	11	100	33	73,632
Female teachers	29	30	19	23	100	41	25,133
Rural teachers	52	17	21	9	100	31	70,048
Urban teachers	33	21	22	25	100	47	28,717
No. of grade 7–12 teachers	9,140	3,894	17,194	55,153			85,381
% of grade 7–12 teachers	11	5	20	65	100	65	85,381
Male teachers	12	4	22	62	100	62	68,246
Female teachers	6	7	13	74	100	74	17,135
Rural teachers	13	5	23	59	100	59	55,341
Urban teachers	6	4	14	75	100	75	30,040

1.3.1.3. Yemeni Textbooks Evaluation: Grades 1 -3

Under General Education Improvement Program (GEIP) supported by the former German Technical Cooperation (GTZ), Ministry of Education (MOE) conducted a wide survey to evaluate school textbooks and teacher guides of grades 1 to 3 in 2009. The main objectives were to evaluate present content and to add new ones. The main approach was consisted mainly of two methods. The first method was carried out through analyzing the content by an educators team while the second one was participatory based implemented through two days' workshop by which the local councils, NGOs and the official sectors representatives were invited. The following points summarize the main outcomes according to (Mutalees, 2009):

- The participants gave high rate of importance to concepts of “water importance for life” and “water save importance” as water learning needs while concepts of “house water sources” and “pollutions sources” were given lower rate.
- “Ablution Lesson” was repeated twice in grades 1 and 2.
- Although their importance for teachers guidance, learning objectives in some textbooks aren’t provided while in some others don’t match the content.
- Almost all subjects lack outclass activities.
- In some textbooks skills side has been recorded with poor provision.
- Visualization is poor so that adequate photos and colors need to be improved.

According to the evaluation report, it is noticed that i) no any water agency was invited to represent the water sector, and ii) water was considered as sub-mater among others matter addressed under the environmental learning needs, one of the six main learning matters put on the table for discussion and evaluation.

1.3.2. Experiential-Based Education

“Experiential curricular model emphasizes the fact that learning is something more than a collection of data and facts. Learning influences the path a person adopts to travel in future. It also influences their attitude and personality and becomes internalized in the process of experience” (Rogers, 1990 as in Keshtiaray, et al., 2012).

Experiential based curricula designing have various perceptions according to doctrines’ philosophies and discourses. According to Horton et.al, (1999), most common doctrines are the behavior, and information processing based models. While behaviorists’ models considering learner as the center of the learning process were built on the work of Skinner (1953), Bloom (1971), and Pfeiffer & Jones (1985), information processing models were developed base on the work of some cognitive theorists like Piaget (1952),

Taba (1962), and Bruner (1967) emphasizing on age and stages of students to acquire the information, process the data, and to develop the concepts their conveying channels as shown in figure 2. The former requires a very effective and professional education conditions starting from effective curricula, high qualified teachers and schools, and ending with very interactive learning environments at home.

	Behaviorial Theorist	**Cognitive Theorists**
Emphasis	Emphasis on learner rather than subject matter and knowledge.	Emphasis on ages and stages of learners to make sense of the world by • acquiring and organizing data • sensing problems • generating solution to problems • developing concepts and language for conveying them
Theorists	Skinner (1953) Bloom (1971) Pfeiffer & Jones (1985)	Piaget (1952) Taba (1962) Bruner (1967)

Figure 2. Comparing behavioral and cognitive theorists. *Source: Horton et.al, (1999)*

Regardless the long history of both philosophies, it is worthy to mention that behavioral approach followers have recently admitted the necessity of melting both; content and learners' personal skills.

Mazurat (2008) states *"goal of competency-based education was to impart to students the necessary knowledge, skills, ethics and attitudes required to establish a general practice upon graduation"*. Ehrlich (2011) points out, *that "there is a need to change the entire concept of education from the present "fill young people up with information for a specific type of job" view to an essential life-long process of upgrading"*.

A planning model for designing experiential based curriculum that links both experiential and cognitive aspects was developed by Williamson, (2005). The model includes four main stages that can be used to design and assess concepts experiential depth. During the first stage "Experience (E)" content related to concepts is given to

students openly. In the second phase "Reflection (R)" learners reflect what they have learnt from many perspectives. Learnt concepts are transferred form observations reflected in stage (R) into "Generalization" (G) in the third phase. Finally, in phase four "Application (A)" students are supposed to apply concepts generalized on real life situations solving problems, making decision…etc. According to Williamson (1995, as in Horton, et al. 1999), "*the framework for experiential path is the same for a 40-minute lesson, a four-week unit, or an entire year's work. For example, a 40-minute lesson might be organized in such a way that the content flows sequentially from one mode to the next until all four modes have been equally addressed. A four week unit might be organized into independent areas of interest, with content flowing back and forth between the first two experiential modes (E) and (R) until all content within an area is addressed. Content could then be collectively generalized and applied in the two remaining modes. A third scenario might be to flow content along an experiential path that crosses an entire unit. In this way, each of unit's interest areas would be connected along a single experiential path*", as shown in figure 3. Finally, the deeper the given experiences are the more learning responsibility learners take on (Gabbion, 1980).

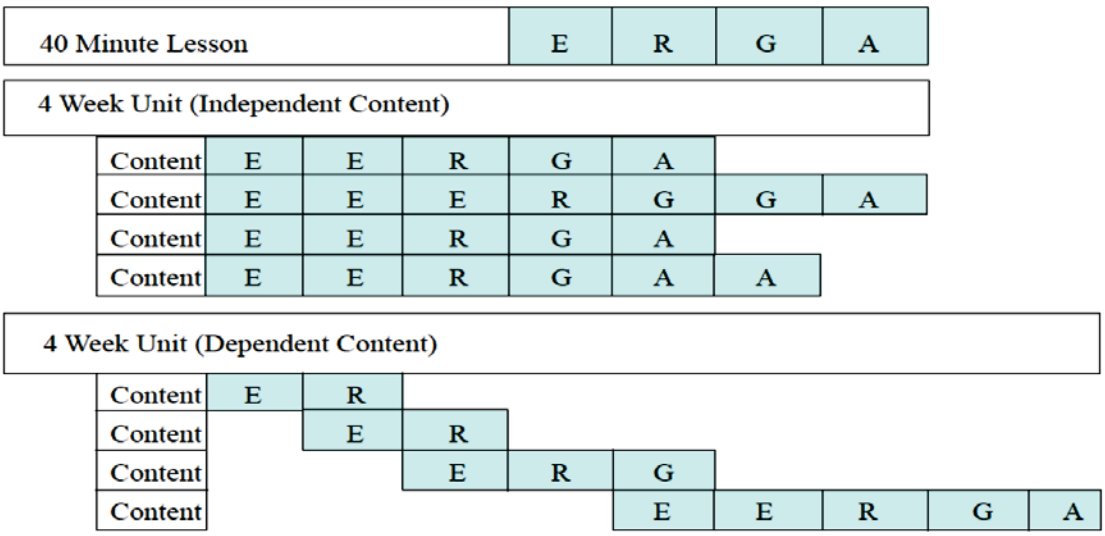


Figure 3. Concept's content organization within the experiential depth model of Williamson. (Source: Horton et.al, 1999)

1.3.3. Environmental Education (EE)

To have the public environmentally literate is one of the most striving challenges humanity has ever faced (Ehrlich, 2011) and (Tao, 2011). Ehrlich argues; since ecosystems have been altered in ways that threat human continuation, a wide struggle to have appropriate modes of behavior has recorded, and educational systems are pivotal to address such challenges. Hence, environmental education should be included in all education systems form kindergarten up to highest educations system. Tao (2011) points out that *"although the great majorities are aware of environmental topics, the average nationality has poor understanding of the issues and limited comprehension of their own responsibilities and actions regarding the environmental situation. In the coming decades, the increasing complexity of a myriad of environmental issues – including energy – will require a citizenry that is knowledgeable and able to make informed decisions"*.

Morris believes that in formal education, EE is given a good attention and already addressed in deferent subjects such as natural science, social studies, science, civics education, or integrated across several subjects (Morris et al, 2007 as in Tao, 2011). Huai-xin & Dillon (2001) argue that both of China and England has made a good progress in EE arena. However, they conclude that China has a shining future moving on the EE development while England does not; yet, hold out much hope for education in the 21st Century. Ehrlich (2011) has a latest view that EE systems are given much little attention in USA Schools evidencing his statement by *"out of the classroom, people have failed to make the link between their individual actions and the environmental condition"*

Bekalo & Bangay (2002) conclude that it is much effective to deliver the environmental education through the informal sector of the public awareness and

participation programs in Ethiopia than to do by the formal sector since the former has a wider broadcast than the later. Contrary, Ehrlich (2011) believes that what is required for individuals is an adequate environment education. He added, *"it reads like a big order, but remember, it would be expected to be stretched over ~16 years of formal education and should be continually reinforced and updated through the media"*.

Finally, Toa (2011) emphasizes that a high gap is still existed by EE assessment especially with the remarkable failure by many EE programs overall the world. He states that *"Evaluation can provide evidence to improve the design and delivery of EE programs, and increase program effectiveness"*.

1.3.4. Water Education

1.3.4.1. International Experience

There is a wide range of materials and projects focusing on water-related education, however, they are not well connected to provide an appropriate learning to individual countries due to some restrictions such as using outdated, biased or irrelevant data; poor if not lack of water education vertical sequence; lack of integration with the wider curriculum and with local knowledge; lack of experiential- based relevance to local and community needs; and lack of resources (IHP 2009). "Education for Water Sustainability: Where Decades Meet" Workshop 1 of UNESCO World Conference on Education for Sustainable Development was conducted in Bonn, Germany in 2009. According to Der Schaaf et al. (2009), about 95 participants from different regions and backgrounds, including school teachers, university lecturers, staff of education and environment ministries and other government officials have attended the two-day workshop. Among other aspects, collection of case studies was presented, an inter-sectorial working group on water education was constituted, and a work plan for water education has been developed.

The workshop outcomes argue that curricula authors lack the required water profile so that any incorporating for the water issues in the curricula can proceed faster. They also emphasized that, *"Water experts should be involved in the formulation and adaptation of school education curricula, to ensure the rightful and fast integration of water issues in the curricula"* Der Schaaf (2009). Furthermore, water values and water concepts such as water harvesting, reuse, conservation, and sustainability; wastewater and water treatment were also recommended to be integrated within curricula different subjects. The participants confirmed the importance to educate students in schools water economic aspects explaining how drinking water passes many stages costing money till it reaches house tap. They also indicated that water utilities and agencies can organize awareness campaigns for students raising their awareness. On the other hand, they also confirmed of the importance to contextualize water issues within all curricula subjects and recommended that national governments should support the production of textbooks and materials needed to cover proposed contextualized water concepts. However, to avoid content over-bulk, the participants stated the necessity of increasing theme-based water presence that develops better water conceptualization. Finally, the participants put three remaining challenges as i) Textbooks and Materials change evaluation on countries level, ii) How to simplify the high water issues such as climate change impacts on water resources in a very attractive representation forms, and iii) The lack of movements support to adapt a holistic water concepts education.

1.3.4.2. Water Education in Africa

The African initiative has brought both water and education professionals in order to have a positive and lasting change in behaviors towards water. The approach adopted for this initiative has focused on both formal and informal education through schools and communities respectively.

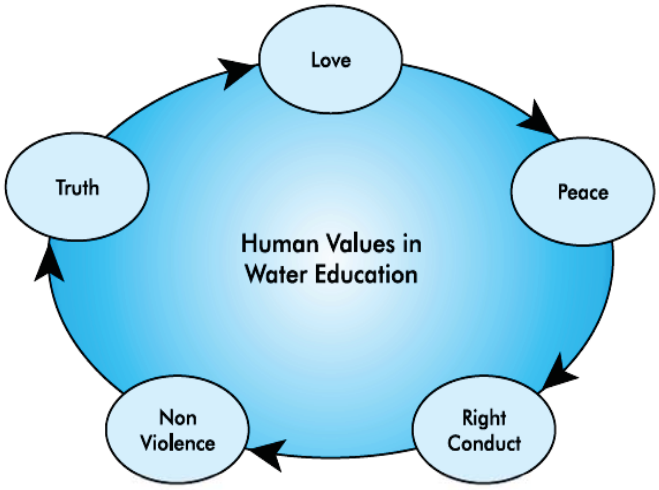


Figure 4. The main human values adopted by African initiative. (Source: UN-HABITAT, 2003)

Among many program activities, curriculum development introducing water education in pilot schools, and establishment of water classrooms has been adopted. The project implemented the African initiative has adopted human values based approach achieving effective water learning in schools. The adopted values illustrated in figure 4 reflect universal values stated in the millennia declaration: freedom, equality, respect to nature, solidarity, and shared responsibilities while figure 5 presents a learning example of human values based initiative (UN-HABITAT, 2003).

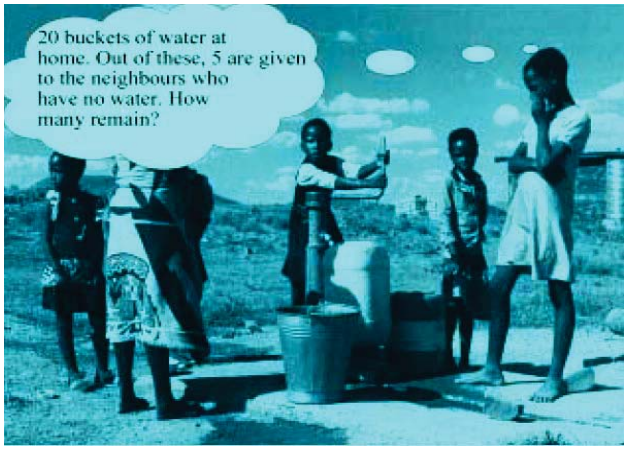


Figure 5. An example of the human values based teaching in grade 3. Source: *UN-HABITAT, 2003*.

1.3.4.3. Jordanian Experience

Under the support of Public Action Project (PAP), Jordanian National Curricula were mapped in 2010 to evaluate concepts of three themes of energy, water and solid wastes. According to USAID/Jordan (2010), the three themes were categorized under six main environmental education principles adapted from the environmental educational materials of California University. The main methodology was to evaluate the concepts against competency based teaching techniques of knowledge, skills, participation, values and attitudes beside the evaluation according to their scope under six main environmental principles. The subjects given to grades 1 to 10 were screened and concepts were identified and assessed according to the prepared methodology. A total of 1777 occasions were found related to the three themes out of which 1045 occurrences were pertaining to water. The final report argues that *"because of the style in which the Jordanian textbooks are presented, where there is greater emphasis on information and knowledge while very little space has been allocated to the synthesis and application of this information, the concepts remain superficially tackled"*. The most effective activities and projects that improve skills and involvement of Jordanian learners are embedded in the teachers' guidelines books which are rarely used. The most concept presence was found by those concepts that have scientific inherent like chemical and physical water properties. The main recommendation was to bridge the gaps in grades and subjects through producing side complementary materials and to train teachers on main principles of the three themes of water, energy and solid wastes.

2. Study Methodology, Approach and Structure

2.1. Study Approach

To achieve the stated objectives, secondary data were gathered from local governmental documents related to the national curriculum and education in general, and to any prior efforts for water issues incorporation in the national school textbooks. The primary data used for analyzing the water concepts presence in the textbooks was mainly generated through an extensive mapping survey conducted for the whole national school textbooks of the basic and secondary education stages in Yemen. In addition, primary data on some findings' justification and ways of improvements were obtained through implementing many open questions interviews, email and personal communication with main relevant stakeholders such as curricula board experts, water experts, and decision makers in both education and water sectors. Statistical vertical, horizontal, and water principle-based analyses were carried out based on several sets of the mapped concepts i.e. vertical sequence and development, cognitive depth (delivery and representation forms), experiential depth, and scope and alignment under main water principles as explained in details in the following section. Finally, Excel software was used for the analyzing purposes.

2.2. Methodology of the Study

2.2.1. Data Collection

Data related to the national curriculum development, and prior efforts to incorporate the water issues in the national curricula were collected from reports and documents from the relevant agencies such as ERDC, MOE, GIZ-GEIP, WEC, Ministry of Agriculture and Irrigation (MAI), NWRA, and NWRA SB. Open interviews were held with the relevant officials in ERDC, GCGD, Education Means and Programs Production Center (EMPPC), WEC, and GIZ-GEIP. Email and personal communication were held with

water experts in NWRA, and former ministers of MWE and MOE. The national school textbooks used for the mapping survey were mostly obtained through two governmental schools of “Al-Kebsi Secondary School” and “Al-Rawdhah Primary School”. The textbooks belong to humanitarian stream in grades 11 and 12 were downloaded from MOE website on 18 Sep, 2012.

The objective of carrying out the various interviews and other communications was not to obtain statistical data but to investigate some historical bases which has led to what now exists in the curricular and to interpret some unexpected results. Further, to gain various views and perceptions of how the current water concepts can be developed.

2.2.2. Textbooks Content Mapping

As presented by World Bank (2010), the school textbooks are almost the sole accessible learning material provided for both students and teachers. Consequently, the education effectiveness and outcomes in the field are mainly determined by the textbooks’ content. Hence, the textbooks’ content was chosen to be screened, described and analyzed with relevance to the water concepts and issues as explained in details within the coming parts of A, B and C.

A. Mapping Matrix Development

For the mapping and analysis purposes a multi-dimensional and comprehensive matrix was developed based on the experience gained during the literature review. The proposed matrix covers many general and detailed assessment criteria in both areas of water and education. For instance, educational evaluation standards such as concept cognitive depth (delivery and representation forms), experiential depth, and visualization were covered in the proposed matrix. Meanwhile, water-based evaluation standards such as relevance to water main principle, detailed water resources, uses,

services, problems, drivers and solutions were also covered by the matrix. Furthermore, some columns in each dimension were empty from the beginning to offer space for any unexpected element that might appear later on during the screening process. The matrix allows for documenting and recording all data relevant to the mapped textbooks and concepts. The developed matrix was reviewed and adjusted with NWRA SB water practitioners (Met on 20 Aug, 2012) and these work supervisors: Dr. Halasheh and Dr. Lichtenthaeler (Email communication on 27 Aug 2012). The final version of the matrix is shown in annex 1.A.

B. Textbooks Screening and Documentation

Each mapped textbook was recorded and documented with all its details. For instance, name of subject, respective grade and semester, total number of pages, issuing date and decree, printing date, and units and lessons' objectives statements all were recorded as shown in annex 1.B. Furthermore, each textbook was given a reference code consisting of the first two or three letters of its subject as well as the respective grade and semester. For example, the science textbook of grade eight-second semester was coded in the matrix as "Sic.08.02".

C. Concepts Identification and Recording

Each concept identified is described and recorded in the matrix mentioned. First, it is described as presented in the textbook and associated with any remarks or weaknesses if existed. Secondly, its general data such as the respective context, topic's name and page, and unit's name and number are also recorded. Further, a reference code was given to each concept that indicates in which page, topic, unite, semester, and grade it is existed. For example, if there is a water concept coded as "Geo.11.02.121", this means the concept exists in Geography subject of grade 11 exactly on page no. 121 in semester II textbook.

2.2.3. Water Concepts Assessment

As stated above that the concepts were assessed against many educational and water assessment standards. Parts A and B present the educational-based and water-based assessment standards respectively.

A. Educational Assessment Standards

Attaining learning meaningfulness requires having a sufficient level of cognitive depth by content taught to learners. Patricia Senn Brevik in her book *Information Literacy,* states "*the whole intent is to get students more meaningfully involved with content so that more of the knowledge and skills stick. Her use of the word meaningfully suggests a learning environment where students are allowed to take responsibility for their own learning by applying skills that allow them to comprehend, appreciate and apply relevant content"* (Horton et.al, 1999). Mazurat et al. (2008) stressed on the importance of having the concepts presented through a balance of representation forms so that better performance and acquisition can be maintained by learners. Finally, USAID/Jordan (2010) raised the necessity of delivering the concepts. Regarding concept delivery form, after deep analyzing for different international styles of content contextualization vs. conceptualization, Oates et.al (2010) concluded that the most effective approach is to have the curriculum content organized mainly as concept-led and knowledge-led not context-led. He stated *"the research in this area is compelling. Organizing concepts' are needed to facilitate retention in memory, develop economic mental processing, and support analytic reasoning. Concepts and principles are critical. The specific information embedded in contexts can decay into mere 'noise' unless individuals have concepts and principles to organize and interpret the content of those contexts"*. Hence the delivery and representation forms were applied to evaluate the cognitive depth of the water concepts as explained as follows:

- **Delivery Forms:** all concepts identified were evaluated against the three forms of delivery as being, i) core to the respective topic, ii) a complementary concept to another content of hosting topic i.e. to present the water absorption in a planting lesson or iii) add-on concepts to a hosting topic such as presenting the phrase “do not abuse the water” as a grammar example. This evaluation is applied on subjects level to determine water concepts cognitive extent by each subject and in which level.
- **Representation Forms:** having an effective concepts acquisition by learners also requires that concepts be transmitted to students in various forms of presentations such as information, skills, ethics and values, and participation. Therefore, the water concepts identified were exposed to this scale to determine their cognitive acquisition depth. This model also was applied to concepts on subjects level since the nature of subjects has a role to play with the applied representation forms.

It is worth mentioning that concept teaching is not a process that can be achieved in one time. Rather, it is a long term process that can take many years. Therefore, concepts usually are given to learners starting in a grade that fits to their age, gaining more cognitive development and complication in grades as students get older and getting out of the content in a grade where its whole planned outcomes are obtained according to Al-Hothi. Moreover, experiential depth in each subject of each grade plays a vital role on concepts cognitive acquisition and behaviors change (Horton et al., 1999). Therefore, both of these models were applied to assess the concepts’ vertical sequence and development on the subject level, and the concepts’ experiential depth horizontally in the grade level as follows:

- **Vertical Sequence and Development:** a map was developed to illustrate the concepts’ vertical sequence and development. The horizontal axis shows the identified concept while the vertical axis presents cognitive depth (delivery and

representation forms), repetition times, and its experiential depth and page number as shown in annexes 2 A, B, C, D…etc. The designed map helped to follow each subject presentation in each subject within the deference grades and sub-consequently to assess its vertical sequence and developments.

- **Experiential Depth:** For its uniqueness, stated by Horton et al. (1999), that link between concepts cognitive and experiential depth the experiential learning depth model of Williamson (1995) is applied for this study to evaluate the water concepts experiential depth in the respective subject content of each grade. Concepts are considered in the first phase of experience if they are introduced for first time or from one perspective. If they are reflected form more than one perspective, they pass to the next phase of reflection. Then if concepts identified are summarized or students are asked to generalized concepts they already learnt within the grade subject's textbook, concepts pass then into the generalization phase. Finally, once the concepts' application to real life situation is assigned to students as task to do the concepts succeed to pass the last four stage of the experiential model. Concepts' advance determination, in each subject of each grade, throughout the four stages model is explained more in details in preceding section 1.3.2

Finally, visualization is also a vital tool used for better education outcomes. Horton et al. (1999) state that visualization is like the mind's eye since it helps to see things in the using space and time relationships. It helps to overcome the limited attention span to the verbal presentation especially by content introduction and exploration phase. It is used for easier and faster concepts acquisition and longer knowledge instilling by learners (USAID/Jordan, 2010). Thus each concept identified was described how it was presented, and what kind of visualization was used, if existed.

B. Water-Based Assessment Standards

- **Water Main Principle Assessment:** water concepts identified were exposed to the six water main principles framework adapted by a bilateral team from the Public Action Project (PAP) and World of Letters (WOL) when assessing Jordanian school curricula content with relevance to energy, water and solid waste. The main principles for the framework were adapted from environmental education materials developed by California Protection Agency. "*The principles begin by considering the earth as a virgin land with its systems in balance and the different components of these systems in equilibrium. The principles then progress to discuss the uses of human of this natural land and developing further to the effect of humans on natural systems and related environmental problems. Ultimately, the principle begins exploring the human role, critical to managing environmental problems and moving towards sustainability"* (USAID/Jordan, 2010). The adapted water main six principles are as follows; i) water characteristics, in nature…etc., ii) water importance and human dependences…etc., iii) human influences on water resources (human drivers), iv) water main problems and issues, v) water resources conservation and management, and vi) reaching water sustainability. This model is applied to assess concepts' scope under water main principles for three main reasons, i) it has good flexibility, and smooth cognitive sequence and transition between its principles, ii) it is designed for environmental school education, and iii) it is already tested and used for water concepts evaluation by Jordanian experience. For instance, the framework assumes that students at first elementary grades can be introduced to simple concepts of water in nature, water uses, general resources and abuses forms, and water save values…etc. Then, in middle grades they can dig deeper to know more about water cycles, national uses, human impacts, water problems…etc.

developing many skills of comparison, synthesis, analysis…etc. Finally, at higher grades it is possible to introduce water resources management and sustainability aspects in a way that fits to their abilities. The concepts can be simulated and applied by students through conducting projects and other practical activities.

- **Spatial Scope:** this analysis was carried out to identify concepts' spatial scope. Each concept identified was classified according to how it is reflected on local (Yemen), regional (Arab region), international and or general context.
- **Concepts Alignment:** concepts that contrast with other concepts in learning context are considered as case of misalignment (Sky-McIlvain, 2003). Al-Hothi gives an example of *"to encourage the fertility is preferred from a religious perspective but this misaligns with family organization concepts we adopt"*. For this research, concepts that do not align with the main stream of the water facts, management and learning needs are categorized into three categorizations: i) Adverse Concepts: are the concepts given to students under other learning matters but they have adverse impacts on the water resources such as the agriculture-based food security and the agriculture horizontal expansion encouragement, ii) Mis-conceptualized concepts: are the incorrect water concepts given to students such as that Yemen has rivers, abundance of rainfall …etc., and iii) advanced concepts are the concepts that exceed learning needs of the stated water main principles for the respective students' grade. For instance, to teach about energy production plants or about water treatment or wastewater treatment for the first grades.

2.2.4. Water Concepts Maps

Concepts identified within each subject in all respective grades are organized in a map that illustrates every concept's location, cognitive and experiential depth, and vertical

sequence. Every concept was categorized on the horizontal axis under one of the main water six principles. Then vertically, it is given a number that indicates its page, colored as blue, green or yellow according to its delivery form, and ranked by letters of “E, R, G and or A” according to its experiential depth. If a concept is given either a red, an orange or a purple color, it means that it is an either an adverse, mis-conceptualized or advanced concept.

2.3. Thesis Structure

It was felt important to include investigation into the general problems with textbook provision in Yemen. Thus, the next third section investigates the main constraints facing the provision and proposes some solutions. Section four presents the materials mapped, discusses and recommends on some observations found out during the screening survey as related to units and lessons’ objectives statement. The fifth section presents, discusses and recommends on the first detailed analysis conducted assessing the water concepts vertical sequence and development, and delivery and representation forms on the subject level. Section six presents, discusses and recommends on the second detailed horizontal analysis evaluating water concepts scope, experiential depth and alignment for the three horizontal stages of the educational path. Section seven presents, discusses and recommends on the third detailed analysis carried out assessing the concepts based on their scope under the six main water principles, and under their spatial local, regional, international and general scope as explained more in the methodology. To evaluate teaching aids and materials supporting teaching water education the analysis in section eight is conducted, presented, discussed and then gives recommendation. In section nine, water concepts presence overall assessment results is presented and discussed. Finally, overall conclusions and recommendations are derived and presented in section ten.

3. Textbooks Provision Constrains

Textbooks provision faces many constrains such as insufficient and or late provision that subsequently hinder schools to finish the content before year ends especially in remote rural areas (Smart, 2005). However, good improvements have achieved during the past few years mainly by; i) Adopting decentralized provision approach that depends on districts administrations for storage and on community participation for covering a part of curricular transfer costs, ii) Increasing the annual financial allocation provided by government to curriculum printing and provision, (World Bank, 2010) and iii) The technical support provided by the German International Cooperation (GIZ)[1] through some house printing machines and training programs to designers and technicians according (Gudrun Orth, GIZ-GEIP Program Coordinator, interviewed on 13 Oct. 2012).

Nevertheless, the provision issue still remains to some extent that many schools in rural areas still require students to recycle the used books for two or three years in order to come over this problem. However, such policy has affected the learning outcomes adversely since the latter textbooks users are deprived from evaluation tasks and activities which already solved by the former users (Smart, 2005). The MOE started to upload the secondary stage curricular in its website from the current year in order to enable schools that have provision deficit to download and print quantities they need. When he was asked, why not to upload the whole textbooks of all grades, Al-Hothi stated that "*even such good proposal remains useless solution due to the lack of internet access by almost all schools in rural areas which suffer from insufficient textbooks provision*".

[1] GIZ is the former GTZ, German Technical Cooperation

Recommendations

It is recommended that MOE separate the evaluation questions and activities of each textbook in a separable annexed booklet. Thus MOE will have to provide the activities booklets only and can recycle main textbooks. However, such solution is valid for grades 7 to 12 who are old enough to manage using of side activities booklets according to Um Al-Saad. By doing so, MOE can spare many various resources fulfilling different requirements of textbooks provision which eventually enables schools to finish the content on time. Another recommended solution is to encourage private and public urban schools to download and print the uploaded textbooks from MOE website and spare the hard copies to rural areas. Finally, MOE should approach the private sector to invest in curricula printing and provision. This will eliminate the burden on MOE and improve provision services.

4. Textbooks Objectives Statement

A total of 165 school textbooks given to students in 17 subjects (table 2) throughout the twelve primary and secondary grades were screened, recorded and documented as shown in annex 1.B.

Table 2. Yemeni curriculum framework of the government schools

Subject	Grade											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Quran												
Islamic education												
Arabic												
Social studies												
History												
Geography												
Yemeni society[2]												
Sociology												
Economics												
Psychology												
Logic												
Philosophy												
Mathematics												
Statistics[3]												
Science												
Biology												
Chemistry												
Physics												
English												

Source: Modified from World Back, 2010 based on MOE Decree No. 32 of 2002.

Table legend:

	Subjects taught throughout the whole educational path of grades 1 to12
	Subjects taught to student enrolled in the Science Stream in grades 11 and 12
	Subjects taught to student enrolled in the Humanitarian Stream in grades 11 and 12

Source: (own illustration)

[2] Yemeni Society Subject is a complementary part of the Social Education Subject

[3] Statistics Subject is considered as the mathematic subject for the arte stream of grades 11 and 12.

The whole content was found having 22035 pages in addition to 172 empty pages at the end of textbooks. Furthermore, the majority of the screened textbooks have been recorded lacking the objectives statement as shown in figure 6. When Yasmeen Abdulwasae, Biology Curricula Expert at GCGD (interviewed on 11 Dec. 2012) was asked why to leave empty papers without any utilization? And further, why not to include learning objectives in all textbooks? She answered, the first happened due to the mismatch between the technical design specification of textbooks and the papers bundle size. In other words, papers are usually produced in pairs and then packed in bundles. If the total paper required for a textbook is less than the papers in a bundle or bindles, then some papers left empty. The second issue is due to the old curricula policy that state to have the learning objectives in teacher guidebooks. She added, *"However we started to insert some teaching instructions for teacher in the new developed science textbooks of grade 2"*

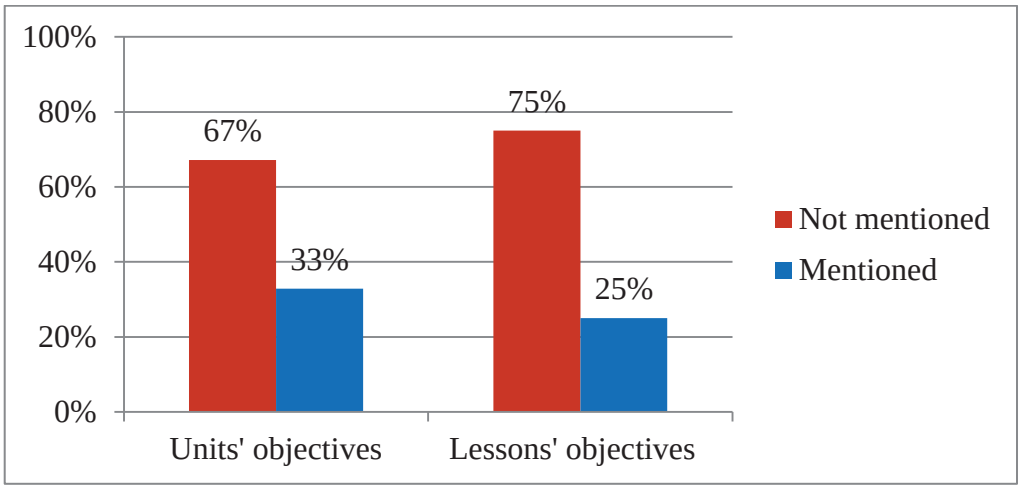


Figure 6. Units and lessons' learning objectives statement

Recommendations

- Objectives provision by units and lessons is a vital tool to attain a comprehensive teaching. Theoretically, they are supposed to help both learners and educators. For learners, they emphasize on the core important areas they should focus for better outcomes attainment. For educators, they play the role of guidance harmonizing and streaming the contents delivery process to achieve the cognitive planned outcomes especially in absence of teacher guidelines by the majority of schools in Yemen (World Bank, 2010). Therefore, it is strongly recommended to always provide comprehensive, clear, practical and achievable learning objectives that match with units and lessons' content. Furthermore, to insert some key teaching methods suitable for each lesson content as footnotes is also recommended such as the recorded case of science textbook in grade 2.
- It is recommended to utilize empty pages at the end of textbooks to deliver some useful water messages associated by attractive meaningful figures and or to present some real-life applications for the water concepts presented previously either in the respective textbook or in any other textbook. Such reinforcement concepts can promote learners understanding and acquiring to concepts they already took.

5. Water Concepts First Detailed Assessment: Subjects level

A holistic and spiral teaching attained when different subjects contribute to conceptualize the matter in question (Bloom 2006). Some subjects inherently can offer theme-based conceptualization while others can offer the reinforcement (Oates et.al 2010). In addition, as elaborated in methodology that cognitive learning is determined mainly by concepts delivery and representation forms in addition to their vertical sequence and development. This section presents concepts delivery and representation forms, and vertical sequence analysis results on subject level. Maps illustrating and summarizing the analysis findings are drawn and presented as well. Finally, detailed discussion and recommendations are attached directly for each subject.

In term of quantity, the identified concepts vary from subject to subject as shown in figure 7. Whereas the highest coverage was found by Geography, the lowest has recorded by Physics. Arabic and Science have recorded a good cover. Some subjects have shown very poor cover, while some subjects have never presented any concept. Hence, from principle such subjects cover could not support widely spiral and holistic conceptualization. However, for more precise assessment there is a need to assess the presence of each subject which is in the coming parts.

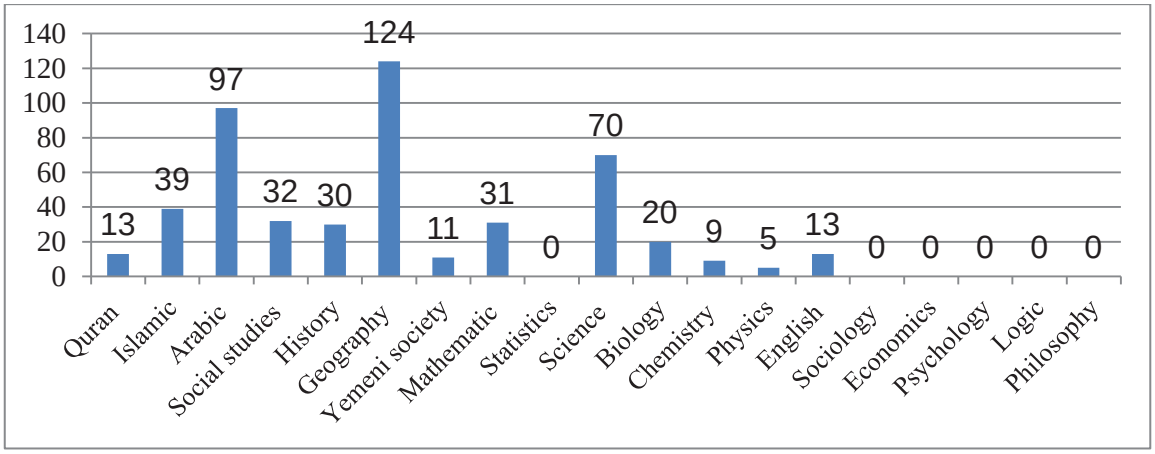


Figure 7. Subjects contribution to water conceptualization

5.1. Social Studies

10th	Experience Depth				E	E		E,R	E	E	E			E	E		E,R		E		E											
	Representation				Kn	Kn		Kn	Kn	Kn	Kn			Kn	Kn		Kn		Kn		Kn											
	Delivery				35	34		33	33	X, 34	X, 34			29	28		28-29		29		55											
9th	Experience Depth											E											E,R									
	Representation											kn											Kn, Sk									
	Delivery											Co											93									
8th	Experience Depth											E			E						E	E		E							
	Representation											kn			Kn						Kn	Kn		Kn								
	Delivery											Co			120						112	80		100								
7th	Experience Depth											E		E									E,R									
	Representation											kn		Kn									Kn, Va									
	Delivery											Co		54									75,76,90									
6th	Experience Depth		E	E									E			E,R, G							E								
	Representation		kn	Kn									Kn			Kn, Sk							Kn								
	Delivery		**80**	X, 73,74									75			III (80/3/4/7)							92								
5th	Experience Depth																						E								
	Representation																						Va								
	Delivery																						45								
4th	Experience Depth		E,R					E,R					E			E	E							E,R, G,A								
	Representation		Kn					Kn, Sk					Va			Kn	Kn							Sk, Va, Pa, att								
	Delivery		13,15					61					II, 13, 18			31	39							62								
3rd	Experience Depth	E															E	E,R														
	Representation	Kn															Kn, Sk	Kn, Sk, pa														
	Delivery	72															II, 22, 60-61	61-62														
Water Identified Concepts		Hydrosphere	Water Resources	water in environment	water resources	dams	Drinking and sanitation	Irrigation	Rained agriculture	Food Security	Agriculture expansion	water importance	increasing the demand	water abuse	water for Qat	Water pollution	Wastewater	Water Depletion		Laws	Awareness	participation	Drinking and sanitation	Conservation	water property								
Water Main Principles		**Water characteristics**					**Water Importance**						**Influences**			**Water Problems**			**W Management**						**Sustainability**							

Figure 8. Water Concepts MAP of Social Studies Subject: Vertical sequence, and cognitive and experiential depth. (Large scale Map is presented in annex 2. A)

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**	**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic	Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept	Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic	Advance	Va	Value	G: Generalization
					Pa	Participation	A: Application
					Att	Attitude	

Social Studies Subject is given to students from grade 3 to 10. In grades 3 and 4, it includes some geographical and historical topics besides environmental and societal issues but then from grade 5 to 10 it is called “National Education” and mainly reserved for society attributes, and administrative and legal framework in addition to some lessons related to Arab region. In grade 10, the subject textbook labeled as “The Yemeni Society” and focuses absolutely on Yemeni Society cultural, social, economic and political features and problems. The mapping survey identified 43 water occasions embedded in all grades.

The identified concepts were mainly delivered in the forms of add-ons to the hosting topic and complementary concept whereas less than 20 % were found as the core of hosting topic as shown in figure 9.

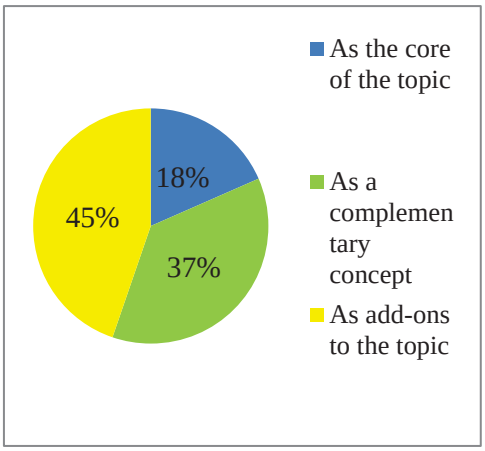


Figure 9.Water concepts delivery forms in Social Studies

Regarding representation form, knowledge form has obtained the main presence while skills and values forms came as second form of presentation. Participation and attitudes have recorded the fewer occurrences as shown in figure 10.

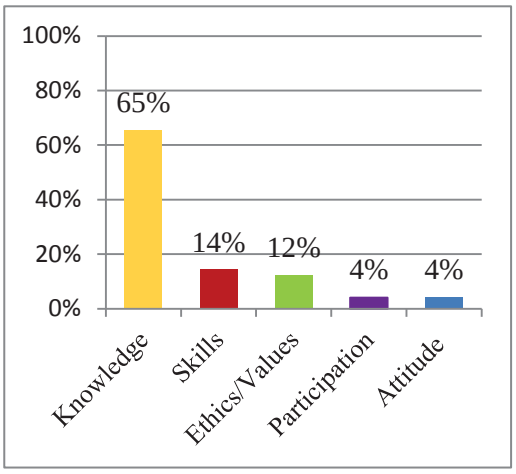


Figure 10. Water concepts representation forms in Social Studies

Water pollution problem and conservation options were the most presented concepts that have vertical sequence in grades 3-6 for the former and 4-9 for the latter. However, other concepts such as water resources, uses

and importance were scattered as shown in Social Studies Concepts Map presented in figure 8. More details of the identified concepts are presented in annex 3.A.

In general, concepts cognitive depth and vertical sequence in Social Studies is relatively poor for many reasons. Firstly, vertical sequence and development was poor and concepts were scattered except by two concepts of water pollution and conservation option. Although the two concepts have shown a relatively good vertical sequence, their cognitive development was found poor and mostly repeated. For instance, different kind of pollutants, how to keep seas free of pollution, home water saving importance and statements home were the most repeated discourses under the two mentioned concepts. In other words, those two concepts were developed in a way that expand the textual formation but with very limited development for the content. Secondly, keeping the most content cover of subject focusing on one or two concepts, such as the water pollution and conservation here, prevents concepts spiral cognitive development within the hosting subject which ultimately sacrifices the chance of developing a holistic understanding by learners (USAID/Jordan, 2010).

Regarding delivery form, less than one fifth of concepts were delivered as the core to the hosting topic serving mainly concept of water pollution while around 35% were delivered as complementary concepts serving pollution prevention options matter. On the other hand; skills, values and participation forms together have recorded the least representation. In other words, the content mainly informs students about problems and normative options of conservation. Such delivery and representation forms do not serve having in-depth cognitive learning due to the superficial and theoretical content.

Recommendations

The subject nature aims mainly to form learners' nationality and loyalty focusing on individual roles and responsibilities to support their country. Thus it offers great opportunities to incorporate many water concepts linked to nation love and loyalty. Hence, it is recommended that ground water depletion, low uses efficiency, water conflicts, water value and prices, individuals and societies responsibilities participating in water resources management are all good themes to be tackle by the social subject. Having such issues vertically sequenced and developed will help students much better to perform a holistic understanding for the national water critical situation, management framework, and individual, societies and state roles and responsibilities to sustain the scarce water resources.

On the other hand, for more cognitive acquisition it is highly recommended to prompt the skills, ethics and values, and participation when present the content. Skills of synthesis, comparison, problems analysis and solving, and deep discussions together with social values and some participation activities instill learnt concepts in minds better than the mere information do. Therefore, it is recommended to conduct field visits for students to traditional and modern irrigation systems investigating the ground water table drops by both systems, asking farmers about the various benefits or loses…etc. Furthermore, students can be encouraged to approach water user association (WUAs) in their areas participating public awareness activities. For students in urban cities, students can be asked to visit water utilities to recognize how drinking water is produced till it reaches house tap, and how it is then treated and reused again in agricultural. They also can visit some grey water models in Mosques. For both in rural and urban schools, students can be prepared to establish water clubs implementing awareness activities inside and outside their schools.

5.2. Geography

		Rainfall	Precipitation	Humidity	Wr esources, cycle	Mineral springs	Seas and oceans	Regional and international water	GW, springs	Floods and spates	Rivers & lakes	Condensation	Hydrosphere	Irrigation	Drinking water and sanitation	Energy production	industrial use	water uses (all)	Agriculture expansion	water importance	Water Abuse	Increasing the demand	Low use efficiency	Inadequate water services	Drought and floods	water conflicted	climate change	GW depletion	Water balance	Scarcity	water security	water pollution	water conservation	technical tools	dams	WWT and reuse	new resources	Desalination	Water security	Water pollution prevention	
11th	Experience Depth	E			E,R, G.A					E,R				E	E,R	E	E		E,R	E,R		E,R	E,R	E	E	E,R		E,R	E	E				E,R	E,R	E,R		E,R, G		
	Representation	Kn			Kn, Sk					Kn, Sk				kn	Kn	kn	Kn		kn	Kn		Kn	Kn	Kn	Kn	Kn		kn, Sk	Sk	Kn				Kn	Kn	Kn, Sk		Kn		
	Delivery	*16-19*			*20-25*					33-34				II, 72, 73, *35*	68-69	X-33, *49*	*54, 57*		III, X 75, *32, 77,78*	49-50		*66*	*66-67*	III 43/5 - 67/8	*76*	*67-68*		19-20	*65*	*66*				*II, 69, 77*	*69-70*	II, 20, 34, *68*		*70-72*		
10th	Experience Depth		E,R	E	E,R			E		E		E						E,R						E	E,R			E					E,R	E						
	Representation		Kn	Kn	Kn			kn		kn		Kn						kn						Kn	Kn			kn					Kn, Pa,	Kn						
	Delivery		23	22	***III, 65, 21, 25-28***			92-93		*II, 53-56, 77-9, 80-6*		*22-23*						*30-31*						78	*II, 19-20, 79, 91*			*66*					*32-33*	II, 33, 56						
9th	Experience Depth	E,R			E,R, G,A									E				E	E	E	E			E		E,R	E			E,R, G,A	E	E,R, G,A					E		
	Representation	kn			Kn, Sk									Kn				kn	kn	Va	Kn			Kn		Kn, Sk	Kn			Kn, Sk	Kn	kn, Sk Pa, Att					Kn		
	Delivery	II, 14,16 ,21			III, 24, 51, 79-83									III, 50, 77, 105				II, 25, 84	X, 109	Co	III, 26, 76, 85			39		85-86	26			88	26	II, 27, 88-89					27		
8th	Experience Depth	E,R			E		E	E							R	E			E	E	E.R. G				E					E,R	E							
	Representation	kn			Kn		Kn	Kn							kn	kn			kn	kn	Sk				kn					Kn	kn							
	Delivery	Many			**15**		II 12, 13	10							96	45, 78			X, II 28, 100	many	14				II, 99, 102					13	100							
7th	Experience Depth	E,R, G	E	E					E	E, R	E		E																										
	Representation	kn, sk	kn	kn					kn	Kn, Sk	kn		kn																										
	Delivery	99-100	99	98					II, 58, 61	II, 71, 114	65		56																										
6th	Experience Depth	E			E, R		E				E			E						E	E			E	E	R					E,R								
	Representation	Kn			Kn		kn				Kn			Kn						kn	kn			kn	kn	Sk					Kn, Va, Sk							
	Delivery	III, 12, 81, 84			II, 30, 80		9,10				39, 59, 73			32						17, 41,51, 62, 75	81			81	81	82					81							
5th	Experience Depth	E			E,R	E													E					E						R							
	Representation	Kn			Kn, Sk	Kn													kn					Kn						Sk							
	Delivery	II, 15 33-34			36-37	71													X, 57-61					46						37							
Water Concepts		Rainfall	Precipitation	Humidity	Wr esources, cycle	Mineral springs	Seas and oceans	Regional and international water	GW, springs	Floods and spates	Rivers & lakes	Condensation	Hydrosphere	Irrigation	Drinking water and sanitation	Energy production	industrial use	water uses (all)	Agriculture expansion	water importance	Water Abuse	Increasing the demand	Low use efficiency	Inadequate water services	Drought and floods	water conflicted	climate change	GW depletion	Water balance	Scarcity	water security	water pollution	water conservation	technical tools	dams	WWT and reuse	new resources	Desalination	Water security	Water pollution prevention	
Water Main Principles		**Water characteristics, in nature…**												**Water importance and human dependence**							**Human Influences**			**Water problems and issues**									**Water resources management**							**Water sustainability**	

Figure 11. Water Concepts MAP of Geography Subject: Vertical sequence, and cognitive and experiential depth. (Large scale Map is presented in annex 2. B)

Geography is taught within social studies in grades 3 and 4, and then is given separately for students in grades 5 to 10. However, in grades 11 and 12 it is exclusively for students enrolled in Humanitarian stream. The subject introduces geographical, demographical, climatic, and sometimes environmental principles on local, regional, and international level. Geography has recorded the largest cover of water concepts with a total of 124 occasions.

Almost half of the concepts were delivered as complementary concepts while the remaining was either as add-ons to the topic or as the core of the topic as shown in figure 12.

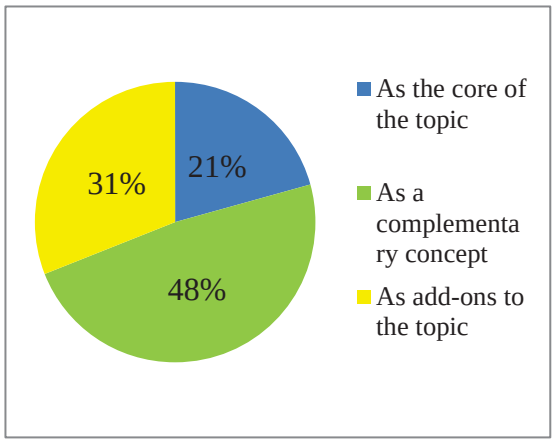


Figure 12. Water concepts delivery forms in Geography

The majority of the concepts were presented in the form of knowledge. Skills came as second form of presentation. other form of ethics, participation and attitude have appeared with the poorest share as shown in figure 13.

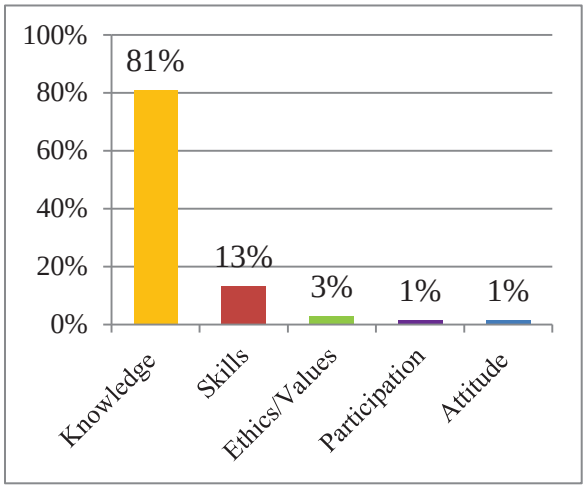


Figure 13. Water concept representation forms in Geography

Water concepts were covered in all grades especially in grades 9, 10 and 11.

The impressive in-depth coverage is recorded in grade 11 mainly on Arab water resources and problems scope. Water resources and importance were the most significant presented concepts, while problems such as flood and drought and water conservation options were the second presented concepts. The vertical sequence for the mentioned concepts is good in general but with

a lot of repetitions as shown in Geography Map presented in figure 11. Finally, more details about the identified concepts in Geography are presented in annex 3B.

In general, vertical sequence is good but development is poor. On the other hand concepts cognitive depth is relatively good where more them-based and complementary concepts have appeared. However, the great majority were presented in the form of knowledge which means that students have to memorize excessive amounts of textual presentations to acquire the introduced concepts. Such approach is too useless since ; i) it requires students to pay many efforts for memorization, ii) concepts of such form do not last for long a period of time (personal communication with Ibrahim Al-Fahd, English Teacher at Al-Naba'a School on 20 Aug, 2012). He states "*Further, students get bored when they have to memorize a lot of dry information and negatively behave when they receive repetitive strict orders such as do not abuse the water*". Furthermore, even the quantified activities did not go beyond the theory. For instance, students are usually requested to write essays thinking about problems and solutions. Such activities were vastly presented in geography. Finally, poor visualization has been recorded.

Recommendations

- It is recommended to deepen the present content enriching debates about water resources, scarcity, ground water depletion, sustainability and water and sanitation services using updated figures and effective visualization aids.
- In-class activities such as simulation, group debates and group projects are strongly recommended
- It is recommended to execute field visits to investigate water resources and associated problems, wastewater reuse, water harvesting pools and climate change impacts.

5.3. History

11th	Experience Depth								E		E												E,R					
	Representation								Kn		Kn												Kn					
	Delivery								Iv 14, 30 67, *28, 67*		II 14, 31												II, 37, 51					
10th	Experience Depth		E	E	E							E			E			E						E	E			
	Representation		Kn	Kn	Kn							Kn			Kn			Kn						Kn	Kn			
	Delivery		**32-35**	*10,24*	II, 41, *11*							*56, 66*			26			25						39	40			
9th	Experience Depth																											
	Representation																											
	Delivery																											
8th	Experience Depth		E										E										E					
	Representation		Kn										Va										Kn					
	Delivery		***8***										*Co*										*9*					
7th	Experience Depth	E	E,R						E				E					E	E,R									
	Representation	Kn	Kn						Kn				Kn					Kn	Sk									
	Delivery	II 21, 54	II, 22-23, 28-29						II, 44, 63				*10, 34, 41, 57*					35	77									
6th	Experience Depth										E																	
	Representation										Kn																	
	Delivery										104																	
5th	Experience Depth								E	E,R																		
	Representation								Kn	Kn																		
	Delivery								II, 09, (20, 23,28)	32-33																		
Water Concepts		W abandunce in Yemen	W resources, arab	W availability international	Dams, canals construction				Dams for irrigation	Water for irrigation	Drinking water supply	irrigation sources	water importance		Dams neglection			climate change	water conflect				Irrigation management	water harvesting	Participation				
Water Main Principles		Water characteristics, in nature							Water importance and human dependence						Human influence			Water problems and issues					Water resources management				Sustainability	

Figure 14.Water Concepts MAP of History Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. C)

Map Legend								
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

History is included within social studies in grades 3 and 4. Then it is taught to students as separate subject from grade 5 to grade 10. In grades 11 and 12, the subject is exclusively given to students enrolled in humanitarian stream. The subject introduces many historical civilizations and states such as Yemeni ancient civilization and various states, Arab old civilizations such as Mesopotamia, Levant , Nabataea…etc. and other international civilizations such as Greek, Roman…etc.

A total of 30 water occasions have been found distributing in all grades. The majority was delivered as add-ons to the topic while the remaining was delivered as complementary concepts as shown in figure 15. Concepts that are core of the subjects have never been shown.

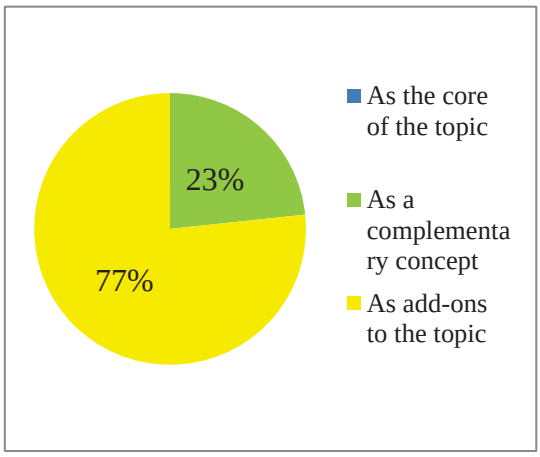


Figure 15. Water concepts delivery forms in History

On the other hand, the vast majority was represented by knowledge and only very few concepts have appeared as skills and values as shown in figure 16.

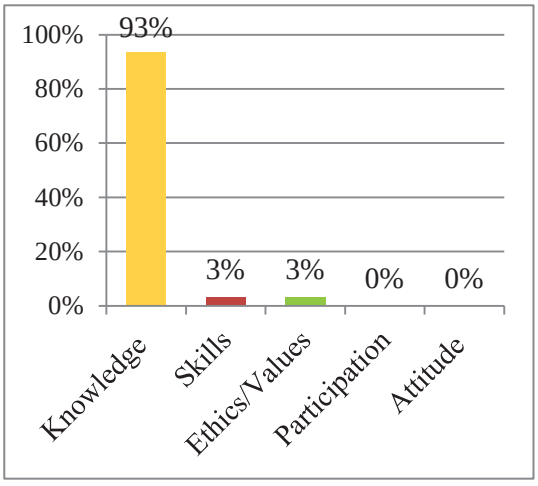


Figure 16. Water concepts representation forms in History

The most concepts were mainly covered either under water importance for civilizations establishment or under water provision for agriculture development. In addition, some repetitions mentioning that people in the past had migrated due to rainfall shortage and draught are existed. The

water concepts were presented scattered without having any vertical sequence as shown in Concepts Map of history in figure 14. Finally, more details about the identified concepts in History are available in annex 3.C.

Water concepts vertical sequence and cognitive depth in History is very poor where almost all concepts were superficially presented and scattered. For instance, the main focus was on historical agriculture importance and states' efforts to provide the demanded water through dams and channels construction. For instance, it was excessively repeated how Yemeni ancient were wise and powerful constructing dams overall the country such as the old great Ma'rib Dam. On the other hand, representation forms of skills, values, and participations were almost non applicable which affect the concepts cognitive learning.

Recommendations:

- It is strongly recommended to revise the whole subject content within all grades providing more in-depth discourses vertically sequenced and developed of how Yemeni ancient could manage to supply villages and cities using different water harvesting techniques such as pools, cisterns, roof harvesting system, and how they could adapt to scarcity conditions through rainfall direct utilization by terraces. Furthermore, regional and international historical water problems and management cases can be introduced to widen the horizon of learners thinking.
- It is worthy to reflect the past migration effects on that people also will have to migrate somewhere else if they continue to deplete water resources and how it will be difficult creating conflicts in places where they want to migrate to.
- Last but not least, students can be encouraged to visit traditional water management systems such as cisterns, pools, and terraces recognizing their importance and how they became neglected in many areas.

5.4. Science

9th	Experience Depth				E,R,G,A	E,R, G,A			E								E,R							
	Representation				Sk, Kn	Kn, Sk			Kn								Kn							
	Delivery				VII (13,20,46,69), *(53-73,84-85, 92)*	65-68			X, *108, 114*								*28*							
8th	Experience Depth			E,R	E,R,G								E						E					
	Representation			Sk	Kn, Sk								Kn, Va						Kn					
	Delivery			*81-83*	II (123-126, *11)*								III (153, Co)						161					
7th	Experience Depth				E,R,G,A						E,R		E											
	Representation				Sk						Kn, Sk		Va											
	Delivery				IIV (10, 50-52, 99,120) *(11-12, 68)*						55-56		II (cover)											
6th	Experience Depth											E		E										
	Representation											Sk		Va										
	Delivery											*70-71*		*160*										
5th	Experience Depth		E,R	E,R	E,R	E,R	E,R						E,R, G			=	E,R			E,R		E,R		
	Representation		Sk	Kn, Sk	Sk	Sk	Sk						Kn, Sk, Va			Sk	Kn, Sk			Kn, Sk		Va, Kn		
	Delivery		*II (78-79, 84)*	II 113-115, (X-125)	*3,5*	*71*	*70*						111-113			115	117-120			122-123		121-122		
4th	Experience Depth		E		E,R, G,A				E, R															
	Representation		Kn		Sk				Kn, Sk															
	Delivery		*150*		***IV (12,33, 58,64)***				II (111-X), 132															
3th	Experience Depth	E	E	E,R	E,R																	E		
	Representation	Kn	Va	Sk	Sk																	Sk		
	Delivery	75	74	80-81	76-79																	80		
2nd	Experience Depth		E					E	E,R															
	Representation		Kn					Kn	Kn, Sk															
	Delivery		78					78	44															
1st	Experience Depth							=	E	R	E,R		R	E								E,R		
	Representation							Kn	Kn	Kn	Kn, Sk		Va, Kn	Kn								att		
	Delivery							X, 83	71	95	II (83/4, 91/2)		87, 94	78								97, 100		
Water Concepts		Marib Dam	Rainfall, spate	W Resources, cycle	Water prosperities	Fug, Dew, acidic rain	Humidity	Domestic	Irrigation	Water Uses	Drinking water services	energy production	W importance, gift …	Abuse		Water losses	Water pollution	GW Depletion	Water for Qat	Drinking W Treatment	Close the tap	Water conservation		
Water Main Principles		**Water characteristics**						**Water Importance**						**Influences**		**Water Problems**				**W Management**			**Sustainability**	

Figure 17.Water Concepts MAP of Science Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. D)

Science subject is taught to students in grades 1 to 9. It mainly presents an integrated content of biological, physical and chemical topics in addition to some geological lessons that appear in some grades.

The surveyed content resulted in identification of 70 water occasions. Almost half of the presented concepts were delivered as complementary concepts whereas the rest have delivered either as the core or as add-ons to the hosting topic as shown in figure 18.

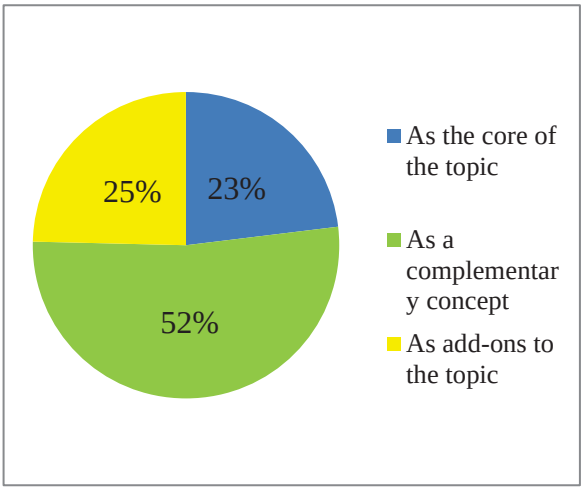


Figure 18. Water concepts delivery forms in Science

Regarding the representation forms, the concepts were mainly presented as knowledge and skills, some as ethics and values, and rarely did others take as attitude as shown in figure 19.

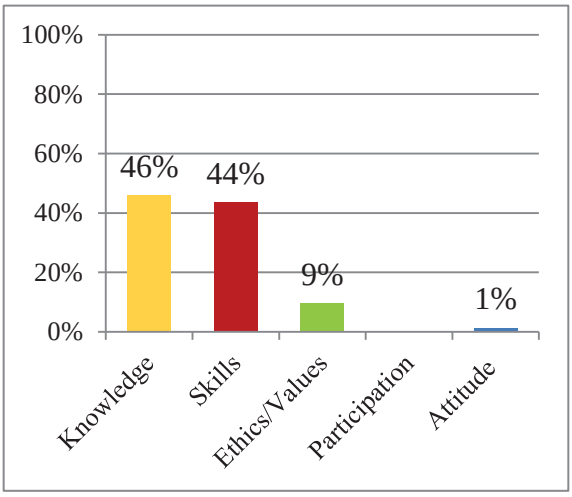


Figure 19. Water concepts representation forms in Science

Due to the subject nature, quite third of the identified concepts were presented empirically through many Laboratory experiments used to prove chemical and physical characteristics as shown in figure 20.

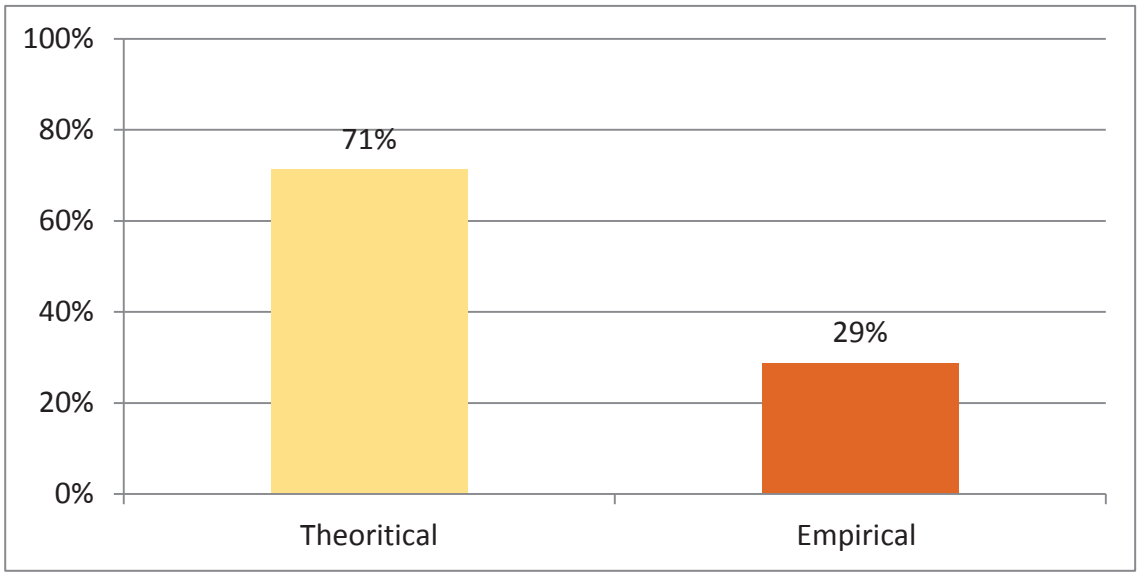


Figure 20. Concepts theoretical V.s. empirical introduction in Science

Water concepts were covered in all grades with good cover in grades 1 and 9. Water resources, importance and uses, and chemical and physical characteristics were the main presented ones. Further, concepts of water cycle and resources, water chemical and physical characteristics have shown good vertical sequence and development increasing difficulty as grades rise as shown in Concepts Map of Science in figure 17. Finally, more details about the identified concepts in Science such as the context, description, remarks and weaknesses are presented in annex 3.D.

In general, water concepts in science have shown good cognitive depth in terms of delivery and representation forms considering the subject nature. This good presence happened due to two main reasons; 1) the key coordinator of the mentioned cooperation project between NWRA and ERDC implemented in 1998, was Um Al-Saad Abdulhai who was assigned later to incorporate and even write the water concepts in science and in the other three subjects. She stated, *"We did not let any possibility unless we utilized it to insert water concepts especially in science"*, ii) subject nature allow to host many water chemical and physical properties which are the presented concepts as theme-

based presentation having good vertical sequence and development. However, how science and technologies can support water management has rarely appeared in all grades. Concepts distribution variation in grades is out of curricular authors' hand rather than it is due curricula general document condition that predetermined the topics for each subject in each grade according to Yasmeen Abdulwasae.

Almost half of the concepts were presented as empirical skills through many Laboratory experiments. However, such presence is rarely applicable and useful since the majority of schools lack laboratories according (World Bank 2010). Furthermore, visualization was either poor or mis-selected in many presentations. According to Um Al-Saad and Yassmeen, put specifications of photos required to visualize concepts and designers select but mistakenly sometimes. Abdullah Al-Senwi (Media and Maps Designer at EMPPC) justified, *"We mostly lack the required photos and do not have financial support to go out in the field getting the required photos or drawings. Thus we used available photos in our archive or even from internet"* (Interviewed on 10. Dec, 2012).

Recommendations:

It is recommended emphasize on real life applications to show how technologies such as modern irrigation systems and house water saving devices have an important role in water management enhancing users soci-economic life. Further, grey water and waste water treatment and reuse are suitable themes for science. Since there is lack of equipment by schools it is recommended to promote the usage of available materials in environment to simulate the presented concepts. Finally, more ethics and values are recommended to link and promote the responsibility of knowledge by learners.

5.5. Biology

12th	Experience Depth	E,R								E	E	E,R			E,R	E,R, G	E,R, G	E,R		E	E		
	Representation	Kn								Kn	Kn	Kn			Kn	Kn	Kn, Sk	Kn, Sk		Kn	Kn		
	Delivery	181								183	X, 179	II 163, 171			164	171 -173	182 -183	182 -183		156	173		
11th	Experience Depth						E	E															
	Representation						Kn	Kn															
	Delivery						123	124															
10th	Experience Depth		E	E,R	E	E,R,G ,A	E					E											
	Representation		Kn	Kn	Kn	Kn, Sk	Kn					Kn											
	Delivery		185	192 -194	170	II (104-108, 170)	175					194											
Water Concepts		Water resources	GW	The Hydrosepher	Water in human body	Water procss es in plant	Water properties	water as environmental system		Agriculture share	Preventing the TWW Reuse	Water importance			Acidic rain	Water Pollution	Ground water depletion	Scarcity		Sludg Treatment	conservation		
Water Main Principles		**Water characteristics, in nature**							**Water importance and human dependence on (Water Uses)**				**Human influence**		**Water problems and issues**				**Water resources management**			**Water sustainability**	

Figure 21. Water Concepts MAP of Biology Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. E)

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**	**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic	Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept	Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic	Advance	Va	Value	G: Generalization
					Pa	Participation	A: Application
					Att	Attitude	

Biology is given to students in grades 10, and 11 and 12-Sience Stream. The total water occurrences identified were 20. The majority was delivered as complementary concepts while the remaining was equally delivered as the core and add-ons to the hosting topic as shown in figure 22.

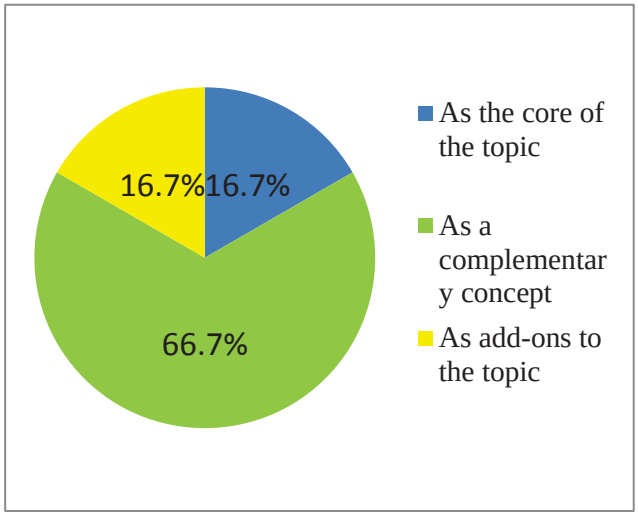


Figure 22. Water concepts delivery forms in Biology

On the other hand, most of identified concepts were presented as knowledge base presentations while very few were presented as skills as shown in figure 23. Values, participation and attitudes have never shown. Concepts mainly have appeared in grade 12 in addition to some in grade 10. While almost all presented concepts in grade 10 were focusing on water in environment, concepts in grade 12 were better distributed covering water uses, problems and management issues. For instance, water pollution and ground water depletion were relatively good covered in grade 12. Finally, the vertical sequence was almost missed as shown Concepts Map of Biology in figure 21. More details about the identified concepts in Biology are presented in annex 3.E.

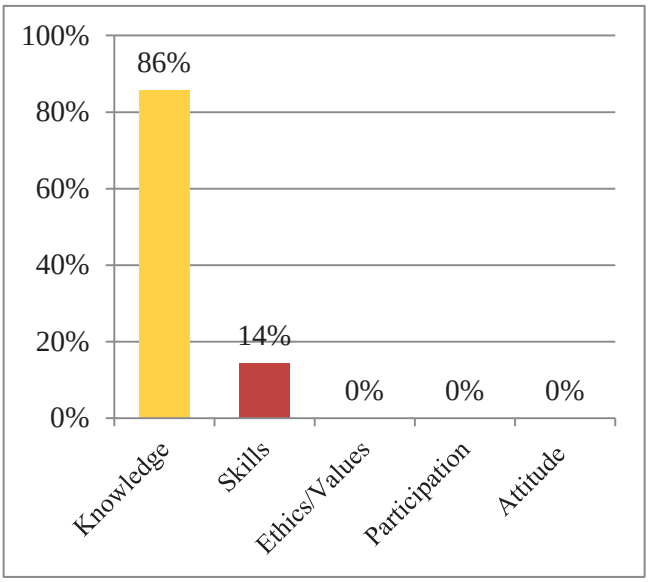


Figure 23. Water concepts representation forms in Biology

All in all, concepts cognitive depth is generally good in terms of delivery but weaknesses are significant by representation forms and vertical sequence. For instance, most of the content is delivered in last grade by mere presentations and even lack the proper visualization.

Some reflections and details have been recorded related to ground water depletion in Sana'a basin in grade 12; however, with very poor and messy textual presentations. Nonetheless, it is too useless to keep such details till the last grade since students' enrollment percentage reaches grade 12-science stream became very low (TIMSS, 2012. Surprisingly; values, participation, and attitudes forms fall totally out of the subject and so did visualization.

Recommendations

It is recommended to expand water concepts scope in Biology for grades 10 and 11 in order to cover missed water main principles such as water for environmental uses, main principles of wastewater and grey water treatment, scarcity, and adverse environmental impacts and associated soci-economic impacts of water depletion. However, it is recommended also that those important issues should be also pre-introduced in earlier grades like 7, 8 and 9 with good cognitive depth allowing the majority to benefit from.

On the other hand, it is highly recommended to promote the presentation forms of skills, ethics and visualization. For instant, students should be actively encouraged to tackle much more activities such as in-depth debates, simulation, group projects recognizing the critical water situation and its impacts on human, environment, and the whole life. In addition, visualizing concepts through using meaningful photos, figures, posters and movies is also recommended since it enhances concept cognitive acquisition by learners.

5.6. Chemistry

12th	Experience Depth	E										E				E,R	E,R				E			
	Representation	Kn, Sk										Kn				Kn	Kn				Kn			
	Delivery	30										**83**				II, 148, 172 -173	170				175, 176			
11th	Experience Depth			E	E,R														E					
	Representation			Kn	Kn														Kn					
	Delivery			95	112-123														58					
10th	Experience Depth																							
	Representation																							
	Delivery																							
Water Concepts		water states	Desalination	Water Cycle	Aqueous solutions											Water pollution	Acidic rain		Drinking water disinfection		Wastwater Treatment			
Water Main Principles		Water existence, characteristics, interlinkage with other elements in the nature						Water importance and human			Human influence (positive and negative impacts)				Water problems and issues related to human impact			Water resources management				Reaching water sustainabili		

Figure 24. Water Concepts MAP of Chemistry Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. F)

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**	**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic	Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept	Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic	Advance	Va	Value	G: Generalization
					Pa	Participation	A: Application
					Att	Attitude	

Chemistry is given to grades 10, and 11- and 12-Science stream. The total number of presented water concepts is 9 distributed in grades 11 and 12 while nothing has been recorded in grade 10. Almost all concepts are delivered as complementary and as add-ons to topic as shown in figure 25.

Regarding presentation forms, almost all concepts were presented as knowledge except one has recorded in the form of skills as shown in figure 26. Other presentation forms of values, participation and attitudes have never shown in the subject.

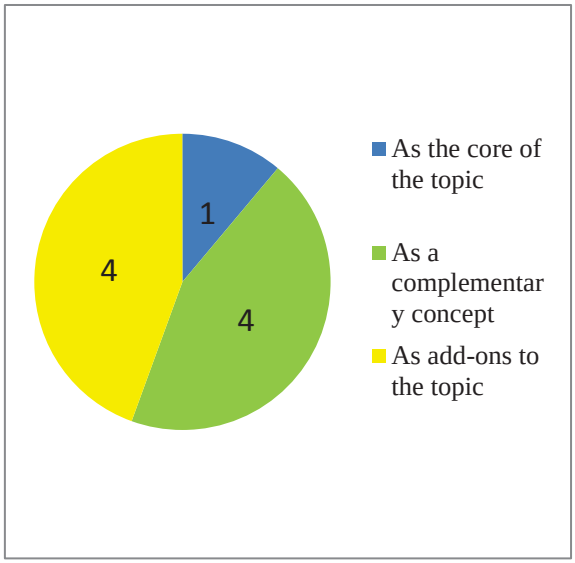


Figure 26. Water concepts delivery forms in Chemistry

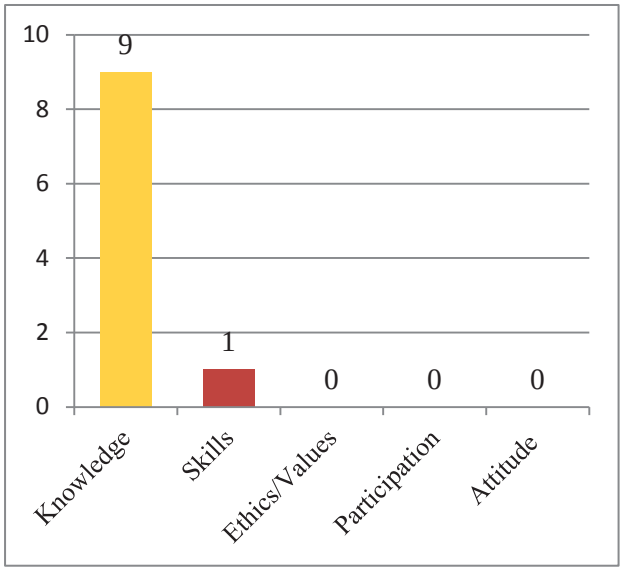


Figure 26. Water concepts representation forms in Chemistry

Concepts vertical sequence is totally absent as shown in the Concepts Map in figure 24. More details about the identified concepts in Chemistry such as concepts context, description, remarks and weaknesses are presented in annex 3.F.

Concepts presence in chemistry is very poor and vertical sequence is totally absent. For instance, concepts are almost repetitively presented and have no added knowledge. For example, water pollution which is the biggest presented topic is almost a repetition case for what has been presented in Biology in the same grade of 12. On the other hand, almost all presented concepts do lack the practical approach of learning.

Recommendation

It is recommended to expand presence scope for all three grades with rational vertical sequence covering many important issues such as drinking water treatment and its safety standards. Besides, simple methods drinking water quality improvement in rural

areas can be also added. Further, recognizing the impacts of inadequate drinking water and sanitation services from many perspectives are also recommended for this subject. However, main attention should be paid on how to promote practical skills by learners when addressing such issues.

5.7. Physics

12th	Experience Depth						A	E,R										A					
	Representation						Kn	Kn										Kn					
	Delivery						194	187										194					
11th	Experience Depth																						
	Representation																						
	Delivery																						
10th	Experience Depth		E,R,G	E,R																			
	Representation		Kn, Pa	Kn, Sk																			
	Delivery		64-65	73-76																			
Water Concepts			water states	Water prosperities (Physical, chemical... etc.)			Domestic (warming)	energy production										Desalination					
Water Main Principles		**Water characteristics, in nature**					**Water importance**			**Human influence**				**Water problems**				**Water management**			**W sustainability**		

Figure 27. Water Concepts MAP of Physics: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. G)

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Physics is introduced for grades 10 and 11&12-Science stream. The total identified water concepts are 5. Only one concept was delivered as core of the topic while almost all concepts were presented as knowledge except one that was supported by a participation activity as shown in figure 28 and 29.

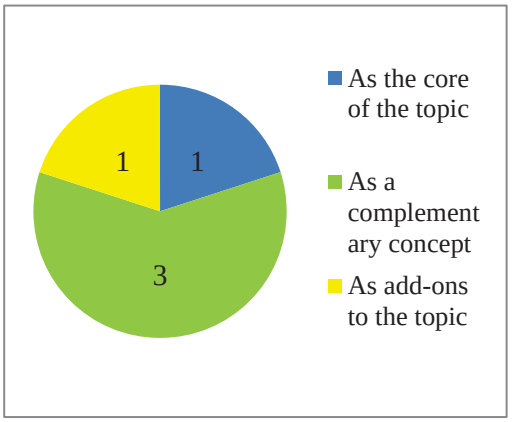


Figure 28. Water concepts delivery form in Physics

All presented concepts are repetitions for concepts presented many times before such as desalination, surface tension….etc. except one that presents water use for house warming. The concepts vertical sequence is not existed at all as shown in the Concepts Map in figure 27. More details about the identified concepts in Physics such as the context, description, remarks and weaknesses are presented in annex 3.G.

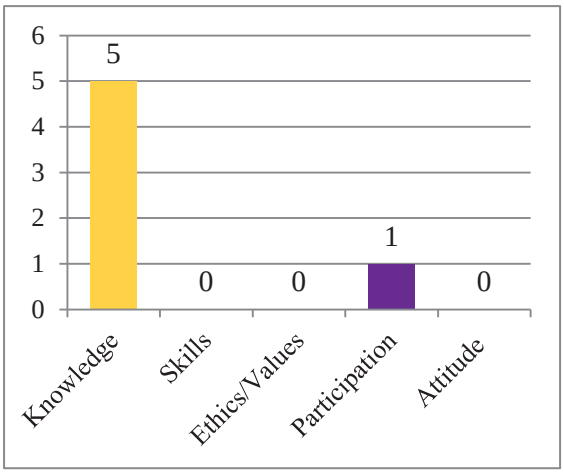


Figure 29. Water concepts representation forms in Physics

The poor superficial presence water concepts presence in physics is due to its nature that do not offers a wide horizon to include the different water concepts. However, physics subject offers many areas that can be utilized to reflect the water concepts as real life applications.

Recommendations

It is recommended to revise the whole content of the subject determining the best areas by which the water concepts can be reflected as applications and case studies for the introduced topics of the subjects. Those proposed water applications can play the role of reinforcement to other concepts presented in other subjects. By doing so, students can form better holistic understanding and appreciation for various water concepts and issues they have learnt.

5.8. Arabic Language

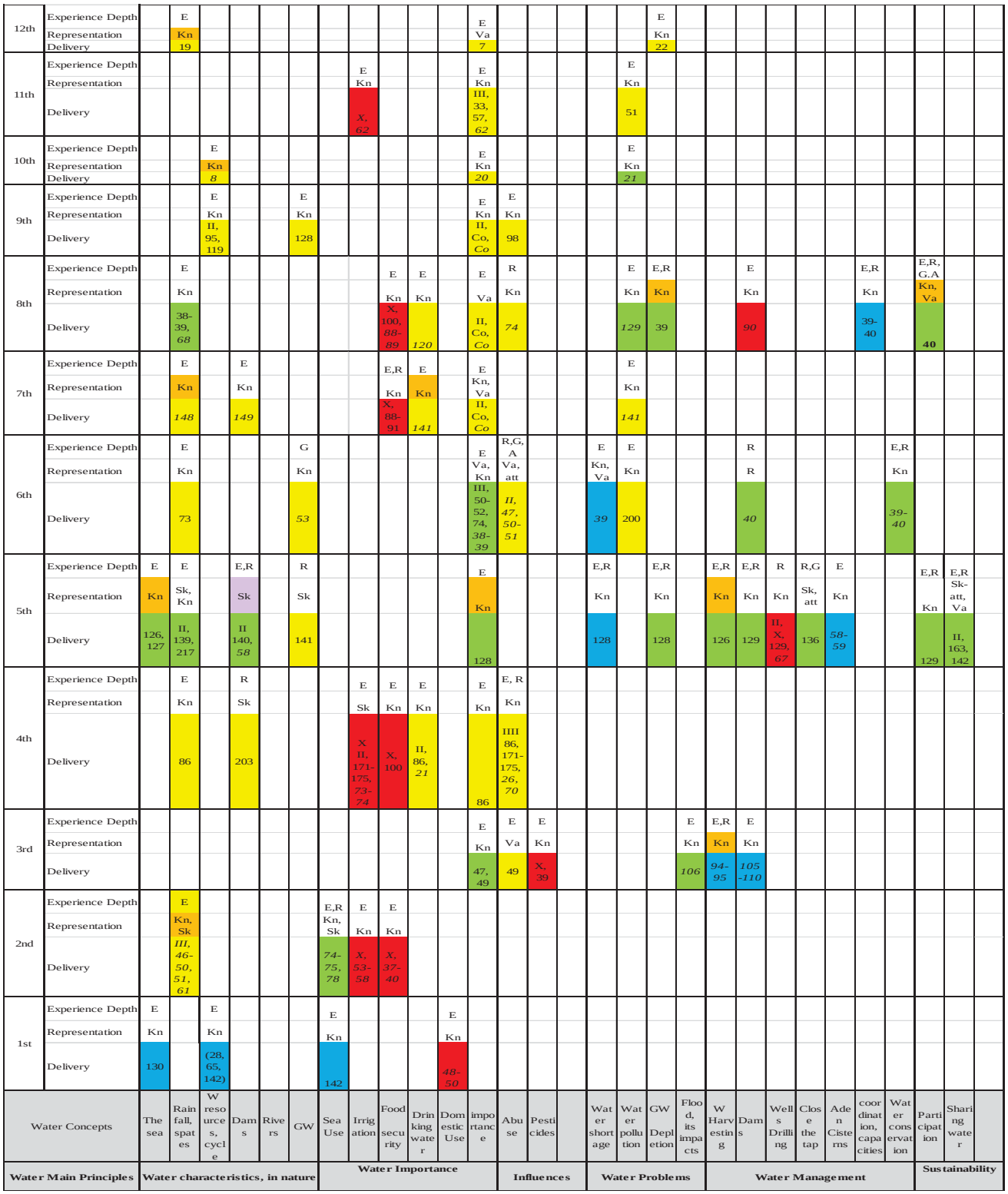


Figure 30. Water Concepts MAP of Arabic Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. H)

Arabic Subject is given to students along the educational path. The subject consisted mainly of reading, grammar and literature elements. It is taught as one integrated material for grades 1 to 9 and then be split into three separate textbooks. The presented topics are utilized to teach various principles.

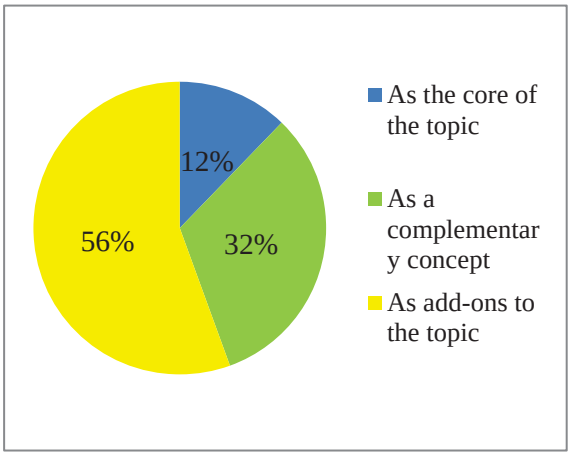


Figure 31. Water concepts delivery forms in Arabic

The mapping has resulted in identifying 97 water occurrences embedded in all grades. While concepts have good cover in grades 5, 6 and 8, it remains poor and scattered in the other grades.

More than half of the presented concepts have been delivered in form of add-ons to topic such as grammatical examples. Complementary concepts came as second form of delivery whereas few occurrences have recorded as the core of the topic as shown in figure 31.

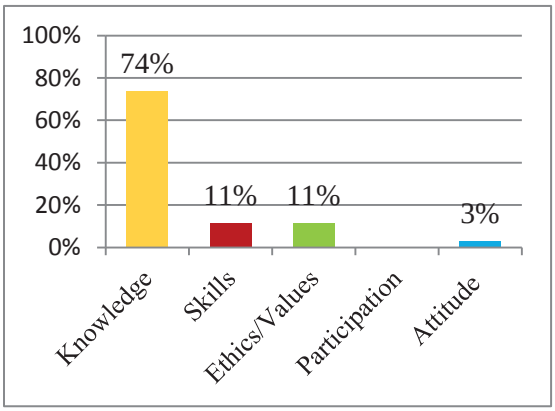


Figure 32. Water Concepts representation forms in Arabic

With respect to representation forms, the majority was presented in form of knowledge. Skills and values have recorded the second form of presentation while attitudes statements were the less occurred presentations. Participation form has never been shown as illustrated in figure 32. Water harvesting was introduced twice by relative good presentations; however, theoretical remained and poor visualized. There is also a superficial indication to people and state cooperation importance.

Concepts of water resources and importance have recorded vertical sequence and so did concepts of water problem and solutions in grades 5, 6 and 8 as shown in Concepts Map of Arabic in figure 30. Finally, more details about concepts identified in Arabic are presented in annex 3.H.

In general, water concepts cover in Arabic is relatively good but with superficial and scattered cognitive depth. This is influenced by NWRA program intervention in 1998. According to Um Al-Saad Abdulhai, it was the easiest for to incorporate water concepts in Arabic since what ally they had to do is just to replace reading text by another without need to give attention to concepts vertical sequence in the subject. Meanwhile, not passing over the curricula general document determines since it did not specify what kind of texts to be used for reading essays. Thus, they managed to insert some theme-based topics related water as in grades 5, 6 and 8 in addition to numerous add-ons concepts such as grammar examples and photos on the back cover of the textbooks. However, most of the inserted concepts were superficially presented and do not go beyond simple introduction containing general information. Furthermore, they were always repeated such as the notions of “save the water, do not abuse the water, water is gift…etc”. Such repetitive boring presentations might result in negative impacts on students’ desire to learn so that they might act negatively towards water (USAID/Jordan 2010).

On the other hand, the whole content was delivered in a very theoretical form that even lacks proper visualization. For instance, the maximum of what students were asked to do is either to solve direct questions which require them mainly to repeat and memorize the textual general information or to write essays about water as gift and water importance for life.

Recommendations

Arabic subject offers good opportunities to incorporate water concepts in much in-depth cognitive manner due it subject flexibility to substitute its lessons' themes. However, any incorporation process should be done in a very holistic approach. Hence it is recommended:

- To revise the already existed water themes in grades 5, 6 and 8 making them much deeper in term of cognitive content and information. In other words, more reflective cases, updated information should be applied.
- To retain a good vertical sequence and development, it is recommended to expand concepts presence in the remaining grades 7, 9 and up to 12. For those grades, the principles of water problems, human influences, water management and sustainability can be applied either as theme-based lessons or as complementary concepts of reflection. For lower grades, principles of water importance and conservation can be introduced in very attractive stories, photos and messages.
- To promote the skills, values and participation forms that ensure behaviors shape of learners. Besides, in-class and out class activities should be promoted. For instance, students can be encouraged to make interviews with friends and relatives investigating local water issues and implications. They also can be asked to prepare school reportages, magazines, postures and brochures out of data they collect. Further, it is recommended to utilize the schools live broadcast program in the morning also offers a good floor to spread water awareness among students.

5.9. The Holy Qur'an

10th	Experience Depth	E	E																
	Representation	Kn	kn																
	Delivery	II 40,44, 46	*9, 11*																
9th	Experience Depth					E	E												
	Representation					Kn	Kn												
	Delivery					38, 40	III, 16/8, 118,120, Co												
8th	Experience Depth						E												
	Representation						Va												
	Delivery						Co												
7th	Experience Depth						E												
	Representation						Kn, Va												
	Delivery						II, 15, Co												
6th	Experience Depth						E,R												
	Representation						Va, Sk												
	Delivery						24, 25												
5th	Experience Depth	E						E											
	Representation	Va						Va											
	Delivery	118						Co											
Water Concepts		Rainfall	water resources			Seas Navigation	Water importance	water abuse											
Water Main Principles		**Water characteristics, in nature**			**Water importance**			**Human influence**			**Water problems**			**Water management**			**W sustainability**	

Figure 33.Water Concepts MAP of the Holy Qur'an Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. I)

The Holy Qur'an is a religious education subject given to students in all grades. For the first three grades, it is merged with Islamic Education in one textbook. According to textbooks introductions, the Holy Qur'an' aims vary after students age but in general it aims to build aware personalities reinforced by Islamic believes and values and being open-minded to contemporaneous life with right Islamic behaviors. Besides religious contents, it is stated that subject textbooks did not overlook to include some of health, demographical, and environmental concepts.

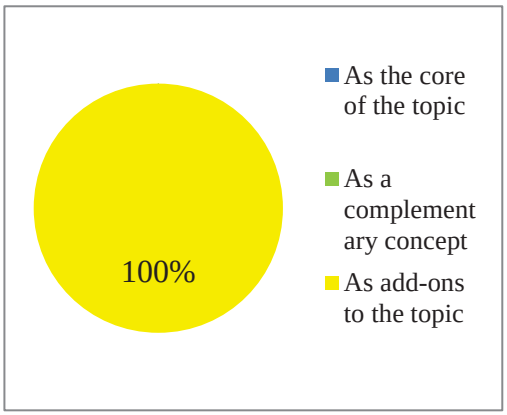


Figure 34. Water concepts delivery forms in the Holy Quran

The mapping identified 13 water occasions throughout the whole subject content mainly presented in grades 9 and 10. The identified concepts were totally delivered as add-ons to the topic as shown in figure 34. Representation form of delivered concepts was knowledge form at first, values and ethics at second and skills as third form of presentation as shown in figure 35. The main presented water concepts are rainfall sending by Allah to relief dried lands and people, water as a grace provided by Allah, water as a gift which should be saved and water importance for all kinds of life on the earth. Due to the subject nature, presented concepts did not follow any vertical sequence as shown in Concepts Map of Holy Qura'n in figure 33. More details about the identified concepts in Holy Qur'an are presented in annex 3.I

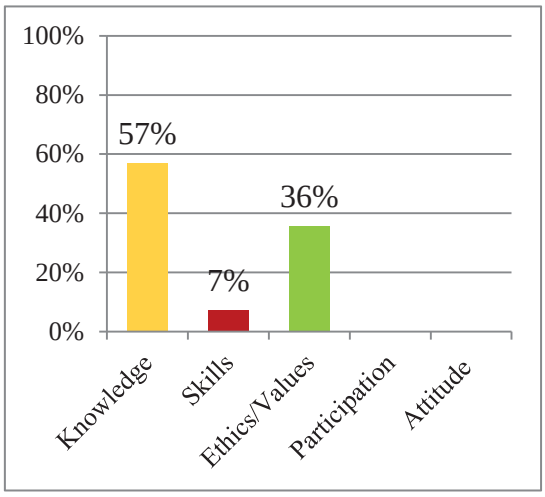


Figure 35. Water concepts representation forms in the Holy Quran

The water concepts presence in the Holy Qur'an subject is found having very poor cognitive depth and vertical sequence excluded mainly to repetitive and superficial presentations of water as a gift and water importance for life even the subject aims and elements offer good opportunity to incorporate different water values, and ethics that promote individuals responsibility toward the environment and societies.

Recommendation

It is evident from numerous verses in the Holy Qur'an that water is an essential theme in Islamic worships, and other daily life activities. Further, Islamic teachings still have strong influence shaping Muslims behaviors in the Islamic countries which suffer from high water scarcity (Faruqui et al. 2001). On the other hand, the subject intendancy of preparing aware students who behave rightly within their societies offer good chances for much effective water teaching. Hence, it is recommended to expand the water concepts coverage in all grades as reflective examples to the main religious verses of ethics and values. For instance, simple values of water appreciation and conservation can be introduced for lower grades from 1-6, water ethical issues such as water share, use priorities, equity…etc can be given to grades 7-9 and finally much in-depth concepts such as human succession (***Istikhlaf***) role on the earth, responsibility of knowledge, corruption elimination …etc can be given to higher remaining grades. Furthermore, skills and participation side should be promoted when presenting the proposed concepts. For example, students can be encouraged to utilize summer religious school events spreading and reflecting what they have learnt in schools to other members of society.

5.10. Islamic Education

12th	Experience Depth																			
	Representation																			
	Delivery																			
11th	Experience Depth		E	E	E				E											
	Representation		Kn	Kn	Kn				Kn, Va											
	Delivery		40-41	42-43	53				45											
10th	Experience Depth						E	E												
	Representation						Kn	Kn												
	Delivery						17, 23	131												
9th	Experience Depth						E													
	Representation						Kn													
	Delivery						II, Co, Co													
8th	Experience Depth		E,R				E													
	Representation		Kn				Va													
	Delivery		17-18				II, Co, 17, Co													
7th	Experience Depth	E	E	E		E	E			E,R, G		E		E,R, G	E,R		E			
	Representation	Kn	Kn	Kn		Kn	Va, Kn			Kn, Va		Kn		Va	Va		Kn			
	Delivery	77-78	47	48		179-180	III, 77, Co, Co			99-102		101		81	80		101			
6th	Experience Depth									E				E,R, G						
	Representation									Kn				Va						
	Delivery									Co				36-38						
5th	Experience Depth																			
	Representation																			
	Delivery																			
4th	Experience Depth	E					E			E										
	Representation	Kn					Kn			Kn										
	Delivery	33-35					33			101										
3rd	Experience Depth						E			E				E						
	Representation						Kn			Kn				Va						
	Delivery						115, 117			120, 123				118						
2nd	Experience Depth							R		E										
	Representation							Att		Va										
	Delivery							X, 26		36										
1st	Experience Depth	E					E			E				E						
	Representation	Kn					Va			Va, Kn				Va						
	Delivery	77-80					79			III, 38,39, 79 111				32						
Water Concepts		Water Puerity	W cycle, resources	Hydrosphere	rivers proerity	Zam Zam well	importance	Irrigation	Drinking supply	W Abuse		Depletion, scarcity		conservation	Values		Awareness			
Water Main Principles		**Water characteristics, in nature**					**Water importance**			**Human influence**		**Water problems**		**Water resources management**				**W sustainability**		

Figure 36. Water Concepts MAP of Islamic Education Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2.J)

Islamic Education is given to grades 1 to 12. It is mainly consisted of four literals; Iman (Belief), Fiqh (Jurisprudence), Haddeeth (Speeches of Prophet Mohammad Pace Be Upon Him, PBUH), and Seerah (The biography of Prophet Mohammad, PBUH). All

four literals are taught in one textbook except for the highest three grades. In addition to the aim of deepening prayers, believes, and daily handlings concepts, the subject aims to prepare students living and behaving as respectful models who retain many values and morals that help supporting the surrounding environment and societies.

A total of 39 water occurrences have been found in all grades except in the 5th and 12th grades where nothing was presented. Almost one third of the concepts were covered in grade 7. Most concepts were mainly delivered as add-ons to topic, some as complementary, and the less as the core of topics as shown in figure 37. With respect to representation form, concepts were mainly presented as pure information, some as ethics and values, while the less have taken form of attitudes statement. Neither skills nor participation have appeared as shown in figure 38.

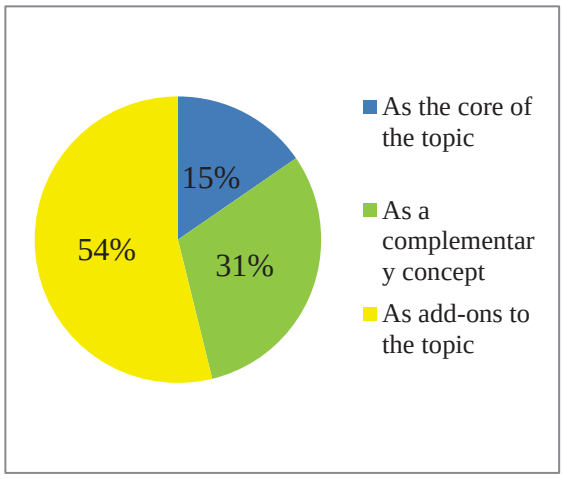


Figure 37. Concepts representation forms in Islamic Education

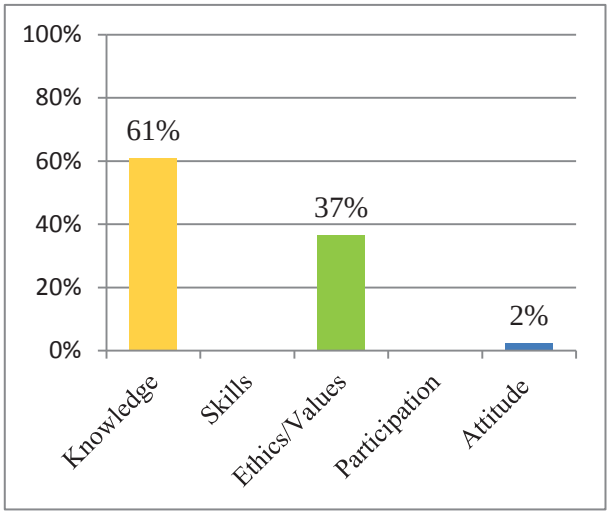


Figure 38. Concept delivery forms in Islamic Education

Types of water for purification and ablution, water importance and "water not abuse" were the main however superficial presented concepts especially concept of "do not abuse water even you are on a river". Besides, concept of not polluting surface water through defecation has appeared twice. Unlike the Holy Qura'an Subject, some concepts such as water importance for life, water not

abuse, and water for purification have recorded a vertical sequence as shown in Concepts Map in figure 36. More details about the identified concepts in the Islamic Education Subject are presented in annex 3.J.

Generally, water presence in Islamic education has poor cognitive depth and sequence except the concept of water for purification. Further, many vital Islamic values that are emphyisized in Islamic discourses have fall out of the subject textbooks. For example, water property is clearly stated "people are partners owning water, fire and grass as resources" (Prophet Mohammad PBUH). Another example, people are allowed to own water only once they invested on it; however, it is not an absolute possession as they are not allowed to own the resources themselves. Equity in getting drinking water is another concept that means Muslims are not allowed to exclude drinking water from anyone who are in need but highly encouraged to introduce it. The Prophet Mohammad PBUH Say "*Any Muslim quenched a thirst of another Muslim; Allah will quench his thirst from a sealed Nectar"*. Furthermore, many other general Islamic values and rules can be applied to water issues such as the principle of "Do no harm, get neither" (Faruqui et al. 2001), *Ithar* (Altruism) and *Amr Be-lmaroof and Nahi An Munkaar* (Promotion of Virtue and Prevention of Vice). Unfortunately, such crucial values and concepts were totally fall out of the subject.

Recommendations

People in Yemen still retain strong adhesion to religious morals, therefore, it is recommended to include such vital concepts mentioned above and to enrich skills of debates, role play, oral presentations…etc helping students forming wider horizon perception and appreciation towards water rendering in influencing the surrounding societies. However, such proposed improvements should proceed in line with more practical teaching. Therefore, it is recommended to, i) encourage students to approach

Mosques' Immams organizing some awareness sessions for people, and ii) to conduct some field visits to Mosques where traditional water harvesting and grey water systems are installed.

5.11. Mathematics

11th	Experience Depth						R Sk								R Sk							
	Representation						III, Sc 99, *Ex 24, 27*								Sc, 82							
	Delivery																					
10th	Experience Depth					R kn		E kn				E kn										
	Representation					9		18				25										
	Delivery																					
9th	Experience Depth								R Sk			E kn										
	Representation								*139*			II, Co										
	Delivery																					
8th	Experience Depth											E kn										
	Representation											II, Co										
	Delivery																					
7th	Experience Depth				R Sk							E kn										
	Representation				268							Co										
	Delivery																					
6th	Experience Depth	E Sk	E Kn	R Sk						E Kn	R Sk								R Sk			
	Representation	141	14	166						X, 141	153								158			
	Delivery																					
5th	Experience Depth	E Kn	E Sk	E Kn					E, R Sk									R Sk				
	Representation	5	20	35					II 15, 80									II, 50, 65				
	Delivery																					
4th	Experience Depth								R													
	Representation								Sk													
	Delivery								III 84,88, 114													
Water Concepts		Rivers	Hydrosepher	Oceans	Rainfall	Marib Dam	Storage measurment	irrigation	Water D. consumption	Food security	virtual water	water importance			water leakage			Water save	Water Bill pay			
Water Main Principles		**Water characteristics, in nature**						**Water importance and human dependence**					**Human influences**		**Water problems**			**Water management**			**W sustainability**	

Figure 39. Water Concepts MAP of Mathematics Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. K)

Mathematics is given to students in grades 1 to 12; however, for students in grades 11 and 12-humanitirian stream the subject is called “Statistic”. A total of 31 water occasions have been identified. Due to the subject nature, all presented concepts were delivered as add-ons to the topic as shown in figure 40.

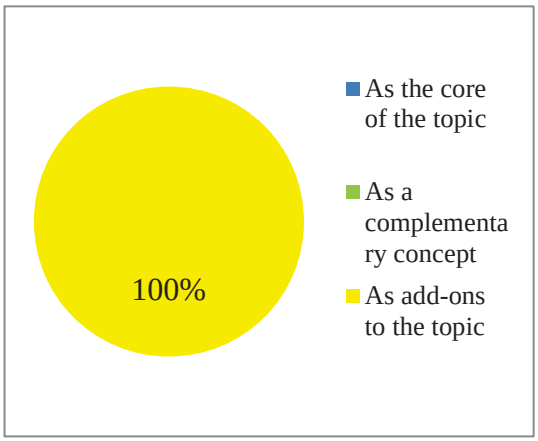


Figure 40. Water concepts delivery forms in Mathematics

Regarding representation form, more than half of the concepts were presented as skills. Knowledge form came as second form of presentation and only few concepts were recorded as values as shown in figure 41.

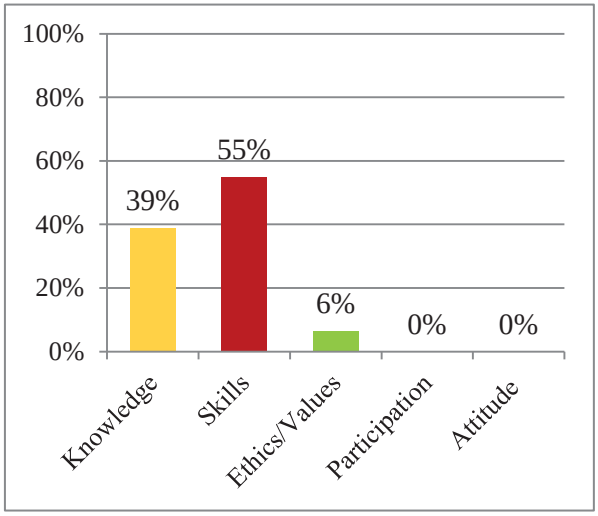


Figure 41. Water concepts representation forms in Mathematics

The concepts were mainly presented in grades 5 and 6 in addition to four concepts in grade 11-science stream while never has appeared in grades 1, 2, 3, 8, 11-art stream and 12. The main covered concepts were “calculate hydrosphere and oceans area, water consumption, and tanks storage capacities”. Concepts scope was very poor and vertical sequence was totally absent as shown in Mathematics Concepts Map in figure 39. More details about the identified concepts in Mathematics Subject are presented in annex 3.K.

It is not surprising to find that all concepts were delivered as add-ons concepts and more than the half were presented as skills due to the technical nature of the subject that does not offer to allocate theme-based concepts nor complementary concepts.

Mathematics role in term of water conceptualization is to reinforce the learnt concepts in other subjects which enhance concepts cognitive spiral teaching in a hand and concepts cognitive acquiring and instilling in students' minds on the other hand. Nevertheless, what have been presented in mathematics cannot fulfill the mentioned vital role for many reasons. Firstly, the existed concepts are mainly excluded to calculate some simple examples lacking any vertical sequence and development that makes concepts growing deeper as students get older. For instance, the majority of presented exercises did not go beyond asking students to add or subtract areas of oceans, land and hydrosphere, to calculate water monthly consumption of a family or some families for another period of time, and to calculate tanks storages. Nevertheless, only few exercises asked students to calculate reduction in water consumption, water leakage in a tank and numbers of rainy days in some cities. On the other hand, it was found during the mapping survey that many lessons offer great opportunities to incorporate many important water concepts that totally fall out of mathematics curricular. Secondly, almost all concepts were superficially prepared. For instance, the maximum of what students are asked to do is to find out final mathematical answers for exercises that mostly have fictional figures. However, reflection, comparisons and conclusions for identified answers were almost not requested. Thirdly, all presented concepts are theoretical base teaching concepts and some seems to be imported. For instance, there is no any concept that involves students in a practical manner by collecting or extracting data that can be used as inputs for the exercise. Another instance for imported examples, students were given water quantities needed to produce one car,

one tire and one ton of paper. Then they were asked to calculate how much water does it take to produce one car and three ton of papers? And to see which consumes more, producing one tire or three tons of paper. It could be argued that invisible objective of such exercise is to encourage students to save water through identifying the less consumption of the mentioned materials. However, key question here is can students and teachers reach such hidden insight and response to it. For sure not since neither any hint has been given nor are teacher guidebooks provided. Another argument could be that the objective is to show the water value of producing the three different materials. A third argument could be that the objective is both to save water and to show the water value. If reached, one can criticize saying that Yemen neither produce cars and tires nor even papers. Thus how fruitful is to propose such “abroad figures”? Why not to prepare the same exercise showing to students how much water does it take to grow 1 kg of weight, 1 kg of banana, 1 bundle of qat…etc and ask them to compare it with drinking water consumption of a family for example. Furthermore, for more outcomes the prices can be given and students can be asked to compare the returns of using the water to produce the mentioned crops and to draw their attention that consuming more of such crops means more water abstraction. By doing so, teaching would yield in much better outcomes.

Recommendations

- It is highly recommended to encourage students to do more practical exercises. For instance, students can be educated how to calculate and reflect water consumption in their houses, water bills they pay, how much water and money they save in repairing leakages…etc. Furthermore, they can be educated how to do some simple statistics and to present it statically and graphically by collecting data investigating the awareness of people for example, ground water tables drop in wells where they live…etc. On the other hand, more Yemenized exercises is strongly recommended for the mentioned reasons above.
- It is also recommended to promote and expand the presence scope providing many exercises that cover other concepts under the water main principles taking in consideration students' age, and vertical sequence and development. For instance, many exercises related to water different issues such as consumptions, taps leaking, ground water over-pumping, water uses and losses in traditional and modern irrigation systems, water monetary values of different uses, water harvesting, suffering of rural women fetching, and many other concepts can be prepared simply and gradually as reinforcement and application for the learnt concepts in other subjects.

5.12. English

12th	Experience Depth		E			E,R, G,A	E																	
	Representation		Kn			Kn, Sk	Kn																	
	Delivery		13			30	66																	
11th	Experience Depth	E		E	E					E						E	E							
	Representation	Kn		Kn	Kn					Kn						Kn	Kn							
	Delivery	67		36	62					69						36	71							
10th	Experience Depth																							
	Representation																							
	Delivery																							
9th	Experience Depth																							
	Representation																							
	Delivery																							
8th	Experience Depth																							
	Representation																							
	Delivery																							
7th	Experience Depth								E															
	Representation								Kn															
	Delivery								II, 29, 40, *65*															
Water Concepts		Arid zones	Floods, draughts	GW Infiltration	Rivers	water pressure	water states and cycle		Domestic Use	Energy production						GW depletion	Climate change							
Water Main Principles		**Water characteristics, in nature**						**Water importance and human dependence**				**Human influence**				**Water problems and issues**			**Water resources management**			**Water sustainability**		

Figure 42. Water Concepts MAP of English Subject: Vertical sequence, cognitive and experiential depth. (Large scale Map is presented in annex 2. L)

English is educated to students from grade 7 to grade 12. The subject teaches language skills in addition to many different concepts embedded in the regular units' lessons and in the annexed reading chapters. The total water occurrences identified in English were 13 delivered mainly as complementary concepts at first and as add-ons to the topic at second as shown in figure 43. Meanwhile the vast majority were presented as pure information as shown in figure 44. The concepts appeared almost in 11 and 12 grades while only two concepts appeared in grade 7 lacking any kind of vertical sequence as shown in English Concepts Map in figure 42. More concepts details are presented in annex 3.L.

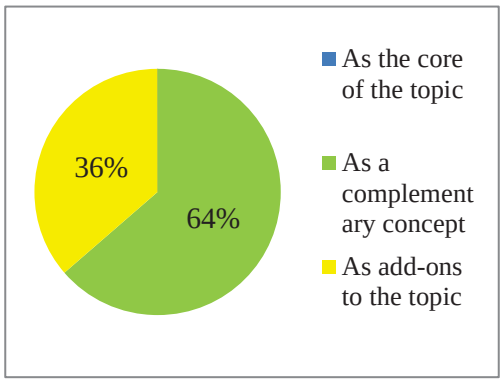


Figure 44. Water concepts delivery forms in English Subject

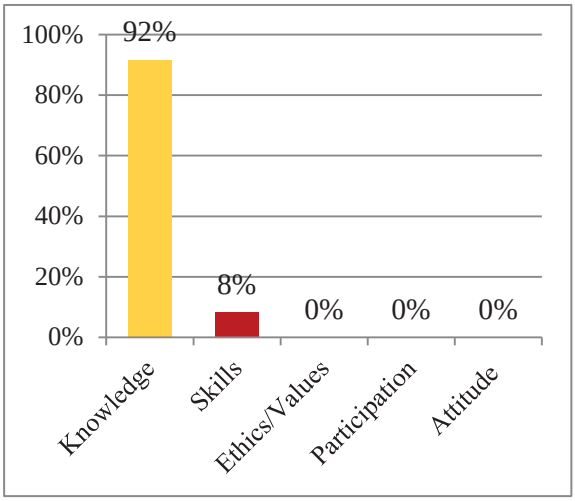


Figure 43. Water concept representation forms in English

Recommendation

The water concepts presence is very limited following the subject needs. In addition; skills, ethics, participation and attitudes were totally absent except one skill has been found. The concept scope and sequence are very poor. Realizing the importance of integrated learning, it is recommended that the whole content of the subject be revised in order to design a comprehensive water presence in all grades.

5.13. Sociology and Economics

Sociology and Economics are two independent subjects given exclusively to students of the humanitarian stream in grade 11. Water concepts have never shown at all in both subjects.

Recommendations

In economics, many general but vital economic principles are provided such as demand and supply market, type of goods, market balance and policies…etc. Nevertheless, reflection on water has never shown. According to Ehrlich (2011),*"in the context of behavior, some basic background in economics and social processes is essential for everyone (e.g., Dasgupta 2007). Topics such as externalities, common property (cooperative governance or the tragedy of the commons), and the differences among markets, corporations, and capitalism, need to be understood by school learners".* Thus and in addition to what is mentioned it is recommended to cover concepts of water value, price, and water demand and supply market…etc as illustration and reflection examples and projects to solve problems.

In Sociology, the fifth and sixth units teach society features, discipline, and behaviors change. Hence, it is recommended that behaviors change towards water can be reflected as group projects. For instance; students in groups can be encouraged to choose one specific case of water misbehaviors in areas where they live, analysis it applying the social and statistical principles they already learnt and propose practical solutions that fits to local area conditions. By doing that, students will not only instill the given concepts in minds but also can develop a holistic understanding to water problems and possible solutions that promote the perception and appreciation towards the water resources.

5.14. Psychology, Philosophy and Logic

Psychology, logic and Philosophy are given separately and exclusively to students of humanitarian stream in grade 12. The mapping has never identified any presence of water in the three subjects. It is noticed that all three subjects' contents are totally new introductions for Psychology, Philosophy and Logic principles that prepare students to enroll humanitarian colleges in the higher education system. Hence, it would be not easy to incorporate water concepts and much more difficult to add them as additional chapters due to necessity of fulfilling alignment and harmonization requirements in the subject. Therefore, it is not recommended to introduce new concepts at the tiara of the educational path since they cannot be developed any more unless they being prepared as bases for the higher education systems.

6. Water Concept Second Detailed Assessment: Grades level

The main objectives of conducting the horizontal assessment on grades level is to evaluate the followings; i) Water main principles scope for education stages, ii) Concepts experiential depth according to Williamson four stages model [Experience (E), Reflection (R), Generalization (G) and Application (A)], iii) Concepts Alignment to the main stream of water situation, management, and stage learning needs. Based on MOE stages category, this assessment was done for consecutive grades in three stages of 1-6, 7-9, and 10-12. According to mapping results, lowest presence has found in grade 2, whereas the highest was in grade 11 in both science and humanitarian streams[4]. In general, concepts between the 5th and 10th grades seem to have a symmetric distribution unlike the first four grades and grade 12 as shown in figure 45.

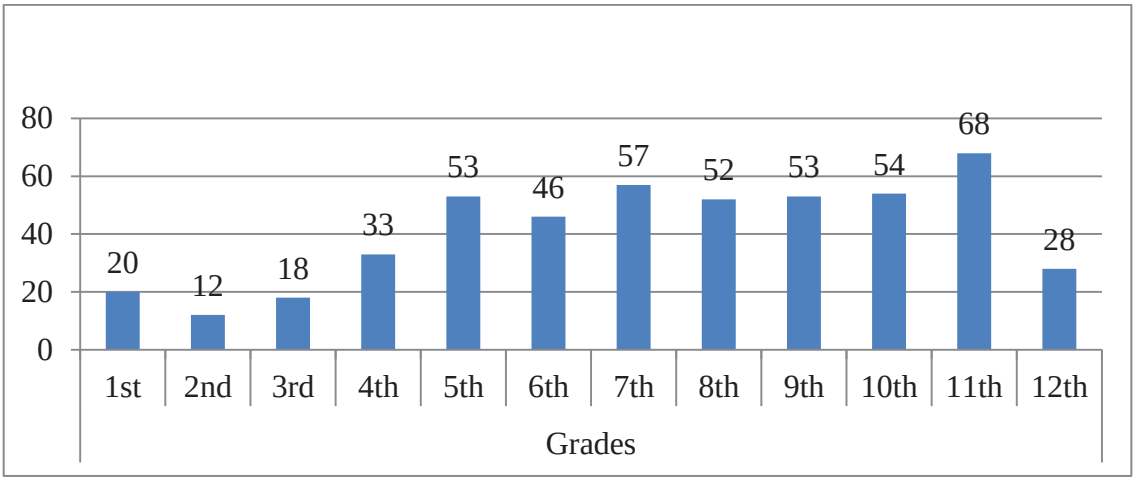


Figure 45. Concepts presence by all grades

The following parts of this section present horizontal stages analyses results, discussion and recommendations.

[4] In grades 11 and 12 some common subjects are given to both science and humanitarian streams while other special subjects confined to each. The common subjects in grade 11 present 18 concepts against 41 in others subjects of both streams. In grade 12, the humanitarian stream did not show any water related presence.

6.1. Water Concept Horizontal Assessment: Grades 1 – 6

The mapping survey identified 182 water occasions in the first six grades as 20, 12, 18, 33, 53 and 46 in 1, 2, 3, 4, 5 and 6 grades respectively. Almost half of presented concept was delivered as add-ons to the topic, 17% as core of the topic and the rest as complementary concepts. Further detailed analysis proved that only 25 % of concepts delivered as add-ons to the topic are reinforcing other concepts. In other words, 25% of the total concepts are presented as stand-alone, repetitive, and mere statements and figures of "water is a gift"; "water is secret of life", and "pleas save water".

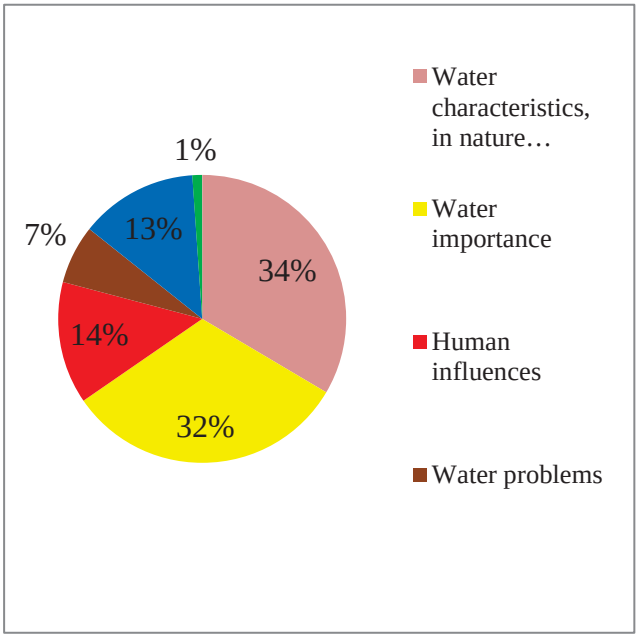


Figure 46. Water main principles scope in grades 1-6

Concepts under principles of water in nature and water importance have recorded the first cover, human influences and water conservation principles have attained the second, and water problems principles came at the third while water sustainability has the least coverage as shown in figure 46.

Regarding experiential depth, majority of the presented concepts were only introduced to students as primary introduction such as mentioning water use types, water resources in general, water abuse statements and water as grace of Allah…etc whereas only few concepts were reflected from more than one perspective such as water harvesting, water irrigation methods in general…etc as shown in figure 47.

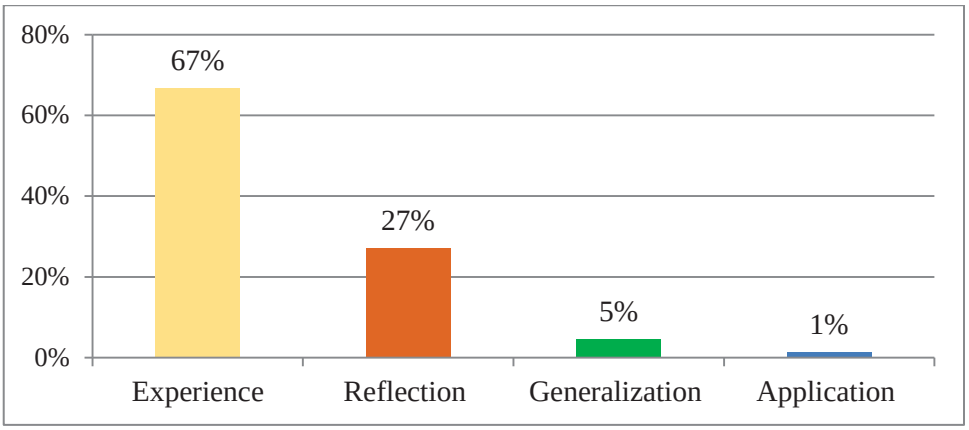


Figure 47. Water concepts experiential depth in grades 1-6

With respect to concepts alignment, 39 water occurrences have recorded as adverse, mis-conceptualized and advanced concepts as shown in figure 48.

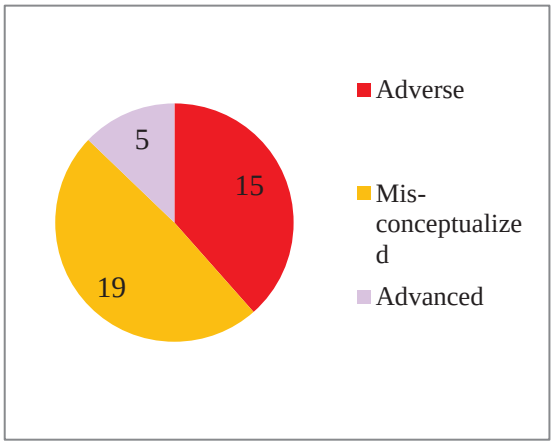
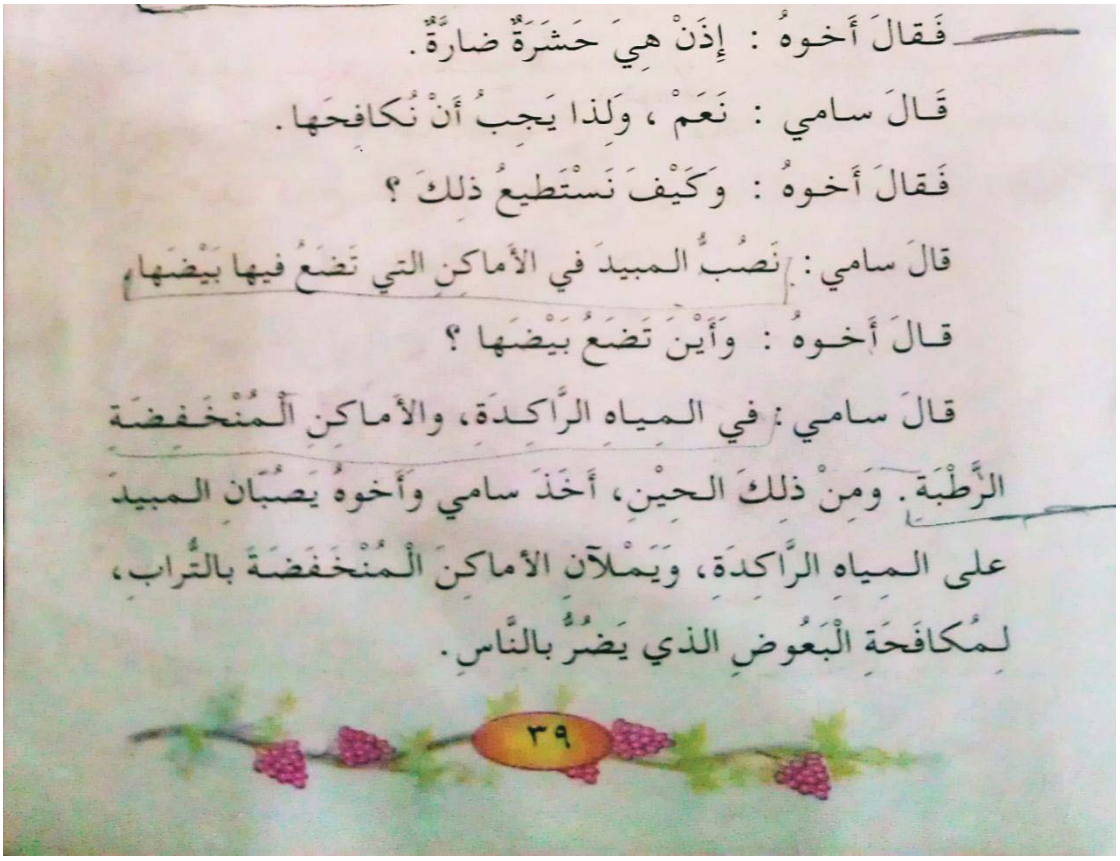


Figure 48. Water concepts mis-alignment in grades 1-6

To begin with adverse concepts, students in this stage are educated with some concepts of other matters such as agriculture for example; however, they have adverse impacts on water resources management and sustainability.

For example, students in grades 1 and 2 are taught that fruits and vegetables have to be cleaned before eating which is totally perfect. Nonetheless, presented cleaning process itself in both grades was visualized in a way that doesn't encourage water saving. Both show fruits and vegetables washed under open tap. Instead of that, it would be better to instill the culture of using water in a pan to clean vegetables and fruits. Another example; in Arabic of grade 2 students were shown a boy who irrigates trees in his uncle's farm as introduction to farms and trees but the way he was pouring the water by instill the culture of flood irrigation. Third example in the same book, students is

introduced to state “we like banana and we like to have it planted in Yemen”. Knowing that Yemen is a water scarce country, what is the use to instill in students minds that Yemen should produce banana which is water-intensive consuming crop. Last example in Arabic of grade 3 (figure 49), students was introduced to health safety requirements and sicknesses causes’ prevention. One action students were taught to do is to pour pesticides over stagnant surface water to prevent insects’ proliferation. Educating students such concept leads for sure to pollute the water resources by chemicals induced by used pesticides.



فَقالَ أَخوهُ : إِذَنْ هِيَ حَشَرَةٌ ضارَّةٌ .

قالَ سامي : نَعَمْ ، ولِذا يَجِبُ أَنْ نُكافِحَها .

فَقالَ أَخوهُ : وكَيْفَ نَسْتَطيعُ ذلكَ ؟

قالَ سامي : نَصُبُّ المبيدَ في الأَماكِنِ التي تَضَعُ فيها بَيْضَها .

قالَ أَخوهُ : وأَيْنَ تَضَعُ بَيْضَها ؟

قالَ سامي : في المياهِ الرَّاكِدَةِ ، والأَماكِنِ المُنْخَفِضَةِ الرَّطْبَةِ . ومِنْ ذلكَ الحِيْنِ ، أَخَذَ سامي وأَخوهُ يَصُبَّانِ المبيدَ على المياهِ الرَّاكِدَةِ ، ويَمْلآنِ الأَماكِنَ المُنْخَفِضَةَ بالتُّرابِ ، لِمُكافَحَةِ الْبَعُوضِ الذي يَضُرُّ بالنَّاسِ .

٣٩

Figure **49**. Adverse concept leads to water pollution (Code: Ar.03.01.01.39)

In grades 4-6, main water adverse concepts pertain almost to flood irrigation, agriculture expansion and food security. For instance, in many cases such as in science

of grade 4 and geography of grade 5 flood irrigation photos are used to support introduction of agriculture production encouragement as shown in figure 50.

Figure 50. Adverse concept encourages flood irrigation (Code: Sci.04.01.01.111& Geo.05.06.57-61)

Another instance, agriculture expansion is encouraged many times as agriculture is the country economy backbone.

Secondly, mis-conceptualization was also recorded even more than the adverse concepts. For instant, in science textbook of grade one a photo of well pumping pressure test was used to visualize flood irrigation as shown in figure 51.

Another example, in Arabic of grade 2 it is conceptualized that rainfall in Yemen resulted in a lot of streams which is not true. Third example, in Arabic of grade 3 (figure 52) water harvesting concept was introduced somehow well to students; however, conceptualized as “Yemenis who harvest rainfall in summer can spare amount of water sufficient for them, their livestock and farms for the rest of the year which is unreliable at all.

Figure 51. Photos mis-selection case (Code: Sci.01.09.97, 100)

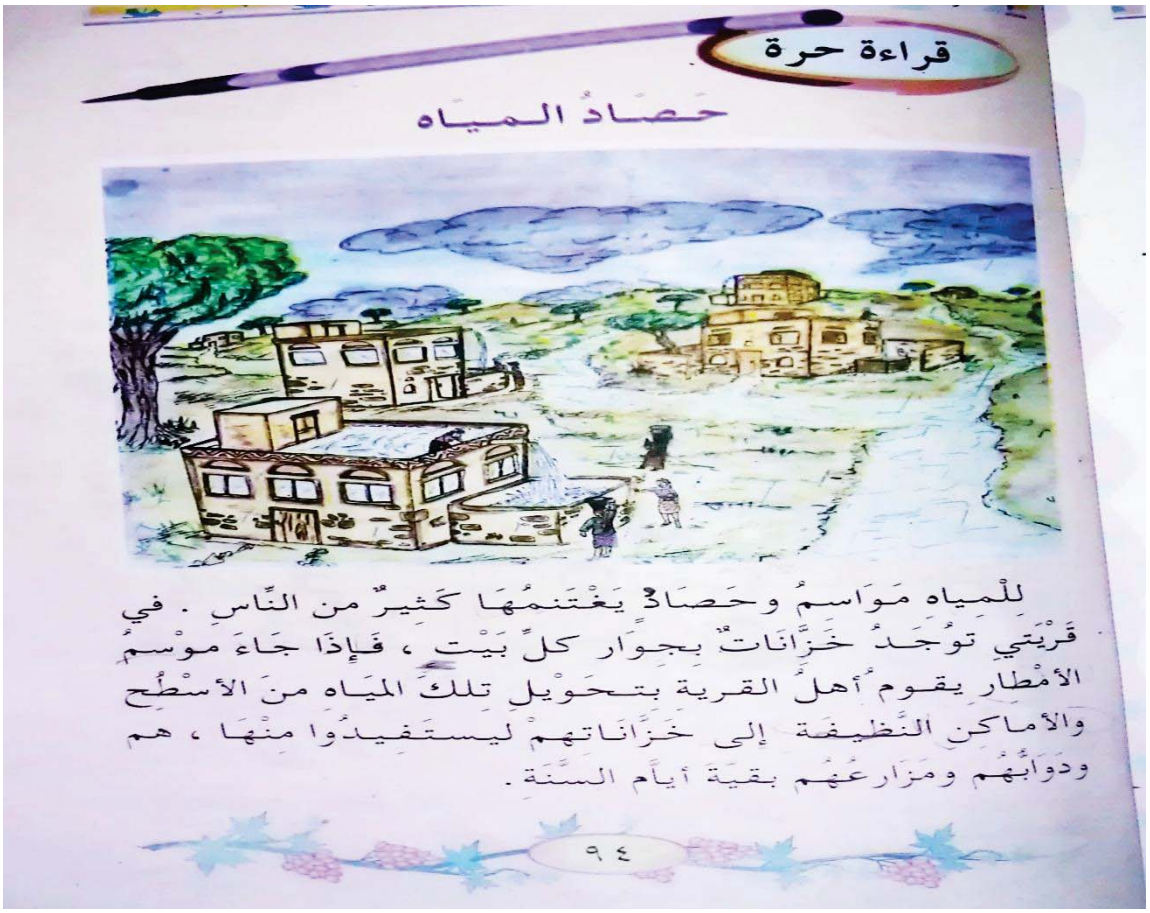
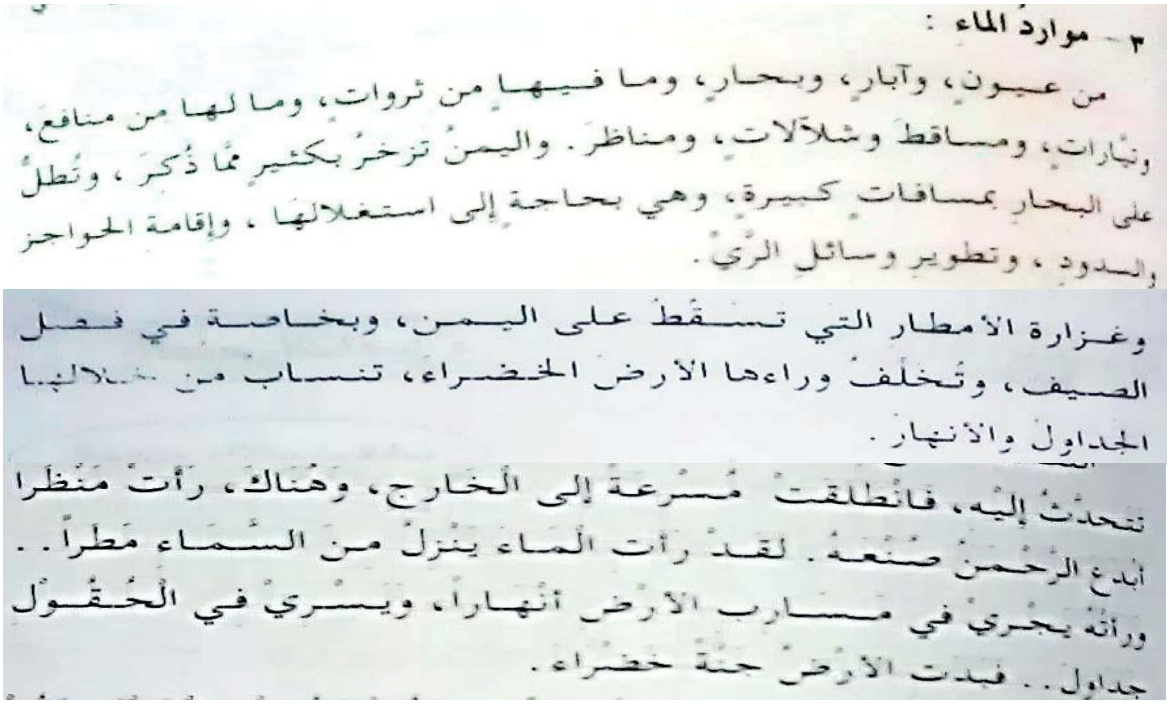


Figure 52. Water harvesting Mis-conceptualization (Code: Ar.03.02.01.94-95)

In grades 4-6, mis-conceptualized concepts presence has grown in line with water concepts growth of this stage. The main mis-conceptualized concepts in this stage are; rivers is one of the main water resources in Yemen, rainfall in Yemen results in rivers, dams are a drinking water source in Yemen, wells are presented as a water harvesting mean, Yemen receives high rainfall rates…etc. as shown in figure 53. Abdullah Saif, Water Resources Senior Expert at NWRA, (Email communication on 5 Dec, 2012)[ii], believes that such mis-conceptualized presentation related to rainfall and rivers are remaining influence of Egyptian old publications used as Yemeni curricula in the past. Nasser Al-Yazidi (Water Senior Expert at GIZ-Component 4, Email Communication 18 Dec, 2012)[iii], argues that this happened due to external consultants influence brought to design the curricula or due to origin influence of local curricula authors. He stated *"I think either the consultant heard that Yemen is near to the equator line or the head of curricula department is from Ibb city or Ibb countryside. If so, and if he is a farmer he would say that Yemen is one of the heavy rain countries*".


٣ - مواردُ الماء :

من عيون، وآبار، وبحار، وما فيها من ثروات، وما لها من منافع، وتيارات، ومساقط وشلالات، ومناظر. واليمنُ تزخرُ بكثير مما ذُكر، وتُطلُّ على البحار بمسافات كبيرة، وهي بحاجة إلى استغلالها، وإقامة الحواجز والسدود، وتطوير وسائل الرّيّ.

وغزارة الأمطار التي تسقط على اليمن، وبخاصة في فصل الصيف، وتخلف وراءها الأرض الخضراء، تنساب من خلالها الجداول والأنهار.

تتحدث إليه، فانطلقت مسرعة إلى الخارج، وهناك، رأت منظرا أبدع الرحمن صنعه. لقد رأت الماء ينزل من السماء مطراً.. ورأته يجري في مسارب الأرض أنهاراً، ويسري في الحقول جداول.. فبدت الأرض جنة خضراء.

Figure 53. Water resources mis-conceptualization (Codes: Ar.05.01.01.126-127& Ar.05.01.11.217)

Finally, some advanced concepts that do not match with learning needs of this stage have recorded as. For instance, in science of grade 1 two advanced concepts have appeared shown in figure 54; i) in context of potable water a very complicated photo of drinking water treatment station was presented and supported by subtext of “water treatment station”. Thus since the learning needs of this grade is to be introduced simply to water resources names and uses, it is too advanced to introduce a modern drinking water treatment technology in this age, ii) in context of water uses, an unclear complicated photo for mechanical site was presented to illustrate electricity production by water. Again, even such poor visualized presentation of energy production by water is too advanced for first grade students that are supposed to be introduced to the simple common water uses such as the domestic uses of cooking, washing, showering and water for plants.

Figure 54. Two examples of advanced concepts in grade 1 (Code: Sci.01.07.91-92)

Another example in Social Studies of grade 3; students are introduced to water pollution and its risks. However, it was presented to them how to distinguish between technical terminology of “treated waste water” and “Sewage”. Thus since this is the first time students are introduced to waste water, they are supposed to know that waste water is a clean water which changed into dirty water via different uses at houses, needs to be collected and somehow treated to avoid us sicknesses and to become clean water again.

Last example, two advanced concepts are identified. The first one in grade 5 students are requested to do a research in technical reference of dams recording dams' names and locations in Yemen. The difficulty here is how can students especially in rural areas access such proposed technical reference to obtain the required information regardless the usefulness of knowing names and locations of dams in Yemen. The second one is in grade 6 by asking students in a thinking card, why Israel tries to occupy water belongs to both of Palestine and Lebanon? Such concept is supposed to appear in higher grades after getting concepts of shared water bodies introduced.

Recommendations

- In general, water main principle scope within the first six grades was well covered focusing on the first two main principles that form the entrance for learners to access the water education field. However, many vital concepts are still either absent or lightly indicated such as groundwater existence inside the earth and the main causes of water problems in Yemen. Hence, it is recommended that students at this stage particularly in grade four to six be introduced to deeper concepts using various effective means of teaching. For instance, a water drop trip starting from the source, passing over treatment, supply, use, waste, waste treatment and reuse stages can be educated in an attractive way having proper visualization and teaching. The same proposal can be applied for water cycle in the nature and groundwater existence inside the earth.
- The current discourse of this stage presents Yemen as the green and lush land which has abundance of rains, streams, and rivers. It is recommended that conceptualization should be substituted by clear emphasized presentations showing Yemen as it is, a water scarce country facing many water problems.

- Many other defects were quantified. For instance, some concepts were repeated like water for ablution, teeth brushing, mere statements of “water not abuse” …etc. Besides, lack of and poor visualization is has been widely recorded. Many concepts are either merely presented or poorly visualized using brute and unclear drawings[5] as shown in figure 55. Therefore, it is

Figure 55. Poor visualization for sprinkler irrigation in grades 1 and 2

recommended to promote the visualization side in textbooks since it is almost the main, if not the sole, mean available by schools and teachers to illustrate the introduced concepts. In this regard, curricula department is recommended to approach the different water public agencies seeking meaningful photos and drawings for water uses, water abuses, irrigation methods …etc.

- School should be encouraged to produce large-scale postures that visualize and link the relevant concepts of this stage. For instance, one posture can be allocated to illustrate water uses, another one to illustrate daily water misuses, and so on.

[5] An exception case of that the science textbook of grade 2 that has better visualization and presentation. This improvement came as result of the revision and updated conducted in 2010 by a bilateral team from MOE and the Life Science Association (LSA) as stated in the textbook introduction

- Textbooks back and inside covers are either not utilized or have normative superficial and repetitive photos and messages presenting abundant water views that do not support the necessity of water save and conservation as shown in figure 56. .

Figure 56. Textbooks back covers' concepts

Hence, it is recommended to prepare some funny attractive but meaningful and understandable caricatures and drawings illustrating concepts that match learning needs of this stage such as the proposal of figure 57.

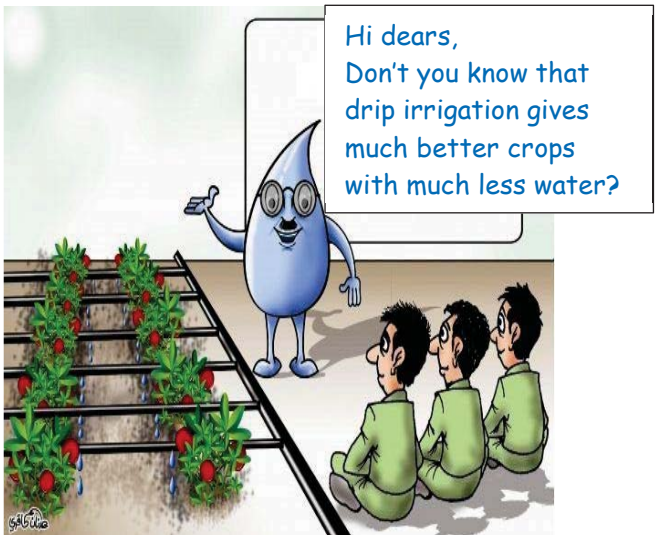


Figure 57. Visualization proposed for textbooks cover in grades 1-3. *Source: ALWAN&Al-Mhaqri 2007*

- Regarding concepts experiential depth, it was found that most of presented concepts remained within the first

phase of introductory experience while just few ones passed into the reflection phase. For instance, water conservation concept of “do not pollute surface water by human defecation” is always superficially presented by stating the prophetic say that prevents urination and defecation in surface water bodies. However, nowadays almost all people in urban and rural areas have bathrooms and it is rarely expected that people will do that as it used to be in the past. Therefore, such concept can be reflected wider to cover other forms polluting occurred on drinking water tanks, swimming pools, water harvesting cisterns and so on. Thus it is recommended to deepen and expand concepts reflection to cope with the current local water issues, conservation needs…etc. On the other hand, students at this age are in a stage of shaping values and attitudes (USAID/Jordan 2010). However, values and attitudes formation cannot be obtained through superficial and theoretical teaching but through practical in-depth learning (Horton et.al 1999). In other words, the deeper span the concepts pass in the experiential path the higher cognitive acquisition and the better behaviors learners perform. Therefore it is highly recommended to promote concepts reflection, generalization and application phases through more effective presentation and activities. For better reflection, students in this stage can be exposed to simple and funny short clips, movies, and games that cope with concepts of water in nature, water uses and abuses, water conservation principles. As far as investigated, NWRA, its branches, some of other water utilities and the national T.V have already produced quit good materials that fits to student in such age. Others can be produced in cooperation between both; curricula and water experts and the media production unites affiliated to NWRA-SB and EMPPC. Such package can be prepared in CDs as side reinforcement content to the textbooks content and be distributed to schools. For better generalization and application and in

addition to proposed activities by each subject in section five, students should be encouraged to visualize and simulate concepts related to real life examples such as water harvesting and groundwater infiltration…etc. using recycled paper, plastic and sponge materials available in their areas. Further, it is recommended to insert key educational instructions as foot notes for teachers proposing to them some participation-based teaching methods that ensure more involvement for students diving more in the experiential path.

- Finally, although the horizontal scope has covered in general most of water main principles which support concepts spiral development, presence of adverse, mis-conceptualized and advanced concepts weaken the concepts alignment and reinforcement. For instance, adverse and mis-conceptualized concepts indirectly promote culture of water abuse and importance of being food self-secured which invalidate the other water concepts given to students for water resources save and conservation in a hand and unintentionally negatively affect students' attitude and appreciation towards water due to the presented concepts that Yemen has abundance of rainfall, streams and rivers. Hence, it is strongly recommended to remove the adverse and to correct the mis-conceptualized concepts, and to simplify and adjust the advanced concepts.

6.2. Water Concept Horizontal Assessment: Grades 7 – 9

A total number of 162 water occasions were found and distributed by 57, 52 and 53 in grades 7, 8, and 9 respectively. According to mapping results, add-ons, complementary and core concepts were delivered by 49%, 38% and 13% respectively. Further detailed analysis revealed that only 6 add-ons occurrences were used as reinforcement concepts. This means that 45% of the total concepts of this stage are superficially disseminated.

Regarding water main principles scope, the focus is still on water importance and uses, and water characteristics and the water resources principles while other main principles have poor cover as shown in figure 58.

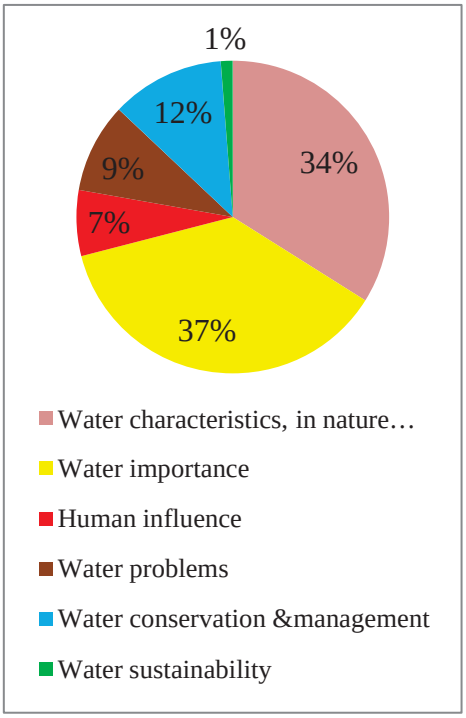


Figure 58. Water main principles scope in grades 7, 8 and 9

With respect to experiential depth, concepts remained significantly in the first phase, less than 20% attained the reflection phase while very few concepts succeeded to enroll generalization and application phases as shown in figure 59.

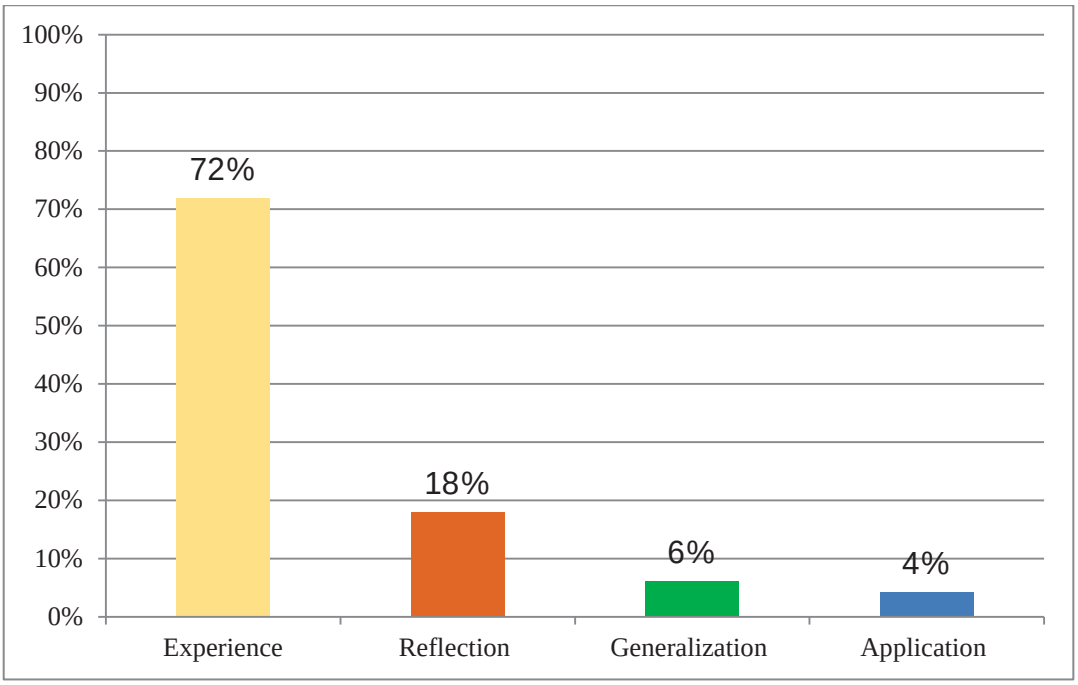


Figure 59. Water concepts experiential depth in grades 7-9

On the other hand, 31 water occasions were identified as adverse, mis-conceptualized and advanced concepts as shown in figure 60.

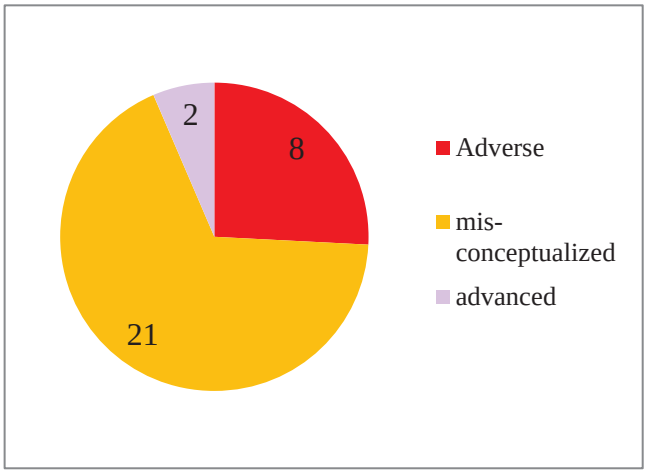


Figure 60. Water concepts mis-alignment in grades 7-9

The main presented adverse concepts are food security and agriculture expansion as shown in figure 61 and 62. For instance, food security was presented three times in details in Arabic textbooks of grades 7 and 8. In grade 7, unite 7 is totally allocated to teach food security for Yemen as it should not only produce but also export food agriculture products. The same is to agriculture expansion that has been presented five times in Arabic, Science and Geography of grade 8. Such adverse concepts have come as normal

results for decades of agriculture encouragement, by the Yemeni political will, to accommodate jobs for the majority of Yemeni young people. However, another political factor might play a role behind such support to agriculture. It is known that Yemeni political regime within the last three decades was lacking real image of being a democratic system so that almost the whole power and authority was concentrated in President hand. Therefore, in order to avoid revolutions and changes that might kick the whole political regime out, it was in the interest of the state to have the people politically illiterate and away from the political arena. Thus agriculture was a very good business achieving such aim. When he was asked about such conclusion, Al-Eryani has agreed and added *"Also, food sufficiency is a positive image for the regime. They would like to promote it among the growing generation"*(Email Communication on 04 December, 2012[iv]).Abdullah Saif has raised another justification for such adoption of agriculture in the curricular. He states that "*Historically the economic activity in Yemen was agriculture, so people will continue supporting such activities weather it should get priorities or not. Another reason is the failure of Yemen politician to find new economic activities that well absorb the people to work in it such as industry"*.

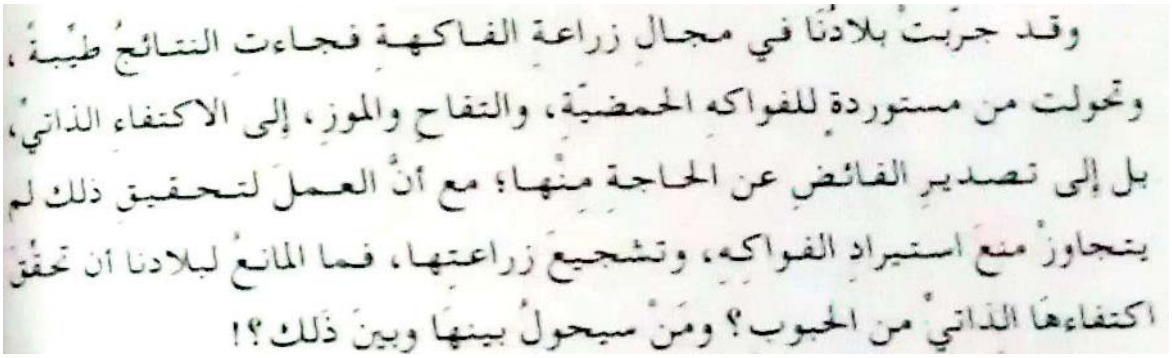

وقد جرّبتْ بلادُنا في مجالِ زراعةِ الفاكهةِ فجاءتِ النتائجُ طيّبةً،
وتحولت من مستوردةٍ للفواكهِ الحمضيّةِ، والتفاحِ والموزِ، إلى الاكتفاءِ الذاتيّ،
بل إلى تصديرِ الفائضِ عن الحاجةِ منْها؛ مع أنَّ العملَ لتحقيقِ ذلك لم
يتجاوزْ منعَ استيرادِ الفواكهِ، وتشجيعَ زراعتِها، فما المانعُ لبلادنا أن تحقّقَ
اكتفاءَها الذاتيَّ من الحبوبِ؟ ومَنْ سيحولُ بينَها وبينَ ذلك؟!

Figure 61. Food security adverse concept (Code: Ar.07.01.01.88-91)

جهود الدولة في تطوير القطاع الزراعي

اقتصر الإنتاج الزراعي قبل الثوره على «الاكتفاء الذاتي» وظل كذلك حتى بعد قيام ثورتي سبتمبر واكتوبر ٦٢ / ١٩٦٣م حيث خضع القطاع الزراعي لاقتصاديات السوق غير المتكافئه بين الداخل والخارج الأمر الذي تسبب في ايجاد علاقات عكسيه حادة وسريعه بين الإنتاج والاستيراد خصوصاً ما يتعلق منه بتجارة الحبوب فأفسح المجال للارتباط بالسوق الخارجية بدءاً باستيراد الحبوب وغيرها من المنتجات الزراعية كاستيراد الفواكه والخضروات، وتنبهت الدولة لخطورة الوضع فعملت على حضر استيراد الفواكه والخضروات وشجعت المزارعين على زراعة الحبوب وسهلت لهم القروض الميسرة، وتعكف الحكومة حالياً على وضع برنامج لتوفير الحبوب والمنتجات الزراعية الأخرى بغية تحقيق الاكتفاء الذاتي وتصدير الفائض إلى الخارج .

وقد تمثلت جهود الدولة في تطوير القطاع الزراعي بالآتي :

١ – استصلاح المزيد من الأراضي الزراعية .

٢ – إدخال الوسائل الحديثة في الإنتاج الزراعي .

٣ – إدخال أساليب حديثة لتحسين البذور والشتلات الزراعية، ومنها الأسمدة

Figure 62. . Food security and horizontal agriculture expansion adverse concept (Code: Ar.08.02.03.88-89)

Mis-conceptualization has appeared widely in this stage with 21 occurrences. Many examples can be presented. For instance, in Islamic education in grade 7 it is mentioned that water coverage area on the earth is four times as the land area. Another instance, it is widely presented that Yemen has abundance of rainfall. Abdullah Saif points out that such mis-conceptualized presentation of rainfall is due to old comparisons between the rainfall rates on mountains and deserts of Yemen and do not include the modern scales of scarcities, arid and semi-arid zones…etc. Al-Eriani, commented *"Those people who write the textbooks have no idea about water in Yemen. There is a need to have water education also in the Colleges of Education, so that the teachers who end up writing these books are aware of the water realities in Yemen"*. Third instance, dams' construction was exaggeratedly conceptualized in History of grade 7. It is conceptualized that ancient of Yemen had never left any wadi where spates flow unless

they constructed a dam to store its water till they covered the whole of Yemen with dams. Fourth instance, in Arabic of grade 8 it is presented that most of groundwater basins in Yemen are already depleted and that awareness dissemination is a duty of the state as shown in figure 63.

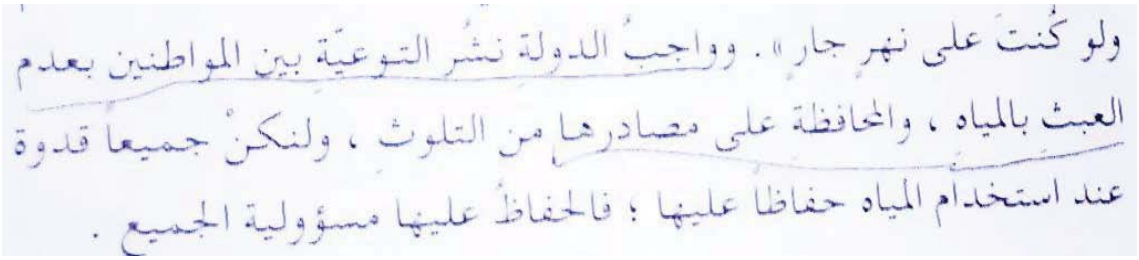

ولو كُنتَ على نهرٍ جارٍ» . وواجبُ الدولة نشرُ التوعيّة بين المواطنين بعدم
العبث بالمياه ، والمحافظة على مصادرها من التلوث ، ولنكنْ جميعا قدوة
عند استخدام المياه حفاظا عليها ؛ فالحفاظُ عليها مسؤولية الجميع .

Figure 63. Public awareness Mis-conceptualization (Ar.08.01.04.40)

In Geography of grade 8, a stand-alone activity has been presented which is very good from principle; nonetheless, its provision is a complete example of brute presentations as shown in figure 64. The activity givens were about some water consumption and saving statistics of a survey conducted in London so that it seems that students are going to calculate, compare and conclude something; nevertheless, the requirements were horses of different colors as follows : [(Givens) A conducted study in England indicates that, i) the total daily water consumption of English employees in offices is quite enough to fill in 150 Olympic swimming pools, ii) Leaving the tap opened for one minute results in 6 gallons of water, iii) If a person needs three minutes to wash his hands and face, this will result in consuming 18 gallons of water, iv) By using modern water taps and maintaining water network in a building in which 100 officers are working, the water consumption was reduced from 55,000 to 33,000 gallons/year. Activity requirements: now participate with your classmates to record different forms of water abuse and provide some suggestions to save water consumption in area you live].

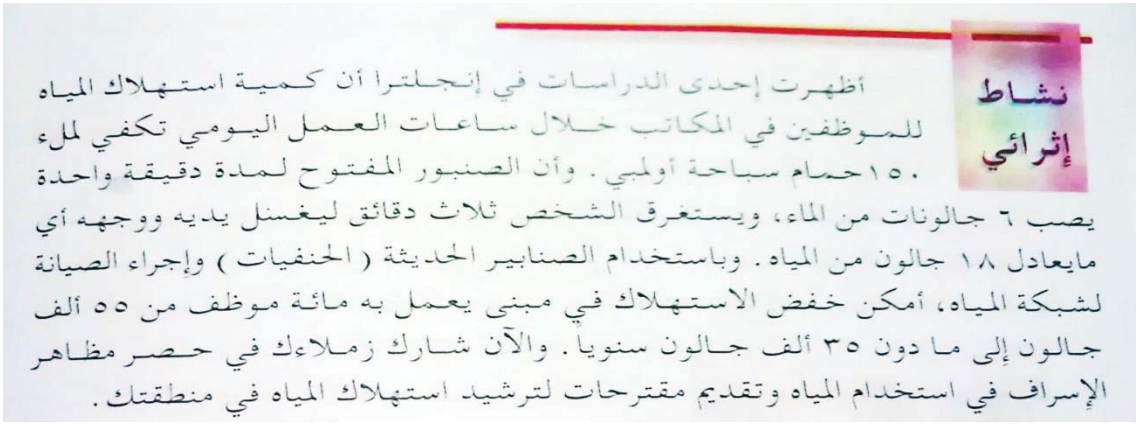


Figure 64. Poor and brute activity (Code: Geo.08.05.14)

Finally, two advanced concepts have been identified in grades 7 and 9. For example, in grade 7 a thinking card as: (it is mentioned that Tigris and Euphrates rivers represent the economic lifeline for Iraq and Syria at present. Then it is inquired: is it in the interest of both countries to take a unified position towards the potential threating dangers of any other party on both rivers?). Such issue of conflicts and cooperation on shared water resources is expected to be presented in higher grades since it is kind of high water policies and institutions.

Recommendations

- At this stage, students are supposed to deepen more and more on principles three and four of human influences on water resources, and water problems and effects in addition to start learning more about principles five and six of water management tools and water sustainability. However, concepts scope of this stage is still mainly focusing on the first and second principles of water resources and importance. Therefore, it is recommended to modify and expand the scope developing concepts of the first and second water main principles, deepening more on the third and fourth ones and concretely introducing the fifth and six principles concepts. However considering having much in-depth presentations that promote skills of exploration,

problem analyzing and solving…etc. By doing so, students can develop a holistic understanding linking and reflecting natural and human made drivers, resulted water problems, tools of management and ways for sustainability.

- Regarding experiential learning, it was noticed that the majority did not go beyond the first phase of introduction. Hence, it is recommended to propose more activities that practically involve students in wider debates understanding the water problems, causes, effects and solutions. Furthermore, it is recommended to support students to apply or at least to reflect concepts they learnt theoretically recognizing their real life examples and applications.
- It is strongly recommended to remove the whole discourse of food agricultural-based security and agriculture horizontal expansion. However, a revision is needed to encourage the conceptualizations of the rational economic-based food security and the modern agricultural practices such as vertical agriculture expansion, better crops pattern…etc in line with water resources scarcity in Yemen and international cooperation and integration related world food sufficiency.
- It is also recommended to involve water experts in relevant authorities when preparing curricula and writing the textbooks to avoid such misalignment of concepts. In addition, conducting an introductory IWRM training program for curricula board experts is also highly recommended.
- Advanced concepts should be shifted to higher grades where the main cognitive background and students skills allow students acquiring them.
- Finally, as AL-Eryani recommended there is a need to incorporate water issues and concepts in the higher education system of university to adequately reinforce teachers and curricula publishers with the required level of water knowledge.

6.3. Water Concept Horizontal Assessment: Grades 10 – 12

Out of 4651690 students enrolled in schools only 11.8% continue to study the secondary education stage in grades 10, 11 and 12 (MOE -TIMSS, 2012). Grades 11 and 12 have two educational streams, science and humanitarian. Having grade 10 finished, students have to decide on which stream to continue in grades 11 and 12. According to MOE, science stream attracts the majority of students in this stage. For instance, 83.7 % of secondary stage students are enrolled in science stream of grades 11 and 12 during 2012 (MOE -TIMSS, 2012). Finally, beside specialist subjects of each stream students in both streams share some common subjects such as The Holy Qura'n, Islamic Education, Arabic, and English.

The mapping has identified 150 water occurrences in the whole secondary stage. In the 10^{th} grade all students are introduced to 54 concepts. After that, if students chose to go through science stream, they will be exposed to 55 water concepts in grades 11 and 12. However, if students decide to go in the humanitarian stream, they will end up with 65 concepts in grades 11 and 12.

Regarding concepts scope presence, as in the previous grades the first two main principles of water in nature and its characteristics, and water importance have attained the main focus in the three grades. Human influences have significantly retreated in the whole stage. Water problems have a good cover in science stream with relatively satisfied presentation in humanitarian stream. Water management principle has almost equal presentation in both streams with very low coverage in grade 10. Water sustainability was insignificantly presented in humanitarian stream, and totally absent in grade 10 and science stream as shown in figure 65.

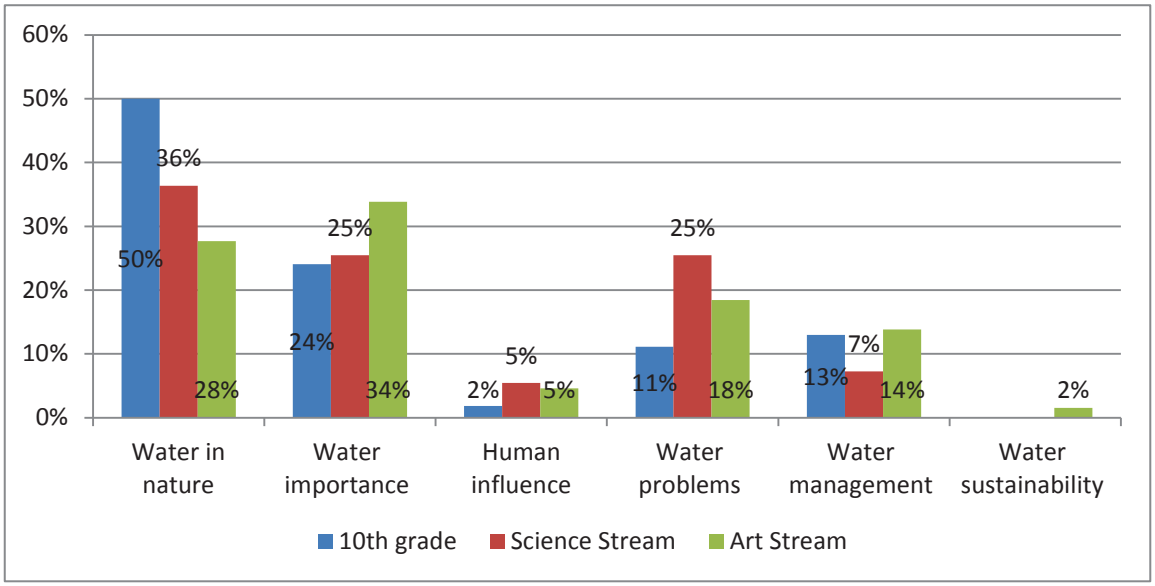


Figure 65. Water main principles scope in secondary stage

With respect to experiential depth, almost two thirds of presented concepts remained within the first phase of introductory experience whereas quit fifth reached the second phase of reflection. Again very few concepts have succeeded to pass into generalization and application phases as shown in figure 66.

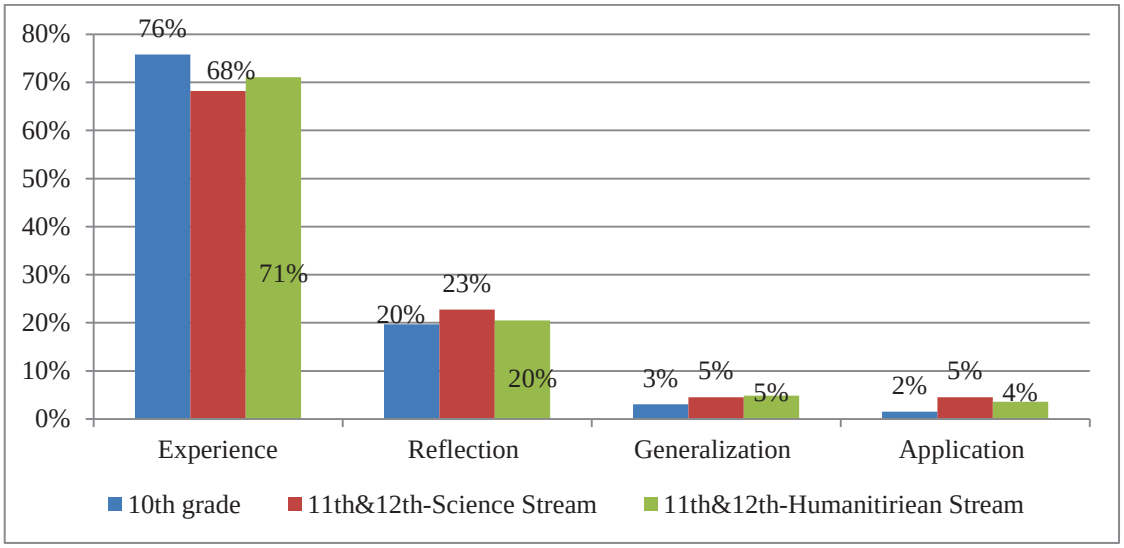


Figure 66. Water concepts experiential depth in secondary stage

Concepts misalignment has been recorded in higher grades as mis-conceptualized and adverse concepts whereas advanced concepts have never presented as shown in figure 67.

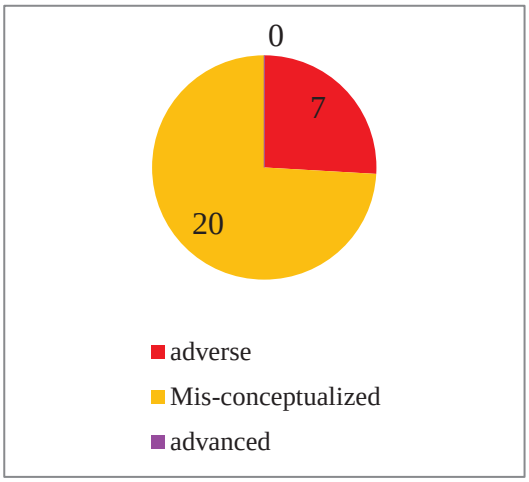


Figure 67. Water concepts mis-alignment in secondary stage

The identified adverse concepts were almost about food security and agriculture expansion encouragement. An exception of that is in one presentation related to treated wastewater rues in Biology of grade 12. It is presented as "Preventing reuse of wastewater and treated wastewater for irrigation especially for vegetables". As known that treated waste water is became an important renewable water source for agriculture especially in scarce water countries like Yemen. So, encouraging students to never utilize such renewable resource means more pressure on the finite vulnerable ground water resources.

Mis-conceptualized concepts have also appeared during this stage through many presentations. For instance, in Geography of grade 11, figure 68, it is conceptualized that Sana'a and Dhamar basins have rich groundwater storages which is not true at all. According to (Bashuaib, 2009) both basins are classified as critical water basins and are about to run out of ground water.

اليمنية من محافظة إلى اخرى؛ لذا تلاحظ بعض المدن تقع على
منطقة غنية بالمياه الجوفية، مثل مدينة ذمار، بينما مدن أخرى
تعاني من شحة المياه الجوفية، مثل مدينة تعز (ما سبب ذلك؟)، ومع أن بعض المدن تقع في
مناطق القيعان الغنية بالمياه الجوفية إلا أن الاستهلاك غير الرشيد للمياه يُعرّض مخزون المياه
الجوفية للاستنزاف وعدم القدرة على تعويضها في السنوات المنظورة، مثل مدينة صنعاء.

Figure 68. Groundwater mis-conceptualization. (Code: Geo.11.01.01.19-21)

Another example, in the same book one lesson was titled as “Water resources in Yemen”; nevertheless, its content was about seas utilization such as fishing, slats production, pearl extraction…etc. as shown in figure 69. Third example, in the same book it is presented that Yemen started early to use hydropower energy to produce electricity in Al-Hodaidah and AL-Makha power plants. However, in reality both plants use diesel to produce energy and use the sea water just for cooling purposes.


الدرس الخامس

موارد اليمن المائية

فكر واكتشف

البحر مورد طبيعي لم تكتشف بعد كل خباياه، يحتوي على كنوز وثروات عديدة؛ لذلك فإن عدداً كبيراً من العلماء يعملون لاكتشاف موارده حتى تكون في متناول الإنسان.

- فما أهم الموارد البحرية لليمن؟ وما وسائل حمايتها وتنميتها؟

الأسماك والأحياء البحرية:

تعيش في المياه الإقليمية للجمهورية اليمنية في البحر الأحمر والبحر العربي والمحيط الهندي مجموعات كبيرة من الأسماك، والحيوانات البحرية النافعة، إلى جانب مجموعات هائلة من النباتات البحرية كالأعشاب التي تصلح لتغذية الأسماك والحيوانات البحرية، وبعضها يصلح غذاء

شكل (١) أحياء بحرية

Figure 69. Mis-match between the title and its content (Code: Geo.11.01.02.33)

Fourth example, water balance in Arab region was introduced and indicated to a figure that presents water poverty index of Arab countries as shown in figure 70.

ملامح مشكلة المياه العربية:

أ- واقع الميزان المائي العربي:

من دراستك للشكل (١) قارن معدل نصيب الفرد من المياه المتجددة في كل من مصر ولبنان والعراق واليمن، ومدى اقتراب الدول من مستوى الفقر المائي الخطير.

مشكلة المياه: تتمثل مشكلة المياه في ضعف قدرة مصادر المياه عن سد حاجة السكان سواءاً كانت طبيعية أو اصطناعية.

الميزان المائي: هو المقارنة بين كمية المياه المتوافرة والكمية المطلوبة منها لسد الحاجات فإذا فاقت الكمية المطلوبة الكمية المتوافرة حدث العجز.

خط الفقر المائي: هو معدل معتمد دولياً بالنسبة لحصة الفرد السنوية من المياه المستهلكة وهي ١٠٠٠م٣

كفاءة استثمار المياه: هي حالة الاستثمار المائي وفق حد أدنى من الهدر وأقصى من الفعالية.

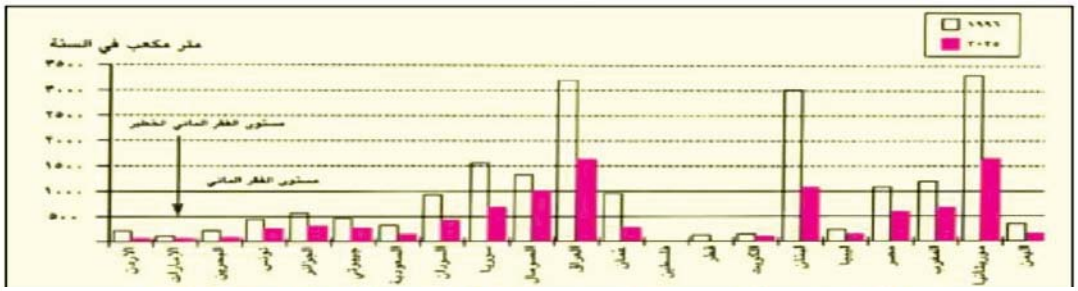


Figure 71. Arab water balance, figure mis-selection (Geography, grade 11)

The same has happened when it came to Arab water scarcity the indication was to a table that presents water imbalance figures of Arab countries. Last but not least example in the same textbook was about the drinking water supply and sanitation services. The concept was presented in details showing coverage percentages, number of beneficiaries, households' connections…etc of both rural and urban areas in Yemen which is good from principle. Nevertheless, all presented figures are very old from 1996 which is useless in hand, and were presented in very brute way i.e figures of urban areas were presented as pertaining to rural areas and vices versa as shown in figure 71.

ورغم التحسن في إمدادات المياه على مستوى اليمن، إلا أن التفاوت بين الريف والحضر لا يزال قائماً، فهناك عجز كبير في إمدادات المياه، فحوالي (٦٤٪) من إجمالي سكان الحضر في عام ٢٠٠٠م لا تتوفر لهم شبكات مياه عامة، بينما لا تتوافر هذه الإمدادات لأقل من (٤٠٪) من سكان الريف.

Figure 70. Water services mis-conceptualization (Code: Geo.11.01.08.68-69)

Recommendations

Water main principle scope of this stage is also poorly prepared. It is expected to focus more on principles of water management and sustainability; nevertheless, the main emphasize was still on water in nature and water uses principles. Abdullah Saif points out that this is due to the fact that IWRM is still new concept especially in the context of Yemen so people who prepared the curricula were in lack of the adequate knowledge to incorporate IWRM principles in textbooks. Hence, it is highly recommended to reform the whole content of this stage focusing more on water management and sustainability principles. Involvement of IWRM national experts in such change is strongly recommended in order to avoid the curricular any misaligned water concepts.

On the other hand, it was found that only in this stage more details about ground water problem in Yemen in grade 10, and much more about Arab water resources, uses, problems, and security in grade 11. Having concepts related to Arab region presented in much more details and better sequence unlike Yemeni ones is due to data and references availability in the case of Arab region according to Yasmeen Abdulwasae. However, presenting such detailed concepts in grade 10 and 11-humanitarian stream has much less fruitful outcomes since only 11.8 % of enrolled students continue in grade 10 and only 1.9% is enrolled in humanitarian stream (MOE- TMISS, 2012). Thus it is recommended to shift such detailed presentation to middle grades of 7, 8 and 9 so students can early recognize and appreciate the realistic water situations, problems, …etc. in Yemen, in Arab region and internationally as well developing a holistic understanding for local, regional and international water issues and needs of cooperation and integration on all levels.

Regarding experiential learning, students at this age are supposed to be able to acquire and apply much complicated concepts and ideas (USAID/Jordan, 2010). Therefore, it is recommended that much more practical based activities and group projects be given to students inside and outside the class such as in-depth debates, problems in-depth analysis, concepts visualization and simulation, field works…etc. To have a yearly graduation project related to water and environmental issues which can be graded as well would be a quantum leap in school system in Yemen; however, such proposal is difficult to apply since it requires changing the annual evaluation and grading system which is quit superior educational issue according to Um Al-Saad Abdulhai.

7. Water Concepts Third Detailed Assessment: Water Main Principles Scope

The preceding two detailed assessment focused on analyzing the identified concepts vertically and horizontally on the subjects and grades dimensions respectively evaluating concepts cognitive and experiential depth, and alignment with improvement proposals for both dimensions. This section analysis and evaluates in details water concepts presence and scope, within the whole content, under the water main six principles, concepts spatial scope and gaps under each principle. Recommendations are given directly after each principle analysis.

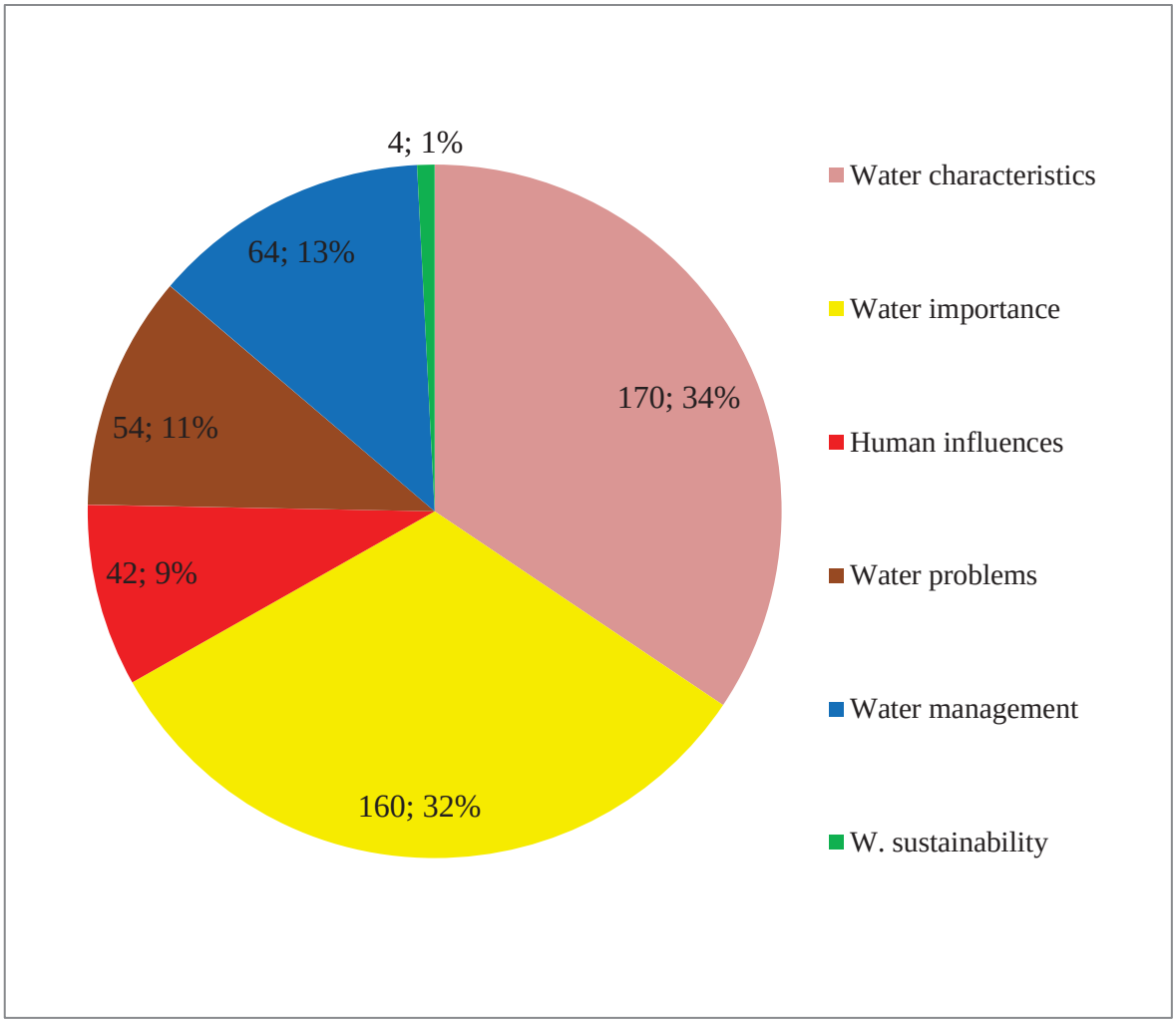


Figure 72. Water main principles scope in the whole textbooks content

7.1. Principle I: Water in Nature

A total of 170 water occurrences were recorded under this principle covering various water concepts such as water properties and cycle, water as part of environment, and water resources in Arab region and Yemen as shown in figure 73.

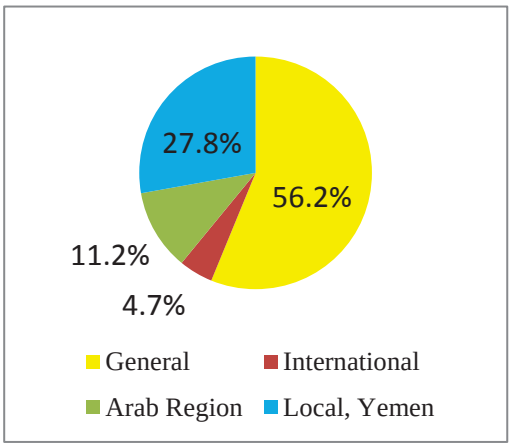


Figure 73 . Water concepts spatial scope under principle I

Generally, concepts of water chemical, physical, and biological properties, water cycle, hydrosphere, and water types for ablution have attained more than half of the total concepts under this principle. For instance, water cycle was presented 7 times but repetitively and superficially. Another instance, water properties and states were presented 25 times with good details in science subject while rainfall as grace provided by Allah to relieve dried lands was repeated 11 times in Islamic studies and Arabic subjects.

Concepts under the international context were the less presented ones with around 8 concepts mostly presenting international rainfall features as part of climate conditions of continents. Only one concept has appeared generally within the context of international efforts to protect the world environment talking 1969 international principles and 1982 Jamaica agreement related to regional and international surface water definition, superiority, duties and rights of riparian countries.

Concepts related to Arab region were covered by 19 concepts. The most repeated and superficial concepts were Arabic rivers names, and rainfall features in Arab region.

Nevertheless, very good detailed presentations of Arab water resources have been found in Geography of grade 11.

Finally, concepts related to Yemen were presented by 47 occurrences. The main presented concepts are rainfall general features, water resources in general, dams as water source….etc. The majority of the presented concepts were superficially and repetitively presented due to lack of information sources according to Yasmeen Abdulasae. For instance; rainfall, GW and dams were repeated by 20, 14 and 17 times respectively. Furthermore, concepts under this principle were highly mis-conceptualized especially in context of Yemen. For instance, in first six lower grades it is presented that Yemen has abundance of rainfall, streams and even rivers. In grades 7-9, it is still presented that rainfall in Yemen has heavy rates. In higher grades, it is conceptualized that ground basins in Yemen are rich but subjected to overuse. Finally, many basic important concepts and figures have never shown. For example, national rainfall average, grey water and wastewater reuse, indicating the high evaporation rate, realistic form of groundwater inside the earth, have never been addressed.

Recommendations

- It is recommended to add theme-based presentations to cover the missed important concepts, to enrich the presented concepts with updated detailed figures and to adjust and correct the mis conceptualized concepts.
- This principle represents the entrance step for students accessing the water knowledge. Therefore, students are supposed to be exposed to its concepts mainly during first basic educational grades; nonetheless, detailed concepts are presented by upper grades content. Hence, it is strongly recommended to reform the content of this principle ensuring its cognitive depth attainment within earlier grades.

7.2. Principle II: Water Importance

The total water occurrences identified under this principle are 160 covering water importance for life and water different uses. Concepts spatial scope is presented in figure 74.

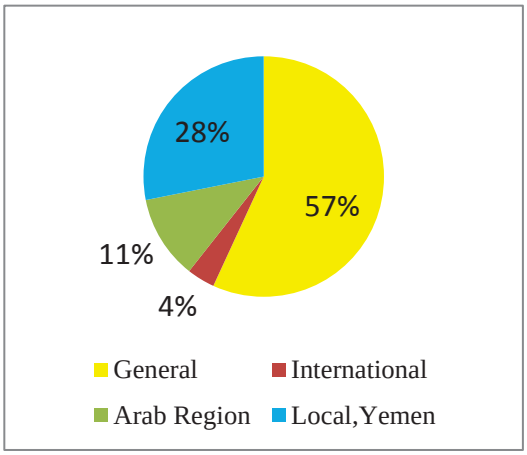


Figure 74. Water concepts spatial scope under principle II

General concepts that were not applied to any specific spatial context were found as 91 occasions covering many concepts such as water as a gift, grace provided by Allah, and water importance for human, plant, water various uses.

International concepts were covered by 6 occasions of water importance for old civilizations, water importance determining population density of continents, and water for energy production in Africa.

Arab region concepts were presented with 18 occurrences. Most of the presented concepts were superficially mentioned about water importance and use in Arab ancient states. Only three concepts in geography of grades 10 and 11 have given good details about water importance and uses in Arab region countries.

Local concepts related to Yemen have presented by 45 occasions. The concepts were vastly focusing on water importance for irrigation, irrigated agriculture, food security, agriculture expansion…etc. Drinking water and sanitation have mentioned six times but in a very shallow way except in grade 11 where quite good details were provided.

In term of quantity, the principle has recorded a good cover. However, the majority were presented as add-ons concepts such as vast statements of “water is life, water is a gift, and water is a grace of Allah showing many mis-selected photos with superficial notions on books covers, and many insertions in lessons. Furthermore, the principle concepts were presented repetitively lacking proper development. It is always presented that water is important for human, plant, animals; no one can live without water….etc. However, vital concepts such as importance of water for population health, education, and economy were almost absent.

The detailed water uses concepts regionally and internationally did only appear with good details in grade 11. However, Yemeni water uses were almost repeated with very poor development. For instance, figures of daily domestic consumption, water uses per sectors, and annual water consumptions fall totally out of the content while other water uses such as touristic and industrial uses are still insignificant. Knowing that concepts of this principle also are supposed to be given to students at the first stage, Finally, many adverse concepts have been quantified under this principle particularly in the context of Yemen such as food security and agriculture expansion that have repeated many times.

Recommendations

- It is recommended to promote the mutual importance and interdependences between human and water from economic, social and political perspectives by providing more in-depth presentations that help students appreciating water more.
- To revise and reform the whole content related to water uses adding and updating the vital figures and missed concepts, and adjusting misaligned concepts is recommended. Doing so, will enable students to recognize and appreciate water importance, uses, and benefits from early grades.

7.3. Principle III: Human influences

A total of 42 water occurrences were identified under this principle covering main human influences such as water abuse, increasing water demand, water for Qat. Spatial scope is shown in figure 75.

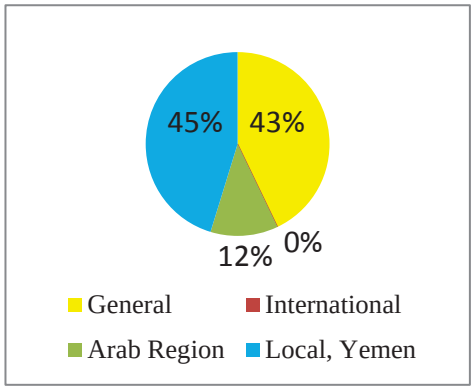


Figure 75. Water concepts spatial scope under principle III

General water occasions are 18 mainly about statements of "do not abuse the water, do not pollute the water, water is gift please save it and so on. Excepted of that, some presentations mention water pollution and abuses causes.

International human influences on water have never shown while concepts relevant to Arab region have appeared with five presentations mentioning water abuse and water demand increase as the main drivers led to the water problems in Arab region.

The local concepts related Yemen have recorded 19 occurrences covering mainly general indication of water abuse and pollution causes. Then water for Qat and increasing water demand has come at second cover. Random wells drilling and low use efficiency was shortly mentioned. It was found that focus was mainly on domestic abuse forms rather than abuse by irrigation which is the critical water wastage Yemen. However, when it comes to discuss water abuse by irrigation the debate be hung on Qat. But, in general all presented concepts did not go beyond mentioning the problems causes. In other words, figures of water abuses and pollutants, real cases, details about water use efficiency…have never presented.

The principle is very important for students to be able to recognize and analysis the bases of water problems from many various standpoints. Nevertheless, what have been presented is still poor and does not pass superficial statements. For instance, illegal wells drilling which is one of the main drivers for the worsening water situation in Yemen was only mentioned twice in very superficial way as “random wells drilling is one of water problem causes”. However, what is random drilling, what are its impacts, why people drill randomly, why it is considered illegal action…etc are totally absent. On the other hand, as mentioned above when it comes to criticize water abuse forms and encourage water saving, most presentations focus on the domestic water abuse and save. Al-Hothi justified this as that Yemeni curricular language speaks manly to males and urban citizens. Abdullah Saif debates that in 1990s people mainly did not consider the water losses in irrigation as abuses. On the other hand, he added, Qat is considered as loss of water, money, health, and environment. Thus in light of lacking the other agricultural figures such as losses it was the easiest then for curricular authors to emphasize on Qat impacts.

Recommendations

It is recommended to enrich and expand human influences scope with more in-depth updated debates and figures emphasizing much main critical drivers such as illegal drilling, low uses efficiency, demand increase, urbanizations, users competition, neglecting of best traditional practices, lack of awareness, laws and bylaws breaching…etc.

7.4. Principle IV: Water problems and issues

A total of 54 water occurrences were identified under this principle covering mainly water problems in Yemen, and Arab region in addition to quite third as general concepts as shown in figure 76.

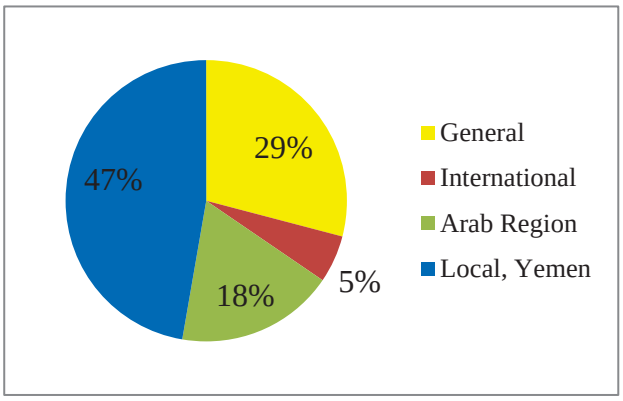


Figure 76. Water concepts spatial scope under principle IV

Further detailed analysis has shown that main presence was applied on water pollution at first and groundwater over-extraction at second as presented in figure 77.

General concepts that are not applied to any specific spatial scope have recorded 16 concepts covering mainly water pollution problem, and pollution sources in details. In addition, some general presentations about climate change, acidic rain, and inadequate water and sanitation services have appeared.

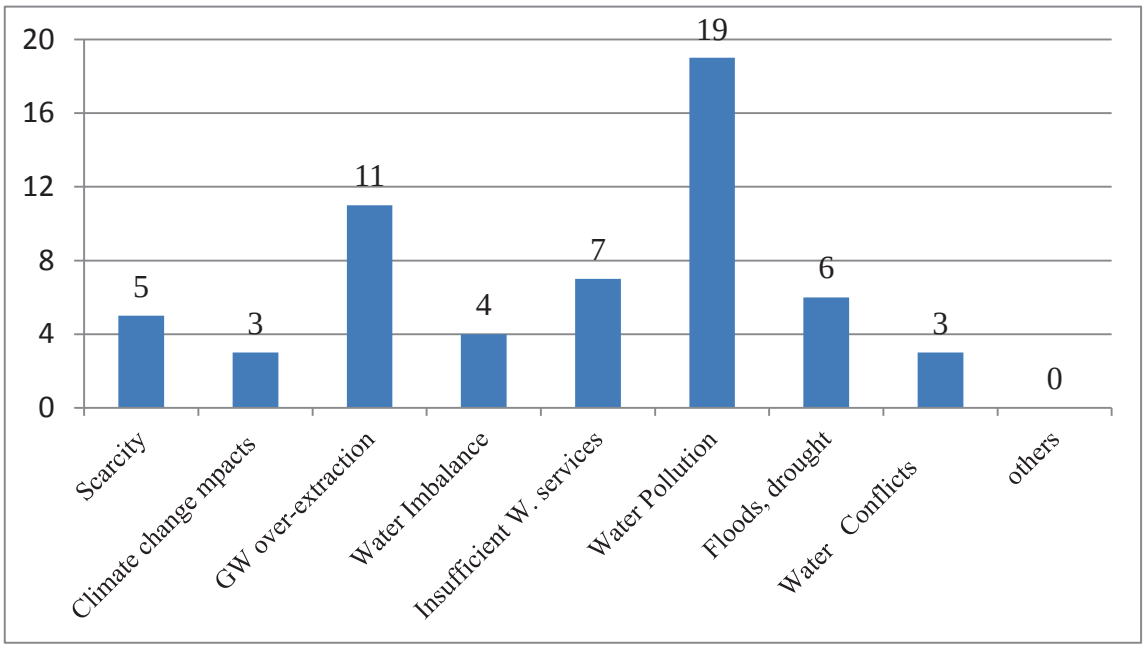


Figure 77. Concepts presence under water problems and issues

Arab region problems and issues have been covered by 10 occasions covering mainly Arab water scarcity and imbalance, low use efficiency and security, trans-boundary water, water conflict between Iraq and Syria with Turkey, and water conflict between Palestine and Lebanon with Israel.

Concepts related to Yemen under this principle were covered by 26 occurrences covering mainly water pollution, ground water over-extraction, and inadequate drinking water services. For instance, ground water over-extraction was introduced 10 times in different subjects and grades. However, most of them were presented in a very superficial way by introducing that ground water has become a subject to overuse due to demand increase, random drilling and water abuse for Qat. Only, in grade 11, the concept was somehow deepened to mention that ground water levels have dropped due to imbalance between uses and recharge, Taiz city has run out of water, and Sana'a basin have more than 13000 thousand wells. However, in some presentations some confusion has been recorded. For instance, it is conceptualized that agriculture in plains and wadies should be developed since ground water availability is quite good in those plains such as in Sana'a and Dhamar basins. On the other hand, water pollution has covered much more but in very general ways of presentation; nonetheless, detailed and updated figures, real life examples and cases were totally absent. With respect to the other issues such as water imbalance and inadequate drinking water supply and sanitation services, presence was very poor that did not go beyond mentioning that demand increase has led to water imbalance and much pressure on services. Finally, climate change has appeared only once in a very superficial way while water conflicts have never shown.

Water problems and issues scope is poorly presented and scattered. For instance, a significant focus has recorded on water pollution, its causes, and impacts in different subjects and grades although water pollution is not the major water issue in Yemen. Um Al-Saad and Yasmeen from the curricula department-Science were assigned by ERDC to write and incorporate water concepts in Science, Arabic, Social Studies, Islamic Studies, Physics, Biology, and Chemistry….etc. Hence, assigning such task to people who have pure technical background justifies the vast coverage of water pollution concept. Yassmeen Abdulwase argues that water pollution is an international water issue which we adequately covered. Furthermore, along pollution presentations it was found that main discourse attention is paid on seas water pollution. Both curricula authors mentioned above are originally from coastal cities. Al-Yazidi argues that person's home-region affects his view towards problems definition. On the other hand, other problems such as ground water depletion and inadequate services were repeated superficially while other issues such as water imbalance, climate change, water conflicts were either scattered or totally Absent.

Recommendations

It is greatly recommended to enrich and expand the whole scope of this principle with much more theme-based presentations focusing more on main critical water issues such as GW depletion, water imbalance, climate change impacts, water conflicts, water inadequate services…etc, emphasizing much more on real life examples and cases, highlighting the social, economic, environmental and political impacts resulted by worsening water situations on individuals, local societies and the whole country.

7.5. Principle V: Water Conservation and Management

A total of 64 water occurrences have recorded under this principle covering mainly water conservation concepts, and water resources management options.

Almost half of the concepts cover water management options for Yemen while one fifth were for Arab region as shown in figure 78.

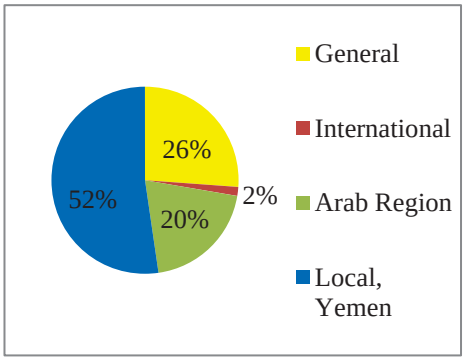


Figure 78. Water concepts spatial scope under principle V

Further detailed analysis has revealed the scope of the different water management options introduced to students as shown in figure 79.

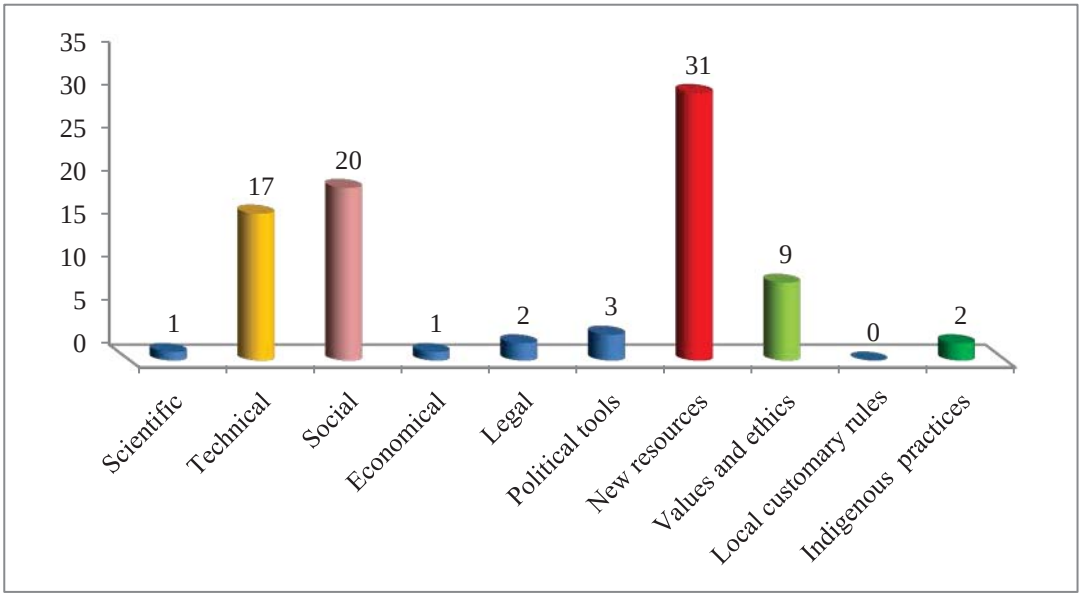


Figure 79. Water conservation and management concepts scope

General concepts have appeared by 17 times covering mainly importance of water resources conservation, statements and inquire about individuals roles to save water, and some general solutions of water resources protection and development. Almost half of the general concepts are presented from more than on perspective while others were just superficially introduced. General water conservation options which mentioned as a package of bullets were the most repeated concepts.

Concepts relevant to Arab water management have counted 13 occasions covering mainly channels maintenance and constructions by Arab and Islamic civilizations, and present non-conventional water resources such as desalination, waste water and drainage water treatment and dams. Historical irrigation management and some drinking supply systems were superficially mentioned. Developing non-conventional water resources as an option of water management was presented in details.

Concepts appeared in context of Yemen were counted by 34 times. New water resources provision mainly through Dams' construction is always presented on top of the water management options list. Individuals' role to water saving and resources conservation comes at second order. At third order, technical tools such as modern irrigation systems, wastewater treatment, and channels construction were superficially presented. Terraces construction and maintenance was the sole indigenous practice merely and limited indicated while Yemeni customary rules managing water resources were totally absent.

To sum up, water resources management options presence is still poorly and merely covered containing very general presentations that lack detailed information and deep cognitive and experiential depth focusing mainly on providing new water resources such as dams, desalination…etc. Abdullah Saif justified this as IWRM is still new approach especially in Yemen and its tools are still unknown for many peoples. However, Al-Yazidi reflects such intention of state advocating dams and desalination as "*It has been politicized to escape forward through giving people hope about flowering future that is actually based on fake facts and to hide the politician failures*".

Recommendations

The following points discuss each presented water management tool separately and propose how it could be promoted:

- **Scientific tools:** have appeared only one time in Arabic of grade 8 that the national water strategy states water conservation through conducting research and studies. Recognizing the importance of sciences and innovation in solving water problems, it is recommended to enrich this aspect encouraging and instilling the innovation culture by students.
- **Technical tools:** have also limited and superficial cover with repetitive focus on modern irrigations systems. For instance, neither various benefits nor water saving figures of modern irrigation systems have been shown. Other technical solutions such as taps and water tanks repairmen and rainfall measurement were rarely and merely mentioned. Therefore, it is very important to educate students how modern technologies are effective in water resources saving, monitoring and management. Thus it is recommended to expand the scope of this aspect by depth presentations covering socio-economic and environmental benefits gained from water saving, monitoring, grey and wastewater treatment technologies…etc.
- **Social Tools:** this aspect was relatively much covered focusing mainly on repetitive inquires to students about their roles in water saving in addition to statements of "do not pollute water". Only in two presentations it was inserted that local councils participate in water projects supervision and water resources conservation. Public awareness was indicated by only three statements; the first one "we should make people aware about water abuse forms", the second one "awareness is a duty of the state", and the third one "awareness becomes a must as other religious instructions". Finally, participation and cooperation of Yemeni ancient to construct

dams were presented many times but did not go beyond information. However, information is not enough. Therefore, it is highly recommended to enrich and reflect the existed presentations through more in-depth debates. Students should be taught how they can participate and contribute in solving water problems. For instance, they should be educated on how to reduce water consumption, calculate water consumption and bills, reuse treated waste- and grey water, participate in raising people awareness, and what is the role WUAs and people in general to prevent wells illegal drilling for example and how water disputes within their areas can be prevented or solved.

- **Economical tools:** have appeared once as “we should remind our fathers to pay drinking water bills”. Such aspect is very important for student to appreciate water value. Hence, it is strongly recommended that students should be introduced to water economic aspects such as; i) water has an economic value varying after the type use, ii) why people should pay for water uses (prices), iii) virtual water in agriculture products, iv) saving water means saving money.
- **Legal tools:** were covered twice in very mere and brute way. The first one in grade 12 on Arab region context as “Arab region should attempt by the international community to issue international laws that ensure and secure Arab water rights”. The second one in grade 10 was about Yemen as “legislations and laws that ensure water cycle for balanced life continuity has to be implemented. Further, penalties should be imposed on those who do not follow the water law issued in 2002”. Therefore, it is recommended to widely expand and enrich legal debates covering water rights and property, highlighting the importance of water law and bylaws for water resources conservation, and emphasizing the adverse impacts of laws breach such as water conflicts and depletion.

- **Institutional tools:** have mentioned twice as i) Arab countries should develop unified strategies and sign agreements to secure and develop Arab water resources, and ii) Yemen has water strategy that assure importance of water resources provision through dams construction, water resources conservation, and pollution and abuse abatement. Hence, it is recommended to provide students with needed knowledge about water management framework in Yemen with its different sectors, roles, national policies and strategy…etc. This can promote a holistic understanding for national water management interventions.
- **New resources development:** this concept has the lion share of the presented concepts highlighting dams' importance in the past and present as the vital solution for Yemeni water crises. Such huge focus on dams came as result of water supply oriented management adopted for many decades in Yemen as in many other countries in MENA region (Al-Hamdi, 2009). In line with that is Al-Eryani is who added *"there is also a cultural historical element. Common knowledge among Yemenis and love for dams"*. Tawfiq Alsharjabi, MOW Deputy Minister, states *"Even though, the old dams constructed by all old Yemeni States were countable, dams are marketed as the vital solution the Yemeni ancient have ever innovated and developed"*, (personal communication on 22 Oct, 2012). Further, according to the national water strategy (NWSSIP, 2005) most of constructed dams in Yemen are mainly inefficient and their construction decisions were mainly taken based on political bases. Hence, it is strongly recommended to eliminate such excessive discourse and encouragement of dams so that be presented linked to construction feasibility and absence of adverse impacts. However, existed allocated space of dams in

curricular can be utilized emphasizing other small scale water harvesting tools such as check-dams, converting dikes, pools…etc.

- **Values and Ethics:** have mainly appeared to show forbiddance of water abuse, and surface water pollution through human urination and excursion. Nevertheless, other vital water values were totally absent. According to Ehrlich (2011),*"Much more attention is needed to ethics in schools"*. Hence, it is recommended to add many complementary concepts emphasizing the various Islamic and human values related to water such as green growth principle, water share, human right to access safe drinking water and sanitation, and acting as areal model of earth Successor who develop and protect water and environment.
- **Local Costmary Rules:** Yemen retains wide range of costmary rules that are used to manage wide range of daily life issues by tribes and villagers such as graze and water, surface water allocation, conflicts' settlement…etc. (Lichtenthaeler, 2010). However, Yemeni ancient wisdom in curricular content was totally excluded to dams' construction. Therefore, it is highly recommended to reveal how such vital tools have been used to sustain water resources and the possibility and importance to enable them again for water conflicts settlement and common responsibility toward water management.
- **Indigenous Best Practices:** it is strongly recommended to teach students the Yemeni indigenous best practices such as surface water and drinking water share, allocation and operation, participation in terraces, pools and cisterns construction, maintenance and operation, irrigation in early morning and late afternoon, lands leveling, and spates direct use and management.

7.6. Principle VI: Water Sustainability

This principle has recorded the poorest presence with only four presentations. The first was presented superficially in grade five by mentioning that "all people should cooperate with government to drill wells, construct dams and underground tanks for water harvesting, and keep tanks clean". The second one has appeared in grade 8 as stating "the necessity of consolidating people and official efforts and cooperation to provide new water resources, and the importance of coordination between different water sub-sectors. It is added, people role can be represented as conserving water for themselves and generations through less consumption and abuse while state role is to disseminate awareness within citizens. Finally, people should be good images when they use water". The third one is presented in grade 8 that "all people own natural resources and public goods since they share their use such as schools, dams, streets…etc. The last one is presented in grade 11 as "Preparing a unified Arabic strategy to face the disputes with upstream countries on the main rivers and encouraging cooperation opportunities not only on the regional level but on the international level in order to solve the water conflicts".

Recommendations: According to Ehrlich (2011) "*environmental issues in governance should become part and parcel of a continuing effort to inform students of how collective decision-making work, whether by informal communities, by governments, or by world bodies"*. Thus it is recommended to prepare a comprehensive content covering in depth roles and responsibilities of individuals, societies and governments and cooperation modalities should be adopted to act integrally to conserve and manage water resources in very sustainable and integrated manners.

8. Teaching Aids Assessment

The Educational Means and Programs Production Center (EMPPC) affiliated to GCGD was established in the beginning of 1970s. Its main role is to produce and provide teaching aids and materials for schools overall the country according to Khalil Mohammed, Educational Aids Consultant at EMPPC (Interviewed on 10 Dec, 2012). EMPPC is in charge of teaching aids and materials designing which works in coordination with ERDC. However a kind of mis-planning between ERDC and EMPPC appears so that recommendations of the former are usually not considered by the latter (Smart, 2005). The center unites has been supported with much technical equipment such as the media production unit that edits and produces T.V and broadcasts, different units of physics, chemistry, biology and geography aids and materials according to Abdulqawi Al-Mikhlafi, Media Editor at EMPPC (Interviewed on 10 Dec, 2012). Recently, as result of involving Yemen in Gulf educational programs many changes have done such as establishing new department of Learning Resources according Quid Al-Qudami, Learning Resources Director at EMPPC (interviewed on 11 Dec, 2012). He added, *"EMPPC has paid many touchable efforts to support the learning environment in schools. For instance; a round 500 schools were supported by computer labs, and around 2500*[6] *schools have received a complete show unit including T.V, Satellite and DVD reader to present to students the learning media materials"*. When he was asked about satellite provision purpose Al-Mikhlafi said *"it is provided to help schools to present some live educational channels*[7] *mainly foreigner ones such as Egyptian educational channels"*. It is noticed during the visits that the main production of the educational aids and materials is employed to support the pure scientific and technical

[6] The computer labs were mainly distributed for schools in urban areas while most of the show units were distributed for schools in the rural areas according to Quid Al-Qudami.

[7] The national educational T.V Channel is still under the experimental show period

concepts of science and geography subjects. According to all interviewed officials, there is no any teaching aid or material with relevance to water. If existed, it would be produced via personal efforts of schools and students.

Teaching aids and materials are very important means supporting teachers to transfer learning content in much effective way and helping students faster and easier acquiring the introduced content. So far EMPPC has gained a significant development and support in term of equipment and human resources; nonetheless, its effectiveness is still restricted by many constrains of which the financial fund availability comes at top of the list according to AL-Mikhlafi. Furthermore, out of the total 15602 schools in Yemen (TIMSS, 2012) around 500 and 2500 schools are provided with computer labs and show unit respectively. However, teaching aids and materials related water have never shown. The reasons behind that are two, i) the culture of Yemeni education system that mainly focus to visualize pure science and technical concepts which mostly depriving most of other social, environmental,…etc concepts from being modeled and visualized, ii) the mutual ignorance from both sectors education and water according to Al-Mikhlafi. Therefore, so far what have been provided to EMPPC and schools forms a solid base to have water concepts better visualized and introduced. Nonetheless, there is a high need for close and integrated cooperation and work bringing to the light an effective visualized water concepts education. For instance, water sector has the required water data, expertise, and even financial fund allocated for public awareness activities while education sector have the required educational equipment, expertise…etc.

Recommendations

- It is highly recommended to integrate the available resources by both sectors to produce water side materials for each grade. For instance, water main principles can be simply arranged in different large-scale postures for each different educational stage. Other concepts such as water harvesting, ground water existence and recharge…etc can also be visualized in 3D models using simple recycled and natural materials existed in the nature. Further, media series can be produced for each grade as a complementary content to textbooks and provided through the national educational T.V and CDs. Donors of both sectors can also be directed to support expansion of show unit provision till covering all schools.
- There is also a high necessity to produce water concepts teaching guidebook to be provided for all schools. Producing 15602 copies of such guidebook will not cost that much and will cover all schools. Hence, it is recommended that NWRA take the lead of forming a bilateral team of both sectors experts to prepare the proposed guidebook. Such guidebook can include in details water resources, uses, issues, management and sustainability in Yemen in addition to an educational chapter for each grade highlighting what and how to teach the water content of each grade.
- Finally, different agencies leaded by NWRA and WEC should organize many IWRM introductory training programs and workshops for textbooks authors, designers, and even for schools teachers to bring all in the mainstream of IWRM in general and Yemeni water situation and management in particular.

9. Water Concepts Overall Assessment

A total of 494 water occasions are identified in the whole textbooks content of basic and secondary education stages which can be considered as relatively moderate presence in term of coverage comparing to other countries in the MENA region. For instance, in Jordan a total of 1045 water occasions have been identified within the national school textbooks in grades 1-10 (USAID/Jordan, 2010). The recorded water presence in Yemeni curricular was mainly influenced by the mentioned cooperation project between NWRA and ERDC implemented between 1998 and 1999 (NWRA, 1999). Nevertheless, almost half of total found concepts were delivered as add-ons to hosting topic and only 15% were delivered as core of the topic as shown in figure 80. Such limited theme-based water presence is due to that only the first phase of the cooperation project between NWRA and ERDC has been implemented which mainly stated to insert water knowledge wherever it fits. Further, the majority are presented as mere information in addition to some skills and values as shown in figure 81. Concepts that involve students and shape or state their

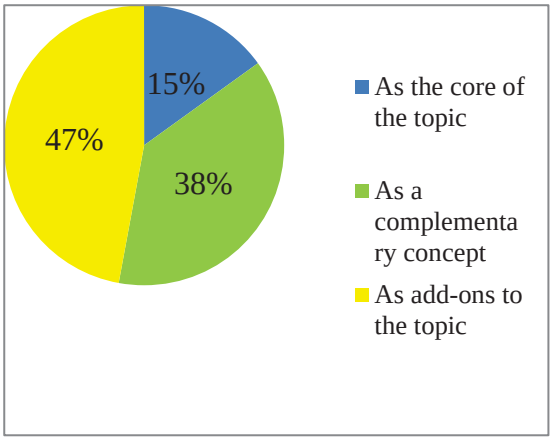


Figure 80.Water concepts delivery forms in the whole content

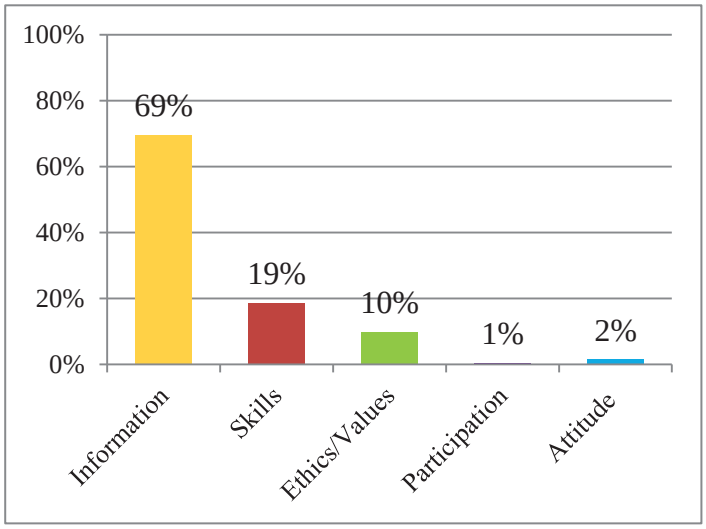


Figure 81. Water concepts representation forms in the whole content

behaviors are insignificantly presented. Thus students are required to memorize wide range of knowledge that cannot last for long in minds however might negatively affect students' appreciation towards the water so that they might acting carless when they deal with water. Furthermore, vertical sequence and development have been poorly recorded by most of the water concepts and many subjects present a reticent cover for water concepts. Hence, having the majority of the water concepts delivered and presented as add-ons mere presentations with poor vertical sequence and development reveals the low cognitive depth of the water concepts in Yemeni school textbooks.

With respect to concepts experiential depth, the vast majority of the identified concepts do not go beyond the first and second phases of introduction and reflection while the least quota passes into generalization and application phases as shown in figure 82. Thus that water concepts in Yemeni textbooks are almost theoretically presented. Such theoretical teaching manner cannot influence learners' behaviors as experiential education does.

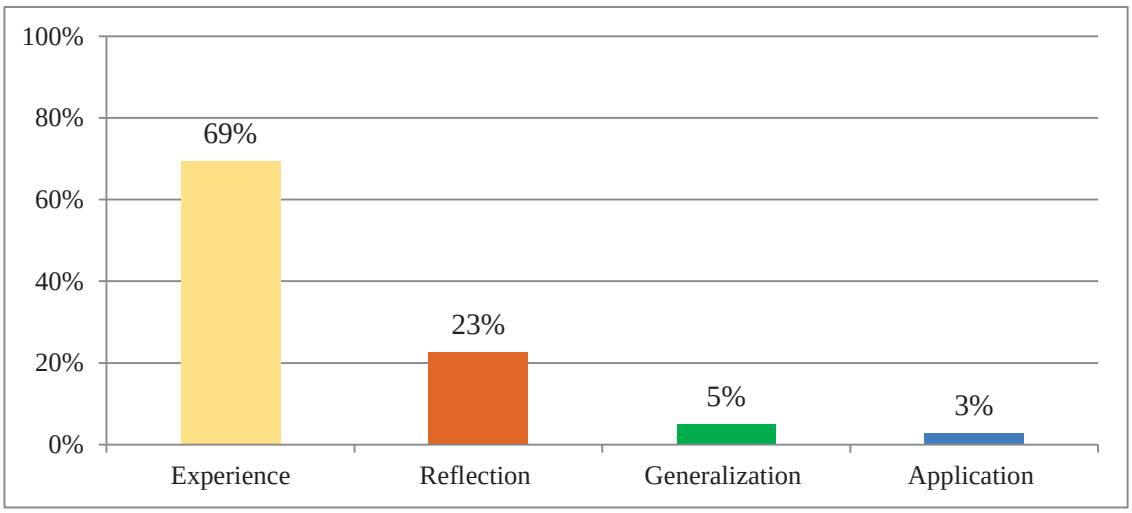


Figure 82. Water concepts experiential depth in the whole textbooks content

Regarding water main principles scope, the main focus of the water presence was applied to the first two main principles. In other words, students are educated mainly with concepts related to water properties, water resources, water importance…etc. However, other important principles such as human influences on water, water problems, water resources management and water sustainability are poorly covered as shown in figure 83. Thus this answers generally the question of what are the main water concepts given to Yemeni Students. However, 97 water occasions have been identified as concepts that misalign to the water situation and IWRM main stream in Yemen either as adverse or mis-conceptualized concepts. Further 7 concepts have been recorded overpassing the learning needs of the water main principles for the respective students' grade as shown in figure 84.

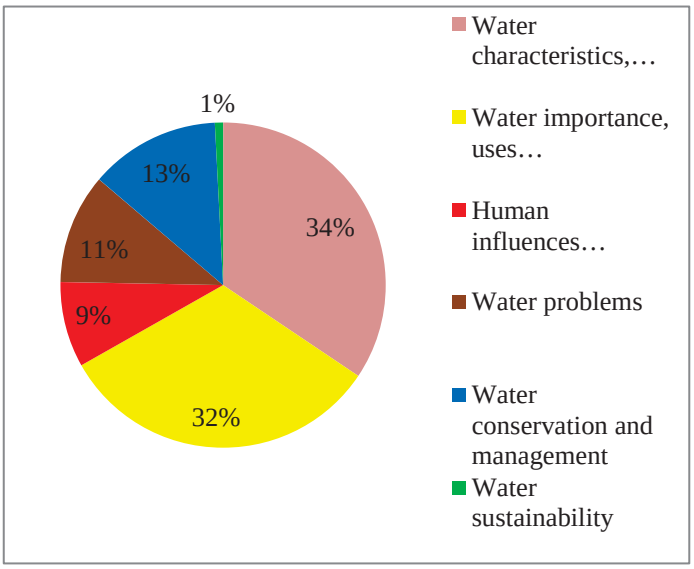


Figure 83. Concepts scope under water main principle

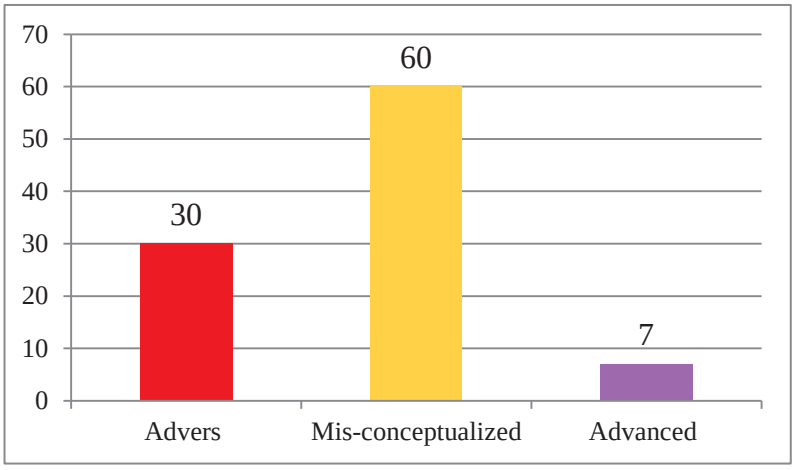


Figure 84. Water concepts mis-alignment presence in the whole content

Al-Eryani points out that *"Such concepts misalignment happened due to the ignorance on the part of those who wrote the text books not knowing the water realities"*. However, the non-appropriate selection for information source is another factor resulted in such random discourse. According to Al- Hothi and Um AL-Saad, GCGD usually rely on governmental agencies' 5yrs plans and workshops' presentations as information sources. Thus there is highly required that curricula board members be exposed to introductory training programs in the field of IWRM in Yemen and that both water and curricula experts should work in an integrated manner ensuring closer cooperation when editing school textbooks. Further, Al-Eryani stressed that *"there is a need to have water education also in the Colleges of Education, so that the teachers who end up writing these books are aware of the water realities in Yemen"*.

Finally, as proved in details in sections 5, 6, 7, and 8 that many vital water concepts, good visualization, and teaching aids and materials fall out of the water concepts education system.

10. Overall Conclusions and Recommendations

10.1. Conclusions

- Water Education in Yemeni National Curricular has been considered officially in 1998 as result of cooperation project between NWRA and ERDC to develop and adopt a comprehensive water education on three stages of initial insertion, presence expansion, and comprehensive professional content design and adoption. Only the first phase was implemented between 1998 and 1999; however, in almost single minded approach.
- Assessment as a culture is not preferable in Yemen. A big evident is that from 2000 up to now there is no any evaluation has carried out to assess what has been included, how was done it…etc. Further, Curricula Department General Director was too reluctant to make statements when interviewed saying *"are you a journalist"?* The same have been expressed by some officials in EMPPC.
- The perception of having a holistic water education in schools is still very low and exclusively linked to normative public awareness message disseminated here and there. As proven, almost half of water concepts are presented as add-ons to the topic. *"Haven't see the whole content, we posted more than twenty water picture on the back cover of textbooks in addition to many of (save the water) statements inside the content"* said a former minister of MOE . Many other curricula board members and officials in NWRA- Public Awareness Department have stated the same and mapping survey have identified enormous of insertions.
- Insightful vision of having water concepts conceptualized from more than one perspective is still insignificant culture as derived from water principles scope analysis. Many vital water concepts fall out of the curricular. Further, many subjects were superficially contributing to conceptualize water different issues.

"You just need the science textbooks for your research. There you only can find the water concepts and issues" said the Regional Director of Education Office-Capital City of Sana'a. Another curricula senior expert said *"you need to change the title of your master thesis. Why? Because you are studying water concepts while water is a sole concept defined as chemical compound of H2O that is existed in nature in three states of liquid, solid and gas"*.

- Educating water resources availability in Yemen is mis-conceptualized after the historical notion considered Yemen as Arabia Felix Land that has abundance of rains, streams and even rivers as proved in the detailed analysis.
- The water importance and uses has been recorded mainly but adversely conceptualized after three false notions. The first one is "Agriculture is the backbone activity of Yemeni economy". "The second one is not only that Yemen has to attain agriculture-based food self-sufficiency but also should be food exporter". The third one "Yemen the green lush Land" that should be green as it used to be for centuries. Furthermore, importance of water is exclusively introduced by superficial cover to human, animal, plants, sometimes for generation…etc. However; water economic value, social value as human right to access safe and adequate drinking and sanitation services, and health, education and economy dependences on water are almost fall out of the whole textbooks content.
- Teaching water problems and issues does not match the worsening water situation in Yemen yet. For instance, main repetitive focus is on domestic abuse and water pollution. Other critical issues such as competition on groundwater use, groundwater depletion, water uses low efficiency, water conflicts, climate change impacts …etc. were poorly indicated if not absent at all.

- In terms of water resources management education, as in reality Yemenis just jump out of the box. For instant, dams' construction always proposed on top of the water management tools recipe. Both misleading historical notion of "Yemenis Fame for Dams" and water supply-oriented management approach adopted during the last decades in Yemen are standing behind such attractiveness towards Dams in Yemen.
- Moving toward a holistic approach by which all stakeholders contribute to sustain the water resources is almost insignificant in the whole content.
- In term of coverage, water concepts in national school textbooks has attained relative moderate cover where the most focus is on general discourses of water properties, importance, and problems beside numerous of add-ons statements such as water is gift, water is life, save the water…etc. Furthermore, what is already incorporated in curricular is almost prepared to merely inform students. Students' involvement to actively take actions in their societies for water resources conservation is still low. In other words, the application and participation based teaching is still insignificant. If existed, it is mostly presented in non-applicable way due to the lack of teaching aids and outside sources or in way that results in theoretical out comes by requesting students to mention and count things or to express their thoughts and ideas. Although only subjects of geography, science and somehow social studies and Arabic have shown a good cover and vertical sequence for some water concepts, concepts vertical development remains very limited if not repetitive in most cases. Such concepts presence approach has resulted in having very low cognitive and experiential depth by the identified water concepts.
- Water concepts visualization in textbooks is mostly found as either poor, mis-selected, or absent. "*We lack the adequate photos and we are not financially*

supported to access the field obtaining the needed photos, so what can we do?!" said a textbooks designer at EMPPC.

- Teaching aids and materials relevant to water concepts education is totally absent; however, the available technical and human capacities in both water and environment sectors to produce such materials forms a solid base for a good start.
- Finally, misaligned water concepts, very old figures and lack of appropriate field data and photos proved a significant mutual ignorance between officials in both sectors.

10.2. Overall Recommendations

To reform the whole curricula with respect to a specific learning matter such as water in this case is a supreme level of change that requires high legislative and administrative arrangements besides long time process and various resources needed for such action. Therefore, it is recommended to promote the water concepts education in Yemeni schools education gradually by three levels of interventions as follows:

- **First urgent phase of action**: start editing misaligned concepts and adjusting them according to the given detailed recommendations to ensure harmonized and holistic teaching which lines with water Yemeni situation and IWRM mainstream.
- **Second mid-term phase of action:** revise the already existed concepts enriching their cognitive and experiential depth. This can be attained by providing more in-depth updated concepts presented by multiple forms of presentations focusing more on skills, values and participations in a hand, and promoting application side through supplying more effective Yemenized activities that ensure a better level of learners' involvement on the other hand.
- **Third long-term phase of action:** start developing and designing a new comprehensive and integrated water education content in a participatory approach

involving all stakeholders in both sectors of water and education and put it in place within the nearest curricula reform.

In addition to detailed recommendations embedded by sections of 4, 5, 6, 7 and 8, and in line with the proposed three phases above, the following points are strongly recommended to be considered:

- Both cognitive and experiential depth should be concerned when adjusting or reforming the water concepts presence in future. Therefore in-depth practical activities inside and outside the class should be widely promoted.
- Paying more attention to principles of water problems, management tools and sustainability with more reflection on Yemeni context.
- Visualization is a very important element that should be promoted during the three recommended phases. Films, Short clips, large-scale posters, models can be produced to bridge the gaps in textbooks and promote concepts acquisition. .
- For phases 2 and 3 mentioned above, side effective materials such as films, models, short clips, stories, games, and coloring booklets that fit to students' ability and learning needs in each grade are recommended to avoid textbooks over-bulking.
- There is a great opportunity to expand water concepts cover through preparing and printing meaningful presentations mainly via photos and figures on writing notebooks covers. However, this requires involving the private sector and considering concepts alignment to notebooks different categorizations.
- Preparing a water teaching guideline book including a comprehensive introduction about water situation, issues and IWRM in Yemen in addition to chapters that instruct to teachers how to teach water content of each grade should be produced and distributed for schools

- Conducting IWRM introductory training programs for curricula experts, designers and teachers.
- There is high need for curricula mapping study of Faculty of Education and consequently development with relevance to water so that graduated teachers who ends up to write the school textbooks or to teach generations become fully aware about Yemeni water situation, issues and management.
- It is also recommended to conduct further assessment study for both teachers and students. For teachers, to investigate and evaluate their capabilities and understanding to water different issues, and to determine what weaknesses they have and or what requirements they still lack to be able teaching water stuff. For learners, to investigate their abilities and responsiveness to the given water concepts.
- Working with distant coordination is neither sufficient nor effective and usual results in many mistakes as happened by the last cooperation of 1999 where many mis-conceptualizations occurred. Hence, any coming content adjustment or reform should be done in close and bilateral manner of work.
- Last but not least, the media and other public awareness activities and programs should be expanded and improved to reinforce the formal water teaching in schools.

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Annexes

Annex. I. A: Textbooks Mapping and Analysis Matrix Model

Subject name	Grade #	12th	Book Code	Is.12.01	Issuing Date and Decree	29.08.2001	Issuing Decree NO	23	Screening date by researcher	07.10.2012	General Remark on Book Contents	
Islamic Studies	Semester	1st	Book size (Pages):	190	Printed for …. and on	2013	Revised or not	Third edtion	Revision date by researcher	13.11.2012		

A. Contexts and Concepts Primary Description						B. Concept Setting				I. Educational-Based Analysis												
						Topic and Unit data		Unit Contents Dependency		Analysis I.A. Concept Delivery			Analysis I.B. Concept Representation/Formulation					Analysis I.C. Concept Experience Depth within the topic/unit (Concept Organization along the experiential path)			
Context	Concept ID	Concept	Description	Remarks	Gaps/weakness	Topic name and Page/s #	Unit name and number	Dep.	Indep.	As the core of the topic/unit	As a complementary concept	As add-ons to the topic	Knowledge (Information/fact)	Skills * (CT, PS, An, Ap, DM, Sy, In…etc)	Ethics/Values	Participation	Attitude	Experience	Reflection (Reflective Observation)	Generalization (Abstract Conceptualization)	Application (Active Experimentation)

II. Water-Based General Analysis						III. Detailed Water-Based Analysis																				
II. A.1. Water Main Principles						II. A.2. Spatial Scope				III. A. Type of Water Resources																
										III. A.1. Precipitation				III. A.2. Ground Water				III. A.3. Surface Water							III. A.4. Non Traditional Water Resources				
Water existence, characteristics, interlinkage with other elements in the nature	Water importance and human dependence on (Water Uses)	Human influence on water resources	Water problems and issues	Water resources conservation and management	Reaching water sustainability	General	International	Regional, Arab	Local, Yemen	Rainfall	Snow	Fug	others	GW (Aquifers, wells)	GW (Shared Aquifers)	Springs	Mineral hot water	Seas, oceans	Rivers, Lakes, pond	Seasonal spates, streams	Dams, Dikes	Water Harvesting (Pools and Tanks)	Sabkhah (low salty ponds in wadies)	Shared surface water (Rivers, lakes, regional water in seas	others	Treated Waste Water, agriculture drainage water	Treated Grey Water	Desalinated Water	Clouds Harvesting	others

Annex. I. A. The Curricular Mapping and Analysis Matrix Model

III. Detailed Water-Based Analysis																															
III. B. Type of Water Use								III. C. Water Treatments and Irrigation services, methods, technologies, benefits…etc					III. D. Main Water Issues and Drivers																		
													III. D.1. Water Main Issues									III. D.2. Water Situation Main Drivers									
Domestic	Irrigation	Tourism and commercial	Industry	Energy Production	Navigation, Fishing, relaxation …etc	Environmental/ grass	others	Drinking water supply	Sanitation	Grey water	Desalination	Irrigation	Scarcity	Climate change & its impacts on water resources	Ground water over-extraction /depletion	Water Imblance/ Gap between water resources demand and supply	Insufficient drinking water supply and inadequate sanitation	Water Pollution, causes	Floods, drought	Water Conflict	others	Water and Qat	Increasing the demand due to the high population growth, economical and industrial	Low use efficiency by Irrigation and Losses by Urban	Lack/low Awareness	Absence/Low application for laws and bylaws	Illegal/random wells drilling	Mis-management, low level of institutional capacit	Water Abuse	Illegal Water Use (Urban)	others

III. Detailed Water-Based Analysis																
III. E.Impacts of the worsening water situation					III.F. Main Crucial Tools/Solutions for Attaining IWRM											
Social	Economical	Political	Environmental	others	Scientific Tools & solutions such as the role of researches, studies and innovation	Technical Tools such is introducing modern technologies of water saving, modern irrigation systems, efficient crop pattern…etc	Social Tools & solutions such as awareness campaigns, water use priorities, community participation, role of individuals and others in water	Economical Tools & solutions such as incentives against commitment, water price paying, water value, cash crops…etc	Legal and organizational Tools & solutions such as water rights verification, standards and control, enforcement of laws, bylaws and regulations, and pollution and misuse punishment principle etc	Political tools such as regional and international agreements, cooperation….	Inistitutional/Secotral tools & solutions such as planning, allocation, role of governmental authorities, role of private sector…etc	Developing new resources such as water harvesting, TWW Reuse, Desalination	Integration of all local and official efforts to conserve and manage the water resources	Water values and ethics (religious, human…etc)	Traditional norms and local costmary rules of water allocation and management, conflict resolution…etc	Indigenous best practices such as adaptation, terraces construction and maintenance, irrigating at best time (in the early morning and the

Annex I.B: Textbooks Recording and Documentation

Grade	Subject	Semester	Book Name	Issuing date	Issuing Decree No	Printed for Year	Pages no	Empty pages	Screening date	Review by Researcher	Notes (**Annex I.B)**
1st	The Holy Qur'an and Islamic Studies	1st	=	29.08.2001	23	2011	173	3	09.05.2012	27.10.2012	Revised edition
		2nd	=	29.08.2001	23	2011	126	2	26.11.2012	26.11.2012	Revised edition
	Arabic	1st	=	29.08.2001	23	2012	224		09.05.2012	27.10.2012	Third revised edition
		2nd		29.08.2001	23	2011	118	4	26.11.2012	26.11.2012	Revised edition
	Mathematic	1st	=	29.08.2001	23	2012	137		09.05.2012	27.10.2012	
		2nd		29.08.2001	23	2012	96		27.11.2012	27.11.2012	Third Edition
	Science	Both	=	29.08.2001	23	2011	122	5	11.09.2012	27.10.2012	
2nd	The Holy Qur'an and Islamic Studies	Both	=	29.08.2001	23	2011	182	2	05.09.2012	27.10.2012	Revised Edition
	Arabic	1st	=	29.08.2001	23	2011	144	1	05.09.2012	29.10.2012	
		2nd	=	11.07.2000	596	2012	144	1	06.09.2012	29.10.2012	Third Edition
	Mathematics	1st	=	11.07.2000	596	2013	96		22.10.2012	08.11.2012	Third Edition
		2nd	=								
	Science	Both	=	Third Version, revised at 2010		2013	128		21.10.2012	08.11.2012	Instructions for teachers are posted in the footer. It is revised and updated at 2010 by bilateral team from the MOE and the Life Science Association (LSCA)
3rd	The Holy Qur'an and Islamic Studies	1st	=	29.08.2001	23	2012	145		22.10.2012	08.11.2012	
		2nd	=	NA	NA	2011	160		22.10.2012	08.11.2012	
	Arabic	1st	=	29.08.2001	23	2012	224		09.05.2012	27.10.2012	Third edition
			=	29.08.2001	23	2010	122	1	07.09.2012	29.10.2012	Revised Edition
	Social	Both	=	29.08.2001	23	2011	112		06.09.2012	05.11.2012	Revised Edition
	Mathematics	1st	=	11.07.2000	596	2009	102	2	22.10.2012	08.11.2012	Second edition
		2nd	=	11.07.2000	596	2012	96		22.10.2012	08.11.2012	Third edition
	Science	Both		11.07.2000	596	2013	151	1	06.09.2012	03.11.2012	
4th	The Holy Qur'an	both	=	NA	NA	2011	135	1	07.09.2012	13.11.2012	Revised
	Islamic Studies	both	=	29.08.2001	23	2012	120		07.09.2012	27.10.2012	Revised edition
	Arabic	1st	=	29.08.2001	23	2012	218		08.09.2012	29.10.2012	
		2nd	=	NA	NA	2010	218		08.09.2012	29.10.2012	Revised edition
	Social Studies	Both	=	11.07.2000	596	2013	91	5	22.10.2012	05.11.2012	Revised edition
	Mathematics	1st	=	29.08.2001	23	2013	135		22.10.2012	08.11.2012	
		2nd	=	29.08.2001	23	2012	148	4	22.10.2012	08.11.2012	
	Science	1st	=	NA	NA	2011	136	1	08.09.2012	03.11.2012	Revised edition
		2nd	=	NA	NA	2011	160		08.09.2012	03.11.2012	
5th	The Holy Qur'an	both	=	NA	NA	2012	200		19.10.2012	14.11.2012	Revised edition
	Islamic Studies	both	=	29.08.2001	23	2011	174	2	19.10.2012	27.10.2012	

Grade	Subject	Semester	Book Name	Issuing date	Issuing Decree No	Printed for Year	Pages no	Empty pages	Screening date	Review by Researcher	Notes (**Annex I.B)**
	Arabic	1st	=	29.08.2001	23	2010	227	5	11.09.2012	30.10.2012	
		2nd	=	29.08.2001	23	2012	216		11.09.2012	30.10.2012	Revised edition
	Social Studies	Both	=	NA	NA	2012	80		19.10.2012	06.11.2012	Third revised edition
	History	Both	=	29.08.2001	23	2012	85	4	19.10.2012	15.11.2012	
	Geography	Both	=	NA	NA	2012	83	2	19.10.2012	09.11.2012	Revised edition
	Mathematics	1st	=	29.08.2001	23	2012	112		20.10.2012	08.11.2012	
		2nd	=	11.07.2000	596	2008	158	2	10.09.2012	08.11.2012	
	Science	1st	=	11.07.2000	596	2013	125	2	20.10.2012	03.11.2012	
		2nd	=	NA	NA	2011	145	1	10.09.2012	03.11.2012	Revised
6th	The Holy Qur'an	both	=	NA	NA	2010	175	1	14.09.2012	14.11.2012	Third revised edition
	Islamic Studies	both	=	29.08.2001	23	2012	136		13.09.2012	27.10.2012	Revised edition
	Arabic	1st	=	29.08.2001	23	2012	201	1	17.09.2012	30.10.2012	Revised edition
		2nd	=	29.08.2001	23	2011	206	2	17.09.2012	30.10.2012	Revised edition
	Social Studies	Both	=	29.08.2001	23	2012	110	2	12.09.2012	06.11.2012	
	History	Both	=	11.07.2000	596	2008	112		13.09.2012	15.11.2012	Revised edition
	Geography	Both	=			2012	90	2	13.09.2012	09.11.2012	Third revised edition
	Mathematics	1st	=	29.08.2001	23	2012	149	3	10.09.2012	08.11.2012	Revised edition
		2nd	=	29.08.2001	23	2012	168		10.09.2012	08.11.2012	
	Science	1st	=	NA	NA	2011	138	1	17.09.2012	03.11.2012	Revised edition
		2nd	=	NA	NA	2010	160		17.09.2012	03.11.2012	Revised edition
7th	The Holy Qur'an	both	=	29.08.2001	23	2012	190	2	22.09.2012	14.11.2012	
	Islamic Studies	1st	=	29.08.2001	23	2011	198	2	21.09.2012	28.10.2012	First edition
		2nd	=	NA	NA	2013	184		21.09.2012	28.10.2012	
	Arabic	1st	=	29.08.2001	23	2012	176		21.09.2012	31.10.2012	
		2nd	=	NA	NA	2013	182	2	21.09.2012	31.10.2012	
	Social Studies	Both	=	29.08.2001	23	2012	119	1	19.09.2012	06.11.2012	Revised edition
	History	1st	=	02.07.2001	9	2008	95	1	21.09.2012	15.11.2012	
		2nd	=	29.08.2001	23	2012	79	1	21.09.2012	16.11.2012	
	Geography	Both	=	29.08.2001	23	2012	128		22.09.2012	09.11.2012	Third edition
	Mathematics	Both	=	29.08.2001	23	2012	272	1	22.09.2012	13.11.2012	
	Science	1st	=	NA	NA	2012	167	1	19.09.2012	03.11.2012	
		2nd	=	29.08.2001	23	2010	118	4	19.09.2012	03.11.2012	First edition
	English	Both	Course and H W books	NA	NA		272		24.09.2012	17.11.2012	
8th	The Holy Qur'an	both	=	NA	NA	2011	207	1	27.09.2012	14.11.2012	
	Islamic Studies	1st	=	29.08.2001	23	2012	218	6	27.09.2012	28.10.2012	First edition
		2nd	=	29.08.2001	23	2011	171	5	27.09.2012	28.10.2012	

Grade	Subject	Semester	Book Name	Issuing date	Issuing Decree No	Printed for Year	Pages no	Empty pages	Screening date	Review by Researcher	Notes (**Annex I.B)**
	Arabic	1st	=	05.08.2001	18	2008	189	2	27.09.2012	31.10.2012	Second edition
		2nd	=	NA	NA	2013	173	3	28.09.2012	31.10.2012	
	Social Studies	Both	=	29.08.2001	23	2012	128		22.09.2012	06.11.2012	
	History	1st	=	NA	NA	2012	88		26.09.2012	16.11.2012	Third revised edition
		2nd	=	01.09.2003	51	2009	96		26.09.2012	16.11.2012	
	Geography	Both	=	29.08.2001	23	2012	104		26.09.2012	09.11.2012	Third revised edition
	Mathematics	1st	=	29.08.2001	23	2012	160		26.09.2012	13.11.2012	Revised edition
		2nd	=	29.08.2001	23	2012	136		26.09.2012	13.11.2012	
	Science	1st	=	NA	NA	2012	179	5	27.09.2012	04.11.2012	
		2nd	=	NA	NA	2012	112		27.09.2012	04.11.2012	
	English	Both	Course and H W books	NA	NA	2012	190	2	26.11.2012	26.11.2012	
9th	The Holy Qur'an	Both	=	29.08.2001	23	2012	174	2	29.09.2012	14.11.2012	
	Islamic Studies	1st	=	29.08.2001	23	2012	242		28.09.2012	28.10.2012	First edition
		2nd	=	30.12.2001	31	2008	144		28.09.2012	28.10.2012	
	Arabic	1st	=	29.08.2001	23	2011	173		30.09.2012	31.10.2012	
		2nd	=	29.08.2001	23	2009	167	1	30.09.2012	31.10.2012	
	Social Studies	Both	=	29.08.2001	23	2011	126	2	26.10.2012	06.11.2012	
	History	1st	=	NA		2011	112		28.09.2012	16.11.2012	
		2nd	=	01.01.2002		2008	128		28.09.2012	16.11.2012	
	Geography	Both	=	29.08.2001	23	2011	128		24.10.2012	10.11.2012	Third edition
	Mathematics	1st	=	29.08.2001	23	2012	160		29.09.2012	13.11.2012	
		2nd	=	NA	NA	2010	141	3	29.09.2012	13.11.2012	
	Science	1st	=	01.08.2001	17	2009	167	1	29.09.2012	04.11.2012	Third edition
		2nd	=	01.08.2001	17	2010	151	1	29.09.2012	04.11.2012	Third edition
	English	Both	Course and H W books	NA	NA		213	1	26.10.2012	17.11.2012	
10th	The Holy Qur'an	1st	=	01.09.2002	41	2012	119		14.11.2012	14.11.2012	Electronic Book
		2nd	=	25.12.2002	45	2008	88		10.10.2012	14.11.2012	
	Islamic Studies	1st	Iman Part	01.09.2002	41	2005	48		21.11.2012	21.11.2012	
		2nd		08.01.2003	46	2009	48		05.10.2012	28.10.2012	
		Both	Fiqh (jurisprudence) and Hadeeth	NA	NA	2012	176		05.10.2012	28.10.2012	
		1st	Prophet Biography	01.09.2002	41	2012	48		21.11.2012	21.11.2012	Electronic Book
		2nd		01.09.2002	41	2005	48		10.10.2012	28.10.2012	
	Arabic	1st	Reading			2013	48		04.10.2012	31.10.2012	
		2nd		25.12.2002		2008	56		10.10.2012	31.10.2012	

Grade	Subject	Semester	Book Name	Issuing date	Issuing Decree No	Printed for Year	Pages no	Empty pages	Screening date	Review by Researcher	Notes (**Annex I.B)**
		1st	Grammar			2012	81	7	04.10.2012	31.10.2012	
		2nd		01.01.2002		2004	72		10.10.2012	31.10.2012	
		1st	Literature	29.08.2001	23	2012	142	2	04.10.2012	31.10.2012	
		2nd		29.08.2001	23	2013	110	2	10.10.2012	31.10.2012	
	Social Studies	Both	Yemen Society	29.08.2001	23	2013	62	2	02.10.2012	07.11.2012	
	History	1st	=			2009	104		04.10.2012	16.11.2012	
		2nd	=	29.08.2001	23	2012	80		10.10.2012	16.11.2012	
	Geography	1st		01.09.2002	41	2009	80		10.10.2012	11.11.2012	
		2nd		25.12.2002	45	2008	96		10.10.2012	11.11.2012	
	Mathematics	1st	=	11.07.2000	596	2013	124	2	05.10.2012	13.11.2012	
		2nd	=	29.08.2001	23	2012	142	2	10.10.2012	13.11.2012	
	Biology	Both	=	01.01.2002		2005	204	4	10.10.2012	04.11.2012	
	Chemistry	Both	=	01.01.2002		2012	184		15.11.2012	15.11.2012	Electronic Book
	Physics		=	11.07.2000	596	2013	204	4	04.10.2012	04.11.2012	
	English		Course and H W books			2013	169	2	26.10.2012	17.11.2012	
11th, Science & Art	The Holy Qur'an	1st	=	29.08.2001	23	2012	119	1	13.10.2012	14.11.2012	
		2nd	=	01.01.2003	42	2012	88		15.10.2012	14.11.2012	Electronic Book
	Islamic Studies	Both	Iman Part	11.07.2000	596	2013	54	2	06.10.2012	28.10.2012	
		1st	Fiqh (jurisprudence) and Hadeeth	29.08.2001	23	2012	93	3	06.10.2012	28.10.2012	
		2nd				2009	109	3	11.10.2012	28.10.2012	
		1st	Prophet Biography	24.08.2003	50	2009	48		11.10.2012	28.10.2012	
		2nd		24.08.2003	50	2009	64		11.10.2012	28.10.2012	
	Arabic	1st	Reading part	11.07.2000	596	2013	56		06.10.2012	02.11.2012	
		2nd		01.01.2003	42	2012	56		15.10.2012	02.11.2012	Electronic Book
		1st	Grammar part	11.07.2000	596	2013	117	3	06.10.2012	02.11.2012	
		2nd		01.01.2003	42	2009	111	1	13.10.2012	02.11.2012	
		1st	Literature part	01.09.2003	51	2009	128	1	13.10.2012	02.11.2012	
		2nd		29.08.2001	23	2011	136		13.10.2012	02.11.2012	
	English	Both	Course book			2012	57	1	05.10.2012	17.11.2012	
11th-Science	Mathematics	1st	=			2011	176		05.10.2012	13.11.2012	
		2nd	=	04.06.2003	48	2009	166	2	13.10.2012	13.11.2012	
		Both	Exercises Book	29.08.2001	23	2011	86	2	13.10.2012	13.11.2012	
	Biology	Both	=	01.01.2002		2005	176		06.10.2012	05.11.2012	
	Chemistry	Both	=	29.08.2001	23	2012	192		06.10.2012	15.11.2012	
	Physics		=	29.08.2001	23	2012	72		13.10.2012	04.11.2012	
11th-	Mathematics	Both	Statistics	04.06.2003	48	2012	101		17.10.2012	13.11.2012	Electronic Book

Grade	Subject	Semester	Book Name	Issuing date	Issuing Decree No	Printed for Year	Pages no	Empty pages	Screening date	Review by Researcher	Notes (**Annex I.B)**
Art		Both	Exercises Book	04.06.2003	48	2012	31		17.10.2012	13.11.2012	Electronic Book
	Sociology Science	Both		01.01.2003		2012	76		17.10.2012	17.11.2012	Electronic Book
	History	1st	=	01.09.2003	51	2012	104		16.10.2012	17.11.2012	Electronic Book
		2nd	=	01.09.2003	51	2012	120		17.10.2012	17.11.2012	Electronic Book
	Geography	1st	=	01.09.2003	51	2012	104		21.10.2012	11.11.2012	Electronic Book
		2nd	=	01.09.2003	51	2012	96		14.10.2012	12.11.2012	Electronic Book
	Principle of Economy	Both		01.09.2003	51	2012	70		14.10.2012	17.11.2012	Electronic Book
12th, Science & Art	The Holy Qur'an	1st	=	11.07.2000	596	2013	192		13.10.2012	14.11.2012	
	Islamic Studies	Both	Iman Part	08.09.2004	4	2007	77	3	07.10.2012	28.10.2012	
		Both	Fiqh (jurisprudence) and Hadeeth	11.09.2004	5	2011	184		07.10.2012	28.10.2012	
		Both	Prophet Biography	11.09.2004	5	2009	77	3	07.10.2012	28.10.2012	First edition
	Arabic	Both	Reading part			2010	103	1	08.10.2012	02.11.2012	
		Both	Grammar part	29.08.2001	23	2011	206	2	08.10.2012	02.11.2012	
		Both	Literature part	08.09.2004	4	2009	215	1	07.10.2012	02.11.2012	First edition
	English	Both	Course book			2006	74	1	07.10.2012	17.11.2012	
	Mathematics	Both	=	29.08.2001	23	2011	256		07.10.2012	13.11.2012	
		Both	Exercises Book	29.08.2001	23	2011	78		07.10.2012	13.11.2012	
	Biology	Both	=			2013	224		13.10.2012	05.11.2012	
	Chemistry	Both	=	29.08.2001	23	2012	182	2	06.10.2012	15.11.2012	
	Physics		=	12.05.2004	1	2013	216		18.10.2012	04.11.2012	
12th, Art	Mathematics	Both	Statistics	19.05.2004	2	2012	64		17.10.2012	13.11.2012	Electronic Book
		Both	Exercises Book	19.05.2004	2	2012	24		17.10.2012	13.11.2012	Electronic Book
	History	Both		11.09.2004	5	2012	190		17.10.2012	17.11.2012	Electronic Book
	Geography	Both	Principle of Cartography	07.09.2004	3	2012	72		17.10.2012	12.11.2012	Electronic Book
	Psychology	Both		01.01.2004		2012	76		17.10.2012	12.11.2012	Electronic Book
	Principle of Philosophy	Both		07.09.2004	3	2012	106		17.10.2012	21.11.2012	Electronic Book
	Logic	Both		07.09.2004	3	2012	110		17.10.2012	17.11.2012	Electronic Book

Annex 2. A, B, C, D…..L: Water Concept Maps

Annex. 2. A: Water Concepts MAP of Social Studies Subject: Vertical Sequence, and cognitive and experiential depth

10th	Experience Depth				E	E		E,R	E	E	E			E		E			E,R		E		E								
	Representation				Kn	Kn		Kn	Kn	Kn	Kn			Kn		Kn			Kn		Kn		Kn								
	Delivery				35	34		33	33	X, 34	X, 34			29		28			28-29		29		55								
9th	Experience Depth											E														E,R					
	Representation											kn														Kn, Sk					
	Delivery											Co														93					
8th	Experience Depth											E			E								E	E		E					
	Representation											kn			Kn								Kn	Kn		Kn					
	Delivery											Co			120								112	80		100					
7th	Experience Depth											E		E												E,R					
	Representation											kn		Kn												Kn, Va					
	Delivery											Co		54												75,76,90					
6th	Experience Depth		E	E									E			E,R, G										E					
	Representation		kn	Kn									Kn			Kn, Sk										Kn					
	Delivery		**80**	X, 73,74									75			III (80/ 3/4/ 7)										92					
5th	Experience Depth																									E					
	Representation																									Va					
	Delivery																									45					
4th	Experience Depth		E,R				E,R					E			E	E										E,R, G,A					
	Representation		Kn				Kn, Sk					Va			Kn	Kn										Sk, Va, Pa, att					
	Delivery		13,15				61					II, 13, 18			31	39										62					
3rd	Experience Depth	E														E	E,R														
	Representation	Kn														Kn, Sk	Kn, Sk, pa														
	Delivery	72														II, 22, 60-61	61-62														
Water Identified Concepts		Hydrosphere	Water Resources	water in environment	water resources	dams	Drinking and sanitation	Irrigation	Rained agriculture	Food Security	Agriculture expansion	water importance	increasing the demand	water abuse	water for Qat	Water pollution	Wastewater	Water Depletion		Laws	Awareness	participation	Drinking and sanitation	Conservation	water property								
Water Main Principles		**Water characteristics**					**Water Importance**						**Influences**			**Water Problems**			**W Management**							**Sustainability**						

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2. B: Water Concepts MAP of Geography Subject: Vertical Sequence, and cognitive and experiential depth

10th	Experience Depth				E	E		E,R	E	E	E			E		E		E,R		E		E											
	Representation				Kn	Kn		Kn	Kn	Kn	Kn			Kn		Kn		Kn		Kn		Kn											
	Delivery				35	34		33	33	X, 34	X, 34			29		28		28-29		29		55											
9th	Experience Depth											E												E,R									
	Representation											kn												Kn, Sk									
	Delivery											Co												93									
8th	Experience Depth											E			E							E	E		E								
	Representation											kn			Kn							Kn	Kn		Kn								
	Delivery											Co			120							112	80		100								
7th	Experience Depth											E		E										E,R									
	Representation											kn		Kn										Kn, Va									
	Delivery											Co		54										75,76,90									
6th	Experience Depth			E	E											E,R, G		E															
	Representation			Kn												Kn, Sk																	
	Delivery			80												III (80/3/4/7)																	
5th	Experience Depth																							E									
	Representation																							Va									
	Delivery																							45									
4th	Experience Depth		E,R				E,R					E			E	E								E,R, G,A									
	Representation		Kn				Kn, Sk					Va			Kn	Kn								Sk, Va, Pa, att									
	Delivery		13,15				61					II, 13, 18			31	39								62									
3rd	Experience Depth	E														E	E,R																
	Representation	Kn														Kn, Sk	Kn, Sk, pa																
	Delivery	72														II, 22, 60-61	61-62																
Water Identified Concepts		Hydrosphere	Water Resources	water in environment	water resources	dams	Drinking and sanitation	Irrigation	Rained agriculture	Food Security	Agriculture expansion	water importance	increasing the demand	water abuse	water for Qat	Water pollution	Wastewater	Water Depletion		Laws	Awareness	participation	Drinking and sanitation	Conservation	water property										
Water Main Principles		**Water characteristics**					**Water Importance**						**Influences**			**Water Problems**			**W Management**						**Sustainability**									

10th	Experience Depth				E	E		E,R	E	E	E			E		E		E,R		E		E											
	Representation				Kn	Kn		Kn	Kn	Kn	Kn			Kn		Kn		Kn		Kn		Kn											
	Delivery				35	34		33	33	X, 34	X, 34			29		28		28-29		29		55											
9th	Experience Depth											E												E,R									
	Representation											kn												Kn, Sk									
	Delivery											Co												93									
8th	Experience Depth											E			E							E	E		E								
	Representation											kn			Kn							Kn	Kn		Kn								
	Delivery											Co			120							112	80		100								
7th	Experience Depth											E		E										E,R									
	Representation											kn		Kn										Kn, Va									
	Delivery											Co		54										75,76,90									
6th	Experience Depth			E	E											E,R, G		E															
	Representation			Kn												Kn, Sk																	
	Delivery			80												III (80/3/4/7)																	
5th	Experience Depth																							E									
	Representation																							Va									
	Delivery																							45									
4th	Experience Depth		E,R				E,R					E			E	E								E,R, G,A									
	Representation		Kn				Kn, Sk					Va			Kn	Kn								Sk, Va, Pa, att									
	Delivery		13,15				61					II, 13, 18			31	39								62									
3rd	Experience Depth	E														E	E,R																
	Representation	Kn														Kn, Sk	Kn, Sk, pa																
	Delivery	72														II, 22, 60-61	61-62																
Water Identified Concepts		Hydrosphere	Water Resources	water in environment	water resources	dams	Drinking and sanitation	Irrigation	Rained agriculture	Food Security	Agriculture expansion	water importance	increasing the demand	water abuse	water for Qat	Water pollution	Wastewater	Water Depletion		Laws	Awareness	participation	Drinking and sanitation	Conservation	water property										
Water Main Principles		**Water characteristics**					**Water Importance**						**Influences**			**Water Problems**			**W Management**						**Sustainability**									

Annex. 2. C: Water Concepts MAP of History Subject: Vertical Sequence, and cognitive and experiential depth

12	Experience Depth																												
	Representation																												
	Delivery																												
11th	Experience Depth								E		E												E,R						
	Representation								Kn		Kn												Kn						
	Delivery								Iv 14, 30 67, *28, 67*		II 14, 31												II, 37, 51						
10th	Experience Depth		E	E	E							E			E				E					E	E			
	Representation		Kn	Kn	Kn							Kn			Kn				Kn					Kn	Kn			
	Delivery		**32-35**	*10,24*	II, 41, *11*							*56, 66*			26				25					39	40			
9th	Experience Depth																												
	Representation																												
	Delivery																												
8th	Experience Depth		E										E										E						
	Representation		Kn										Va										Kn						
	Delivery		***8***										*Co*										*9*						
7th	Experience Depth	E	E,R						E				E						E	E,R									
	Representation	Kn	Kn						Kn				Kn						Kn	Sk									
	Delivery	II 21, 54	II, 22-23, 28-29						II, 44, 63				*10, 34, 41, 57*						35	77									
6th	Experience Depth										E																		
	Representation										Kn																		
	Delivery										104																		
5th	Experience Depth								E	E,R																			
	Representation								Kn	Kn																			
	Delivery								II, 09, (20, 23,28)	32-33																			
Water Concepts		W abandunce in Yemen	W resources, arab	W availability international	Dams, canals construction				Dams for irrigation	Water for irrigation	Drinking water supply	irrigation sources	water importance		Dams neglection			climate change	water conflect			Irrigation management	water harvesting	Participation					
Water Main Principles		**Water characteristics, in nature**						**Water importance and human dependence**						**Human influence**			**Water problems and issues**			**Water resources management**				**Sustainability**					

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2. D: Water Concepts MAP of Science Subject: Vertical Sequence, and cognitive and experiential depth

9th	Experience Depth				E,R,G,A	E,R, G,A			E									E,R							
	Representation				Sk, Kn	Kn, Sk			Kn									Kn							
	Delivery				VII (13,20,46,69), *(53-73,84-85, 92)*	65-68			X, *108, 114*									*28*							
8th	Experience Depth			E,R	E,R,G								E						E						
	Representation			Sk	Kn, Sk								Kn, Va						Kn						
	Delivery			*81-83*	II (123-126, *11*)								III (153, Co)						161						
7th	Experience Depth				E,R,G,A						E,R		E												
	Representation				Sk						Kn, Sk		Va												
	Delivery				IIV (10, 50-52, 99,120) *(11-12, 68)*						55-56		II (cover)												
6th	Experience Depth											E		E											
	Representation											Sk		Va											
	Delivery											*70-71*		*160*											
5th	Experience Depth		E,R	E,R	E,R	E,R	E,R						E,R, G			=	E,R			E,R		E,R			
	Representation		Sk	Kn, Sk	Sk	Sk	Sk						Kn, Sk, Va			Sk	Kn, Sk			Kn, Sk		Va, Kn			
	Delivery		*II (78-79, 84)*	II 113-115, (X-125)	*3,5*	*71*	*70*						111-113			115	117-120			122 -123		121 -122			
4th	Experience Depth		E		E,R, G,A				E, R																
	Representation		Kn		Sk				Kn, Sk																
	Delivery		*150*		***IV (12,33, 58,64)***				II (111 -X), 132																
3th	Experience Depth	E	E	E,R	E,R																	E			
	Representation	Kn	Va	Sk	Sk																	Sk			
	Delivery	75	74	80-81	76-79																	80			
2nd	Experience Depth		E					E	E,R																
	Representation		Kn					Kn	Kn, Sk																
	Delivery		78					78	44																
1st	Experience Depth							=	E	R	E,R		R	E								E,R			
	Representation							Kn	Kn	Kn	Kn, Sk		Va, Kn	Kn								att			
	Delivery							X, 83	71	95	II (83/4, 91/2)		87, 94	78								97, 100			
Water Concepts		Marib Dam	Rainfall, spate	W Resources, cycle	Water prosperities	Fug, Dew, acidic rain	Humidity	Domestic	Irrigation	Water Uses	Drinking water services	energy production	W importance, gift …	Abuse		Water losses	Water pollution	GW Depletion	Water for Qat	Drinking W Treatment	Close the tap	Water conservation		
Water Main Principles		**Water characteristics**						**Water Importance**						**Influences**		**Water Problems**				**W Management**			**Sustainability**		

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .E: Water Concepts MAP of Biology Subject: Vertical Sequence, and cognitive and experiential depth

9th	Experience Depth				E,R,G,A	E,R, G,A			E								E,R						
	Representation				Sk, Kn	Kn, Sk			Kn								Kn						
	Delivery				VII (13,20,46,69), *(53-73,84-85, 92)*	65-68			X, *108, 114*								*28*						
8th	Experience Depth			E,R	E,R,G								E						E				
	Representation			Sk	Kn, Sk								Kn, Va						Kn				
	Delivery			*81-83*	II (123-126, *11*)								III (153, Co)						161				
7th	Experience Depth				E,R,G,A						E,R		E										
	Representation				Sk						Kn, Sk		Va										
	Delivery				IIV (10, 50-52, 99,120) *(11-12, 68)*						55-56		II (cover)										
6th	Experience Depth											E		E									
	Representation											Sk		Va									
	Delivery											*70-71*		*160*									
5th	Experience Depth		E,R	E,R	E,R	E,R	E,R						E,R, G			=	E,R			E,R		E,R		
	Representation		Sk	Kn, Sk	Sk	Sk	Sk						Kn, Sk, Va			Sk	Kn, Sk			Kn, Sk		Va, Kn		
	Delivery		*II (78-79, 84)*	II 113-115, (X-125)	*3,5*	*71*	*70*						111-113			115	117-120			122-123		121-122		
4th	Experience Depth		E		E,R, G,A				E, R														
	Representation		Kn		Sk				Kn, Sk														
	Delivery		*150*		*IV (12,33, 58,64)*				II (111-X), 132														
3th	Experience Depth	E	E	E,R	E,R																	E	
	Representation	Kn	Va	Sk	Sk																	Sk	
	Delivery	75	74	80-81	76-79																	80	
2nd	Experience Depth		E					E	E,R														
	Representation		Kn					Kn	Kn, Sk														
	Delivery		78					78	44														
1st	Experience Depth							=	E	R	E,R		R	E								E,R	
	Representation							Kn	Kn	Kn	Kn, Sk		Va, Kn	Kn								att	
	Delivery							X, 83	71	95	II (83/4, 91/2)		87, 94	78								97, 100	
Water Concepts		Marib Dam	Rainfall, spate	W Resources, cycle	Water prosperities	Fug, Dew, acidic rain	Humidity	Domestic	Irrigation	Water Uses	Drinking water services	energy production	W importance, gift…	Abuse		Water losses	Water pollution	GW Depletion	Water for Qat	Drinking W Treatment	Close the tap	Water conservation		
Water Main Principles		**Water characteristics**						**Water Importance**						**Influences**		**Water Problems**				**W Management**			**Sustainability**	

Map Legend

Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .F: Water Concepts MAP of Chemistry Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth	E										E				E,R	E,R				E			
	Representation	Kn, Sk										Kn				Kn	Kn				Kn			
	Delivery	30										**83**				II, 148, 172 -173	170				175, 176			
11th	Experience Depth			E	E,R														E					
	Representation			Kn	Kn														Kn					
	Delivery			95	112-123														58					
10th	Experience Depth																							
	Representation																							
	Delivery																							
Water Concepts		water states	Desalination	Water Cycle	Aqueous solutions											Water pollution	Acidic rain		Drinking water disinfection		Wastwater Treatment			
Water Main Principles		Water existence, characteristics, interlinkage with other elements in the nature						Water importance and human			Human influence (positive and negative impacts)				Water problems and issues related to human impact			Water resources management				Reaching water sustainabili		

Map Legend

Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .G: Water Concepts MAP of Physics Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth						A	E,R									A				
	Representation						Kn	Kn									Kn				
	Delivery						194	187									194				
11th	Experience Depth																				
	Representation																				
	Delivery																				
10th	Experience Depth		E,R,G	E,R																	
	Representation		Kn, Pa	Kn, Sk																	
	Delivery		64-65	73-76																	
Water Concepts			water states	Water prosperities (Physical, chemical… etc.)			Domestic (warming)	energy production									Desalination				
Water Main Principles		**Water characteristics, in nature**					**Water importance**			**Human influence**				**Water problems**			**Water management**			**W sustainability**	

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .H: Water Concepts MAP of Arabic Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth		E										E						E											
	Representation		Kn										Va						Kn											
	Delivery		19										7						22											
11th	Experience Depth								E				E					E												
	Representation								Kn				Kn					Kn												
	Delivery								X, 62				III, 33, 57, 62					51												
10th	Experience Depth			E									E					E												
	Representation			Kn									Kn					Kn												
	Delivery			8									20					21												
9th	Experience Depth			E			E						E	E																
	Representation			Kn			Kn						Kn	Kn																
	Delivery			II, 95, 119			128						II, Co, Co	98																
8th	Experience Depth		E							E	E		E	R				E	E,R			E			E,R		E,R, G.A			
	Representation		Kn							Kn	Kn		Va	Kn				Kn	Kn			Kn			Kn		Kn, Va			
	Delivery		38-39, 68							X, 100, 88-89	120		II, Co, Co	74				129	39			90			39-40		40			
7th	Experience Depth		E		E					E,R	E		E					E												
	Representation		Kn		Kn					Kn	Kn		Kn, Va					Kn												
	Delivery		148		149					X, 88-91	141		II, Co, Co					141												
6th	Experience Depth		E				G						E	R,G, A			E	E				R					E,R			
	Representation		Kn				Kn						Va, Kn	Va, att			Kn, Va	Kn				R					Kn			
	Delivery		73				53						III, 50-52, 74, 38-39	II, 47, 50-51			39	200				40					39-40			
5th	Experience Depth	E	E		E,R		R						E				E,R		E,R		E,R	E,R	R	R,G	E			E,R	E,R	
	Representation	Kn	Sk, Kn		Sk		Sk						Kn				Kn		Kn		Kn	Kn	Kn	Sk, att	Kn			Kn	Sk-att, Va	
	Delivery	126, 127	II, 139, 217		II 140, 58		141						128				128		128		126	129	II, X, 129, 67	136	58-59			129	II, 163, 142	
4th	Experience Depth		E		R				E	E	E		E	E, R																
	Representation		Kn		Sk				Sk	Kn	Kn		Kn	Kn																
	Delivery		86		203				X II, 171-175, 73-74	X, 100	II, 86, 21		86	IIII 86, 171-175, 26, 70																
3rd	Experience Depth												E	E	E				E	E,R	E									
	Representation												Kn	Va	Kn				Kn	Kn	Kn									
	Delivery												47, 49	49	X, 39				106	94-95	105-110									
2nd	Experience Depth		E					E,R	E	E																				
	Representation		Kn, Sk					Kn, Sk	Kn	Kn																				
	Delivery		III, 46-50, 51, 61					74-75, 78	X, 53-58	X, 37-40																				
1st	Experience Depth	E		E				E				E																		
	Representation	Kn		Kn				Kn				Kn																		
	Delivery	130		(28, 65, 142)				142				48-50																		
Water Concepts		The sea	Rainfall, spates	W resources, cycle	Dams	Rivers	GW	Sea Use	Irrigation	Food security	Drinking water	Domestic Use	importance	Abuse	Pesticides		Water shortage	Water pollution	GW Depletion	Flood, its impacts	W Harvesting	Dams	Wells Drilling	Close the tap	Aden Cisterns	coordination, capacities	Water conservation		Participation	Sharing water	
Water Main Principles		Water characteristics, in nature						Water Importance						Influences			Water Problems				Water Management							Sustainability		

Map Legend

Concept Record		Concepts delivery as:		Concepts Misalignment		Representation Form		Experiential Depth
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .I: Water Concepts MAP of Holy Qur'an Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth Representation Delivery																	
11th	Experience Depth Representation Delivery																	
10th	Experience Depth Representation Delivery	E Kn II 40,44, *46*	E kn *9, 11*															
9th	Experience Depth Representation Delivery					E Kn 38, 40	E Kn III, 16/8, 118,120, Co											
8th	Experience Depth Representation Delivery						E Va Co											
7th	Experience Depth Representation Delivery						E Kn, Va II, 15, Co											
6th	Experience Depth Representation Delivery						E,R Va, Sk 24, 25											
5th	Experience Depth Representation Delivery	E Va 118						E Va Co										
4th	Meaningfulness Representation Delivery																	
3rd	Experience Representation Delivery																	
2nd	Experience Depth Representation Delivery																	
1st	Experience Depth Representation Delivery																	
Water Concepts		Rainfall	water resources			Seas Navigation	Water importance	water abuse										
Water Main Principles		**Water characteristics, in nature**			**Water importance**			**Human influence**			**Water problems**			**Water management**			**W sustainability**	

Map Legend								
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .J: Water Concepts MAP of Islamic Education Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth																		
	Representation																		
	Delivery																		
11th	Experience Depth		E	E	E				E										
	Representation		Kn	Kn	Kn				Kn, Va										
	Delivery		40-41	42-43	53				45										
10th	Experience Depth						E	E											
	Representation						Kn	Kn											
	Delivery						17, 23	131											
9th	Experience Depth						E												
	Representation						Kn												
	Delivery						II, Co, Co												
8th	Experience Depth		E,R				E												
	Representation		Kn				Va												
	Delivery		*17-18*				II, Co, *17, Co*												
7th	Experience Depth	E	E	E		E	E			E,R, G		E		E,R, G	E,R		E		
	Representation	Kn	Kn	Kn		Kn	Va, Kn			Kn, Va		Kn		Va	Va		Kn		
	Delivery	77-78	47	48		179 -180	III, 77, Co, *Co*			99-102		101		81	80		101		
6th	Experience Depth									E				E,R, G					
	Representation									Kn				Va					
	Delivery									Co				36-38					
5th	Experience Depth																		
	Representation																		
	Delivery																		
4th	Experience Depth	E					E			E									
	Representation	Kn					Kn			Kn									
	Delivery	33-35					33			101									
3rd	Experience Depth						E			E				E					
	Representation						Kn			Kn				Va					
	Delivery						115, 117			120, 123				118					
2nd	Experience Depth							R		E									
	Representation							Att		Va									
	Delivery							X, 26		36									
1st	Experience Depth	E					E			E				E					
	Representation	Kn					Va			Va, Kn				Va					
	Delivery	77-80					79			III, 38,39, 79 111				*32*					
Water Concepts		Water Puerity	W cycle, resources	Hydrosphere	rivers proerity	Zam Zam well	importance	Irrigation	Drinking supply	W Abuse		Depletion, scarcity		conservation	Values		Awareness		
Water Main Principles		**Water characteristics, in nature**					**Water importance**			**Human influence**		**Water problems**		**Water resources management**				**W sustainability**	

Map Legend

Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .K: Water Concepts MAP of Mathematics Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth																					
	Representation																					
	Delivery																					
11th	Experience Depth						R								R							
	Representation						Sk								Sk							
	Delivery						III, Sc 99, *Ex 24, 27*								Sc, 82							
10th	Experience Depth					R		E				E										
	Representation					kn		kn				kn										
	Delivery					9		18				25										
9th	Experience Depth								R			E										
	Representation								Sk			kn										
	Delivery								*139*			II, Co										
8th	Experience Depth											E										
	Representation											kn										
	Delivery											II, Co										
7th	Experience Depth				R							E										
	Representation				Sk							kn										
	Delivery				268							Co										
6th	Experience Depth	E	E	R						E	R									R		
	Representation	Sk	Kn	Sk						Kn	Sk									Sk		
	Delivery	141	14	166						X, 141	153									158		
5th	Experience Depth	E	E	E					E, R									R				
	Representation	Kn	Sk	Kn					Sk									Sk				
	Delivery	5	20	35					II 15, 80									II, 50, 65				
4th	Experience Depth								R													
	Representation								Sk													
	Delivery								III 84,88, 114													
3rd	Experience Depth																					
	Representation																					
	Delivery																					
2nd	Experience Depth																					
	Representation																					
	Delivery																					
1st	Experience Depth																					
	Representation																					
	Delivery																					
Water Concepts		Rivers	Hydrosepher	Oceans	Rainfall	Marib Dam	Storage measurment	irrigation	Water D. consumption	Food security	virtual water	water importance			water leakage			Water save	Water Bill pay			
Water Main Principles		**Water characteristics, in nature**						**Water importance and human dependence**					**Human influences**		**Water problems**			**Water management**			**W sustainability**	

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annex. 2 .L: Water Concepts MAP of English Subject: Vertical Sequence, and cognitive and experiential depth

12th	Experience Depth		E			E,R, G,A	E																	
	Representation		Kn			Kn, Sk	Kn																	
	Delivery		13			30	66																	
11th	Experience Depth	E		E	E					E						E	E							
	Representation	Kn		Kn	Kn					Kn						Kn	Kn							
	Delivery	67		36	62					69						36	71							
10th	Experience Depth																							
	Representation																							
	Delivery																							
9th	Experience Depth																							
	Representation																							
	Delivery																							
8th	Experience Depth																							
	Representation																							
	Delivery																							
7th	Experience Depth								E															
	Representation								Kn															
	Delivery								II, 29, 40, *65*															
Water Concepts		Arid zones	Floods, draughts	GW Infiltration	Rivers	water pressure	water states and cycle		Domestic Use	Energy production						GW depletion	Climate change							
Water Main Principles		**Water characteristics, in nature**						**Water importance and human dependence**				**Human influence**			**Water problems and issues**			**Water resources management**			**Water sustainability**			

Map Legend							
Concept Record		**Concepts delivery as:**		**Concepts Misalignment**		**Representation Form**		**Experiential Depth**
I,II,III	Times of frequency		Core to topic		Adverse	Kn	Knowledge	E: Experience
Numbers	Pages numbers		Complementary concept		Mis-conceptualization	Sk	Skill	R: Reflection
Italic Numbers	Concept is in second semester book		Add-on to topic		Advance	Va	Value	G: Generalization
						Pa	Participation	A: Application
						Att	Attitude	

Annexes 3 A, B, C, D……..K: Detailed Description of the Identified Water Concepts

Annex. 3. A: Water Concepts in the Social Studies Subject in grades 03-10

(Annex. 3.A) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic , Page	Unit
Grade 3rd							
Healthy House	A drawing for two boys cleaning a water tank. It is sub texted as "in our home we avoid the pollution of …..''. the student is supposed to complete the answer as" the pollution of water"	Soc.03.01.22	Water pollution	The visualization is good. However, it is too early to introduce the term of Pollution	Hence, it is better and easier to replace it by " we always keep our drinking water tank clean"	My Home. 22	Student Family. 01
Environmental problem	It is introduced that we drink the clean water that avoid us ……. And we don't drink the non-clean water that will cause us ……. Then it is referred to boil the uncertain water in term of its cleanness. Then some diseases are mentioned as result of the water pollution.	Soc.03.02.60-61	Water Pollution and Risks	Well presentation	A photo of flood irrigation is used to support the discourse of not to drink the polluted water (photo of miss selection).	Environmental problems in our nighborehood.60-61	Student School.02
water pollution	After that, the wastewater term is defined as the process of draining the polluted water that avoids us the risks. It is added that it is the water that is already used at houses	Soc.03.03.61-62	Wastewater	The purpose of the activity is to have visit to wastewater project if possible, for students and teacher. Otherwise to ask students to collect photos for wastewater and water treatment projects	It seems a bit advanced to introduce the difference between the terms of untreated wastewater drained on streets and the wastewater network. The same is with mentioning the illnesses names such as kidney stones. 2. The proposed activity is non-applicable at least for the majority in rural areas. Furthermore, what is the benefit of collecting photos!		
The earth and the sun	The land area is smaller than the water area	Soc.03.04.72	hydrosphere		1. No visualization. 2. Mere presentation	The Earth and the Sun.72	Phenomena around us.4
Grade 4th							
Water resources	it is introduced that water is one grace of Allah's non-countable graces that cannot be neglected by any living being. Allah says: From water we made every living thing	Soc.04.01.13	Water is gift		It is not reflected, so what should be done?	Climate, Water and Soil. 13	My country (its land and population). 01
Climate, Water and Soil	It is inquired from where the water comes to us? What are the water resources in Yemen? Then it is directly answered there are three water resources in Yemen: rainfall, GW and surface water. It is added that the rainfall is the main water source supplying the GW and the surface water resources. The activity, asks that each student write three lines about the water resources in his/her region. As thinking card: two Qs are posted: 1. What is the water importance in our life? 2. How could it be conserved?	Soc.04.02.13,15	Water resources		1. It is not visualized. 2. Thinking cards are kind of standalone concepts. Hence, it is not sure whether students response to their contents or not.	Climate, Water and Soil.13,15	My country (its land and population). 01
Population Concentration Causes	Water availability is mentioned as one main causes for population concentration	Soc.04.03.18	water importance		Mere	My country population. 18	My country (its land and population). 01

(Annex. 3.A) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic , Page	Unit
Agriculture constrains	The whole lesson is introducing the agriculture, crops…etc. in Yemen. Then constrains facing agriculture are posted. Water shortage in some regions and consuming huge water quantities for qat agriculture are mentioned.	Soc.04.04.31	Water for qat	1. In fact, almost all Yemeni basins have either critical situations or on their way to have critical water crises unlike what it is mentioned that only some regions have water shortage. On the other hand, agriculture expansion is the main driver behind reaching such water crises which is not introduced as constrain of agriculture. 2. Cash crop is introduced in non-appropriate way. It is mentioned that they are crops cultivated on the purpose to be exported abroad for foreign currencies	1. Instead of encouraging students on agriculture, it is more credible and practical to encourage them on how to save water in agriculture even by Qat as crop. 2. Cash crop need to be redefined correctly and linked to the less intensive water consumption crops principle. 3. One of the unite objectives is stated as student are expected to appreciate the rationalizing the water consumption. However, the contents do not meet this objective	Agricultural resources. 31	My country resources. 02
Seas Pollution	Seas pollution is introduced as the existence of the harmful materials in sea water like: 1. Oil leakages. 2. Factories wastes thrown into seas. 3. Waste water (the polluted water). That pollution threats the aquatic beings life and exposes them to death. Hence, the state has paid attention to protect the Yemeni beaches against pollution	Soc.04.05.39	Water Pollution	Well presentation. The activity asks to write four lines about the seas pollution ant its risk on aquatic beings and then to read it in the class	1. poor visualization. 2. Student might repeat the given information of the lesson to meet the requested writing activity. In this case, the activity is useless	Sea resources.39	My country resources. 02
Water Services	The concept is introduced through some inquiries such as from where do we get the clean drinking water? What is the right method to drain the water consumption wastes? Can you mention examples of the state services in the field of water? Then it start to present that the state constructs dams and tanks and drills wells to provide clean drinking water to citizens. People contribute also in specific water projects proposing to invest in this field. The state also installs the sewers and constructs wastewater treatment plants to conserve the environment and eliminate diseases. People who did not covered by sewers services yet, dig cesspits to drain the used water while the others drain it to the spates wadies.	Soc.04.06.61	Drinking water and sanitation services	1. Generally, it is in-depth presented. 2. Three photos of a dam, water tank and WWT plant are presented. 3. Dams are mentioned as the first drinking water supply which is not true at all. All dams were constructed mainly for irrigation and sometimes for GW recharge purposes. 4. It is noticed that this unite aims in one hand to introduce the governmental ministries, their efforts and affiliated corporations that provide the services as it is done within the preceding lessons of education and health. Nevertheless, neither the MWE nor its local corporations have been introduced. 5. As thinking card, students are asked to think about the impacts of non-covering the waste water or their draining to wadis where seasonal spates flow	1. It is odd to have dams presented as the first drinking water source in Yemen. So, it must be removed. 2. The photo of the dam is extra while the one for the water tank is useless since it presents a wall of concrete. The third one of the WWTP has bad resolution and hardly can be seen. 3. The presented private contribution is not clear. It would be better to clarify that they participate in providing the drinking water either through private networks or water mobile tankers. 4. The importance of having WWT is presented yet the importance of having access to safe and enough drinking water is absent. 5. It is not indicated that cesspits or drainage to wadies are wrong methods and not reflected what kind of risks they cause. 6. What about the impacts of cesspits, it is sided out of the activity. Furthermore, it is not sure whether student will do the proposed thinking card or not. Hence, to have in the form of group discussion in class or with family members and to present it later on might be much more fruitfull	The Water.61	Corporations and Services. 03

(Annex. 3.A) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic , Page	Unit
Water Services	It is started with a verse from the Holy Qur'an "Abusers are considered as brothers of devils". Then it is inquired what does Allah describe the abusers with? What does it lead to when people drill water wells excessively and without state's supervision? What are the best methods to save the water by house uses (cooking, shower...etc)? In a side box, it is stated that water is a gift that we all should conserve and save. We have to take the amount we only need and close water taps tightly after use repairing them once it is required. The proposed activity asks for two things: 1. To write the Holy Qur'an Verse that indicates that every living thing is made from water. 2. To check the house water taps and to participate in repairing the broken-down ones	Soc.04.07.62	water conservation	1. To some extent it is good presentation. 2. It encourages student participation. 3. The wells drilling by people is almost for irrigation purposes however it is presented here as result of water abuse at houses	1. However, it still a kind of mere presentation which mainly dependents on inquiries. 2. No visualization at all. 3. The title of this context should be either modified to indicate the water consumption save in domestic/houses uses only and exclude the wells drilling indication or the contents should be expanded to present the water save by irrigation sector. The first one is more practical to do since the lesson scope is about drinking and sanitation services. 4. If not, the wells drilling should be modified since it presents the role of the state confined to supervise wells drilling which is not appropriate. It would be better to change it to … without getting the needed studies and permission.	The Water.62	Corporations and Services. 03

Annex. 3. B: Water Concepts in Geography Subject in grades 05-12

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
05th Grade							
Types of Maps	The types of maps are divided into natural and human maps. Rainfall and water resources maps are mentioned as examples of the natural maps	Geo.05.01.15	Water Resources		They are only mentioned even without any visualization	Types of Maps.15	Maps main principles.01
Climate and Weather	Weather and Climate are defined. Rainfall is mentioned as a parameter of the climate. Then a table presents the main three topographical zones in Yemen with general description of the temperature and rainfall in the summer and winter	Geo.05.02.33,34	Rainfall	It is said that highlands receives heavy rains in summer. Nonetheless, the annual average of rainfall in highlands is about 250mm	Mis-conceptualization	Climate.33,34	Natural Geography of Yemen. 02
Water resources	A sketch is presented illustrating rainfall, wadis water, spring, well and groundwater layer between a permeable and non-permeable layers. Then it is mentioned that there are many water resources in Yemen such as rainfall, flowing water (springs and spates) and the water existed inside the earth. Rainfall is the main water resource and the water resources can be divided into: 1. surface water: represented by the flowing water like the springs and spates that flow in wadies and stagnated water such as water in dams and lakes. 2. Ground water: it is the water existed inside the earth	Geo.05.03.36-37	Water Resources	The activity asks student two things: 1. to visit one of the water sources in his city/village and write down its type and purposes of use. 2. To collect photos illustration the different water resources, classify them, clip them in the activity notebook and to present them to the teacher.	1. One of a stated objective is expecting students after the lesson to appraise the importance of the water conservation. This objective is not met by the content. The contents does neither refer to the scarcity of water in Yemen nor to any mis-practices harming water. Hence how to expect student to appreciate the water conservation. 2. The illustration figure presents the groundwater as solid big storage which might promote the misperception of GW in Yemen as hug lakes or tanks inside the earth. 3. In Yemen there are no lakes. 4. The second activity is useless due to inability of rural students to collect the proposed photos. 5. As improvement for activities: it would be better to assign them based on spatial existence of students; urban or rural. Then for rural they can be asked to investigate by their father/mother the wells number, how people irrigate their farms at present and how they used to do before drilling wells, and how people get the drinking water in the respective village. For urban students, they might be asked to investigate by their father and mother about the water source at home and in the city, how much they pay in average for a month, is it expensive...etc.	Water resources.36-37	Natural Geography of Yemen. 02
Water Resources	As thinking card tailed to the previous concept, a statement is presented as “Do not abuse the water even you are on a flowing river". Then it is asked, what is your role to save the water consumption?	Geo.05.04.37	Water save		Amputee presentation	Water resources.36-37	Natural Geography of Yemen. 02
Population Increase Impacts	It is mentioned that population increase resulted in many problems one of them is the inadequate services for citizens such as……., clean water,….etc.	Geo.05.05.46	Non-sufficient water services		It needs to be much précised as insufficient drinking water supply and inadequate sanitation services	Population and its growth. 46	Population in Yemen. 03
Agriculture	It is introduced that Yemenis were known since a long way back as good agriculture practitioners due to the availability of water and the fertile soil. Agriculture is presented as the most important economic activity that the state widely supports it via dams’ construction, wells drilling, fertilizers and pesticides providing....etc. Then it is said that agriculture now is concentrated in the areas where the water is available and soil is fertile. The most significant regions are: 1. Coastal plains in wadies of Tehama, Lahj and Abyan ..... etc. The most important crops are banana, mango, cotton...etc. 2. Plains existed in Amran, Dhamar...etc that depends on the	Geo.05.06.57-61	Irrigation sources	1. High encouragement for agriculture. 2. Photos for Banana cultivation are presented twice. A photo of farm uses the flood irrigation and the earthy water channels is presented in the context of showing the agriculture diversity not as wrong practices of irrigation	1. It is repeated that water is much availability in Yemen. 2. Banana and mango that are intensive-water consuming crops are encouraged. 3. Traditional inefficient irrigation methods are indirectly encouraged. 4. The coastal plains are suffering now from salinity due to the excessive GW pumping however they are introduced as food production basket. 5. Plains of Amran and Dhamar are considered within the most critical GW basins in Yemen, however, it is said that GW is available there.	Agriculture and Graze. 57-61	Economic Activity in Yemen. 04

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
	groundwater. The most cultivated crops are grains, fruits and vegetables. 3. Terraces that depends on rains and springs. 4. Eastern and north eastern wadis that grow grains and dates						
Tourism Supportive Supplies	The Yemeni natural hot springs that pour the hot mineral water are mentioned to be used as healthy bathing places that people use	Geo.05.07.71	Hot mineral springs		mere	Tourism. 71	Economic Activity in Yemen. 04
6th Grade							
Arab region location	It is mentioned that the Arab region located on wide water surfaces and important navigational roads such as ……..	Geo.06.01.9-10	Seas and oceans			Arab world, location and importance. 9-10	Arab World. 1
Climate diversity	The climatic characteristics in term of rainfall is introduced	Geo.06.02.12	Rainfall		Mere presentation	Natural Features of the Arab World, climate diversity. 12. 13	
Demographic and economic features	It is mentioned that population and agriculture density and distribution are determined by many factors of which water availability is mentioned	Geo.06.03.17, 41,51, 62, 75	Water Importance	The main economic activities in the Arab region such as agriculture, graze, Fishing, mining, industry, and tourism are introduced Only agriculture and fishing are lightly referred to be water-dependent activities.	There is a need to highlight the importance of water as an input determines all of the presented activities	Population and Economical Activities. 17, 41, 51,62, 75	
Climate and plant	The water resources in the Arab Peninsula are merely mentioned. The rainfall is stated as the main water source falls in the summer. The surface water is defined as the water flows in the wadis. The ground water is defined as the water exists inside the earth.	Geo.06.04.30	Water resources		Very mere introduction	Natural Features of the Arab World, water resources. 30	Arab Peninsula. 2
Agriculture and Graze	It is mentioned that agriculture and graze activities are determined by the rainfall in Yemen and Asser (a part of Saudi Arabia) whereas determined by GW availability in the middle part of the Arab Peninsula.	Geo.06.05.32	Irrigation		In Yemen, the irrigated agriculture by GW is the significant part of agriculture. Nevertheless, the GW availability as a factor determines the agriculture is elided	Population and Economical Activities. 32	Arab Peninsula. 2
Arab crescent fertile region	Some of the Arabic rivers are introduced	Geo.06.06.39	Rivers			The Arab crescent fertile region.39	The Arab crescent fertile region
Topography of the Nile Wadi	The Nile, its branches, Nasser Lake and Qaroon Lake are mentioned as one of the topographic features for the Nile region	Geo.06.07.59	Rivers and lakes		It seems a bit odd to introduce rivers and lakes as topographic features	Natural features of the Nile Region. 59	Nile Region. 5
	Some Moroccan rivers are mentioned	Geo.06.08.73	Rivers		It seems a bit odd to introduce rivers and lakes as topographic features	Natural features of the Arab west region. 73	The Arab West region. 6
Arab water shortage	Rainfall, surface water and groundwater are mentioned as the Arab water resources	Geo.06.09.80	water resources	Some examples of the Arab surface water are mentioned. A poor map is presented to illustrate the rainfall distribution in the Arab region. It is noticed that the rainfall rates unit are presented in mm without mentioning the time	The map shows that almost half of Yemen has a precipitation rate of more than 500 mm which is not right	Water shortage in the Arab region.80	Environmental Problems in the Arab World. 7

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
Arab water shortage	"The Arab world faces a big and serious problem which is the water shortage. Many causes are behind this problem from which some are natural causes such as rainfall scarcity while the others are man-made causes such as water mis-use. The water shortage problem leads to many negative results such as: 1. Lack of water for drinking and domestic use by the most of the population. 2. Difficulty to expand the agriculture. 3. Drought expansion and green cover disappearance. Suggested solutions for the water shortage in the Arab world are briefly introduced. It is mentioned, discuss the following proposed solutions with your teacher: 1. Sprinkler and drip irrigation systems, 2. Dams and Tanks constructions, 3. Not to pollute the water by the waste and chemicals. 4. Not to abuse the water at homes, 5. Treating the WW and reuse it in agriculture	Geo.06.10.81	Water shortage causes		1. Mere presentation. 2. No visualization	Water Shortage in the Arab World. 81	Environmental Problems in the Arab World. 7
		Geo.06.11.81	Water Impacts	Remarkable focus on the importance agricultural expansion	Mere presentation		
		Geo.06.12.81	Water shortage solutions	1. The evaluation Qs are almost prepared as direct Qs that need to memorize and repeat the lesson's information. Additionally, it is asked, Is it possible for Yemen to desalinate the sea water? Why? 2. The activity presents the prophet Mohammad's say (Hadeeth) “do not abuse the water even you are on a river". Student are asked to explain the Hadeeth and to state their role to save the water	1. The solution no.03 and the last question of the evaluation part seem to be a padding point. 2. Visualization is absent. 3. The activity is repetitive and mere		
Arab water shortage	As thinking card: Why does Israel try to occupy the water belongs to Lebanon, Syria and Jordan	Geo.06.13.82	Water occupying		1. The thinking card is a stand-alone concept. 2. It seems a bit a advance to introduce students at this age to such concept especially in a very mere way as presented here	Water Shortage in the Arab World. 82	Environmental Problems in the Arab World. 7
Droughts causes	Rainfall scarcity is the only water-based cause lead to drought presented in the lesson.	Geo.06.14.84	Rainfall scarcity	A map is used to present the arid and semi-arid areas in the Arab region. Yemen is presented as arid to semi-arid region	The presented map is right however it opposes the previous one presented on page 80 showing that almost half of Yemen receives heavy precipitation rate of more than 500 mm which is not true. So, student might get confused	Drought.84	Environmental Problems in the Arab World. 7
7th Grade							
Earth spheres	Water presents 71% of the earth area out of which 97% is salty water and 3% is fresh water existed in rivers, lakes, pools, groundwater and the water in the tropical forests' plants.	Geo.07.01.56	Hydrosphere	The mentioned fresh water forms present less than 1% since the most of the 3% of the fresh water is not accessible in the north and south polar; however, it is totally elided	Mis-conceptualization	Rocky sphere structure.56	Rocky sphere.03
Sedimentary Rocks	It is mentioned that sedimentary rocks contain ore materials such as oil and water	Geo.07.02.58	GW Aquifer		Mere presentation	Rocky sphere structure.58	Rocky sphere.03
Earthquake Impacts	Earthquake has many impacts. One of them is the spring’s water depletion due to the water leakages into the faults. And other springs appear as well.	Geo.07.03.61	Springs depletion		Poor formation	Topography Formation. 61	Rocky sphere.03
Erosion	The water flow speed and power leads to erode wadis banks and beds	Geo.07.04.65	Water Flow impacts		Mere presentation	Topography Formation. 65	Rocky sphere.03
Topography	Permanent-flow, seasonal-flow and dry wadies are introduced	Geo.07.05.71	Water Wadies		No visualization	Topography. 71	Rocky sphere.03
Rainfall and Humidity	Humidity is defined as the water steam in the air. Its main sources are evaporation from the water surfaces such as seas and transpiration from the plants. Two illustration measurements devices are simply posted	Geo.07.06.98	Humidity		It is not reflected	Humidity and rainfall.98	Atmosphere. O4
Rainfall and Humidity	All kinds of precipitation are introduced such as ice, fug, clouds, rainfall…etc. a simple visualization for the rainfall measurement device is posted.	Geo.07.07.99	Precipitation		Clouds are introduced as a type of precipitation which is not true.	Humidity and rainfall.99	Atmosphere. O4
Rainfall and Humidity	Rainfall main three patterns are introduced. Then rainfall measurement and its device are simply presented. As thinking card: the rainfall in the western highlands of Yemen is too much while it is limited in the eastern highlands. Justify?	Geo.07.08.99-100	Rainfall	(It is stated that the rainfall in the western highlands is too much however in reality the average does not exceed 250mm/year)	Mis-conceptualization	Humidity and rainfall.99-100	Atmosphere. O4

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
Natural dangers	Spates and Floods impacts are introduced as to damage villages and cities, roads and agricultural lands	Geo.07.09.114	Floods Impacts	In the thinking card, it said that a lot of the Yemeni agriculture lands are subject to the damage of the floods. So, what are the tools you suggest to protect the lands?	Mere presentation	Environmental imbalance. 114, 116	Biodiversity. 5
8th Grade							
Continents	The regional water is defined as the seas/oceans water existed alongside countries and belongs to them. The respective country has full supervision and sovereignty on the regional water	Geo.08.01.10	Regional water		Mere	The Land (the continents). 10	Land and Water. 01
Water Surfaces	Oceans' definition, names and areas are introduced. In addition, seas and their categorization such as open seas, semi-close seas and closed seas are presented with some examples. Besides that, lakes are defined also as a closed surface water body that varies after their water quality (fresh/salt lake). Some Arabic and international lakes' names are stated as examples of the lakes. Oceans and seas importance is introduced using a verse from the holy Qur'an mentioning that Allah is the one how prepared the sea (means seas and oceans) for you from which you eat fresh meat, extract the Jewelries you wear, navigate, and other benefits hopping that you will praise. Then it is stated that seas and oceans are huge sources for many resources. The most important ones are: Fishery, mineral (salts, oil and gas) and energy (waves) resources in addition to navigation and transportation uses. Seas and oceans are subjected to many types of pollutants such as oil leakages and industrial wastes (pesticides, radiation materials and oil wastes). So, to invest in seas and oceans resources, it is a must to conserve the sea environment against pollution. There are different tools that countries use to prevent the pollution such as: 1. preventing the ships from throwing solid wastes, radiation materials, pesticides and oil wastes. 2. Encouraging the environmental conservation associations and empowering their role. 3. Agreements between the riparian countries to conserve and empower the controlling role on ships navigation. 4. Using equipment to fight the water pollution.	Geo.08.02.12	Water Surfaces	Rivers are dropped out		Water Surfaces. 12-13	Land and Water.01
		Geo.08.03.13	Seas and oceans uses				
		Geo.08.04.13	Seas and oceans pollution	1. A photo of burning ship supported by a subtext of "Oil Pollution in seas" is presented. 2. It is stated that in order to invest the seas and oceans resources, we should conserve the seas environment from the pollution.	1. Meer and poor presentation. 2. Aquatic environment conservation must be always ensured not only for the investment purposes. 3. The mentioned "water pollution fighting equipment" is a passive and therefore unnecessary point.		
	An enrichment activity is introduced as follows: 1. A conducted study in England indicates that the total daily water consumption of the English employees in offices is quite enough to fill in 150 Olympic swimming pools. 2. Leaving the tap opened for one minute results in 6 gallons of water. If a person needs three minutes to wash his hands and face, this will result in consuming 18 gallons of water. 3. By using the modern water taps and maintaining the water network in a building in which 100 officers are working, the water consumption was reduced from 55,000 to 33,000 gallons/year. Now, participate with your classmates to record the different kinds of the water abuse forms and provide some	Geo.08.05.14	Water Abuse	From principle, the activity idea is very good however its application is a case of confusing, useless and fruitless application	1. The given parameters are mismatched. 2. It is overestimation to state that a person needs 3 minutes to wash his hands and face which result in more than 50 l. 3. The students are supposed to calculate, indicate, compare and or conclude something. Nevertheless, what is requested from them to do is an hours of different color. 4. It would be better to give an activity that presents some local facts/numbers the water consumption, to do some calculations and comparisons, and to conclude and propose how to save. By doing that student can realize, reflect, conceptualize and apply what they learnt.	Water Surfaces. 14	Land and Water. 1

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	suggestions to save the water consumption in area you live.						
Mutual effects between land and water	The water cycle is presented and illustrated by a simple drawing	Geo.08.06.15	Water cycle	Mere presentation	1. The illustration figure presents only the evaporation, condensation, clouds and rainfall. Run-of and infiltration are not illustrated. 2. The evaporation illustrated as to be mostly from lands not from seas water. 3. It is mentioned that the all GW goes again as springs forming rivers that pour into the seas	Exchange Impacts of land and water. 15	Land and Water. 01
Population Density	Water availability is mentioned as one of the elements determining the population density and agriculture development in all world continents.	Geo.08.07.25,32, 42, 44, 48, 54, 87	Water Importance		Mere presentation	Demographic Features and agriculture. 25,32, 42, 44, 48, 54, 87	Continents
Economical activities	Asia countries have supported agriculture very much by cultivating the fertile and even less fertile lands, constructing dams. Channels and terraces and drilling the wells	Geo.08.08.28	Irrigation		1. Agriculture expansion encouragement. 2. it encourages wells drilling for agriculture	Economical features. 28	Asia Continent. 02
Mineral Resources	Water as an important rich source for energy production is still rarely utilized in Africa. Nevertheless, Aswan, Senegal and Caribe dams are generating the energy. The latest one is one of the biggest dams in the world producing 600 kw	Geo.08.09.45	Water for Energy	It is also mentioned very merely on pages 59, 78 as the water falls are used to produce the energy	It seems odd to be presented as mineral resource	Economical features. 45	Africa Continent. 02
The developed and developing countries	A comparison between the developed and developing countries is presented. In term of safe drinking water supply, it is presented that the coverage reaches 97% in the developed countries while it is 51% only in the developing countries	Geo.08.10.96	Drinking water Supply		Mere presentation	The international economic development variation. 96	The international present issues. 06
Hunger Causes	Floods and drought are mentioned as one of the main natural causes for hunger happening in many developing countries	Geo.08.11.99	Drought and Flood impacts	The non-sustainable use of water resources can lead to drought, poverty and subsequently to hunger. However, it is not mentioned at all	Mere presentation	Hungers. 99	International present issues. 06
Hunger alleviation	Good surface and ground water utilization such as dams and tanks construction and saving the water consumption to develop the agricultural production for food is mentioned as a method to alleviate the hunger	Geo.08.11.100	Water Good utilization	Dams on the tope as usual.		Hungers.100	International present issues. 06
Hunger alleviation	Cultivating new agricultural areas is mentioned as a method to alleviate the hunger	Geo.08.12.100	Agriculture expansion	Agriculture expansion encouragement	Adverse concept	Hungers.100	International present issues. 06
Threats on the earth	It is mentioned that depleting green covers (forests) of the earth leads to raise the CO2 that results in raising the earth temperature. Accordingly, the ice caps in the north and south earth polar are being melt day by day raising the water level in seas which might lead to disasters such as the floods	Geo.08.13.102	Floods		Mere presentation	International Environment degradation. 102	International present issues. 06
Climatical Characteristics	Rainfall patterns, amounts and its affection by the climatical conditions are presented many times within the context of the climatical characteristics of the presented continents and some of their countries	Geo.08.14. many times	Rainfall	Well presented		Climate	
9th Grade							
Mountain and costal	1. Mountain environment: it is mentioned that western highlands receive heavy rains especially in summer	Geo.09.01.14,16,	Rainfall	The annual average of rainfall on the western mountains is	Mis-conceptualization	Mountain and Costal	Yemen Diverse Environments.0

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
Environmental Features	season 2. Costal environment: Its rains are scarce			250mm/year. So the used term of heavy rains is not appropriate		Environments. 14, 16	1
Desert Environmental Features	Desert Environment: It is presented that rainfall quantities do not exceed 200 mm and sometimes more than year passes without rain. And due to the high evaporation rates that lead to vanish the flowing water making the groundwater saline water or subjected to salinity in case it is mis-used. Rainfall in desert environment is characterized by strong rainstorms resulting in floods that sediment the clay, sand...etc.	Geo.09.02.21	Rainfall	1. The average Pr in deserts and coastal areas does not exceed 50-100mm. 2. The mentioned strong rainy storms happen in the highlands resulting quickly in spates that get together from wadi to wadi resulting in the mentioned floods in the desert.	1. The first paragraph is formed poorly lacking the adequate transition that makes it difficult to be acquired by students. 2. The 200 mm is not mentioned as the average not defined in term of time. Hence it needs to be adjusted by the average and adding the time unit as /year.	Desert Environment. 21	Yemen Diverse Environments.01
The water	The concept is initiated by a verse from the Holy Qur'an that refers to the two types of flowing water; salty and fresh and some of their benefits. Then it is mentioned that rainfall is the main water source for both surface and ground water. The water is divided based on its quality kind into two types: fresh and salty water. Fresh water is springs, streams, wells and dams such as Marib Dam illustrated in figure no. 18. Salty water is the water of seas and oceans. Water forms the environment for flora, fish...etc. Human utilizes the water environment to meet his needs of food, drinking, cloth, transportation and energy. Then a map presenting the Yemeni wadis is posted and students are asked to look at and mention what are the wadis that flow to the north, east, west and south.	Geo.09.03.24	Water resources	The following section is presenting the water uses, so why it is padded here	1. The presentation sequence needs to be revised and adjusted. 2. The photo of marib dam is repeated many times.3. wadis should be clear defined as flowing spates wadis. Furthermore, wadis map is not utilized. It needs to be reflected that they represents the water flow system from highlands to other areas where people benefited from their water as long as they flow. 4. Yemen does not have any hydro energy production yet	The water.24	Yemen Diverse Environments.01
	It is mentioned that the Yemeni human uses the fresh water for agriculture, drinking and for fishing in streams. Whereas he uses the sea water for many uses such as transportation routs, navigation and fish and salt extraction	Geo.09.04.25	Water Uses	1. Presenting the fisheries in the fresh water as one type of water uses in Yemen sounds odd, 2. Mentioning that sea water is used for transportation and navigation is kind of repetition	1. Mere presentation. 2. Industrial and touristic uses are absent3. A photo of stream is presented but in very bad quality of printing	The water.25	Yemen Diverse Environments.01
Water problem	The climate change impacts is mentioned as probable problem that caused spates quantities decrease resulting in unmeet the water demand for agriculture which subsequently leads to GW over-extraction via wells random drilling that results in over-extracting the GW which in the future will extend drought, neglect the agricultural lands and damage the rural economy	Geo.09.05.26	Climate change	1. The climate change impacts is mentioned as probable problem, meanwhile it is presented that it caused spates quantities decrease….etc.	1. Poor presentation. 2. The GW over-use, random wells drilling and GW over-extraction are mainly resulted by agriculture expansion and low use efficiency rather than as what are mentioned	The water.26	Yemen Diverse Environments.01
	The water abuse for Qat and in the domestic use is mentioned as water problem in Yemen	Geo.09.06.26	Water Abuse	The most important water problems such as scarcity, insufficiency of the drinking water supply and inadequate of the sanitation services, Low use efficiency of the conventional irrigation methods...etc are elided from the whole presented concept of the water problems in Yemen	Mere presentation	The water.26	Yemen Diverse Environments.01
	Many of the water pollutions types in Yemen are presented as follows: 1. Streams and tanks water pollution by the human wastes. 2. Pesticides misuse. 3. Seas pollution by wastewater.4. Seas pollution by oil leakages. 5. Pesticides volatilizing to soil depths, plants	Geo.09.07.26	water Pollution	1. Each of the mentioned problems is presented with some details which is good in principle. However, there are many mis-conceptualizations. 2. No	1. Pesticides mis-use impacts are excluded on killing some micro-organisms that help in treating water while the main risky impacts is to pollute the water quantity by their chemical contents. 2. Untreated wastewater impacts are presented confined to pollute the seas in coastal areas.	The water.26	Yemen Diverse Environments.01

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	and seas. 8. Thermal pollution in seas			visualization at all. 3. More than 75 % of the presented problems are related water quality problems. However, in reality the main water issues and problems are related to the water quantity	Whereas the main problem of the waste water is that it pollutes the GW and creates many risks for human, animals and the soil when used. 3. Pesticides impacts is repeated in very silly way that it volatilize to the seas and polluting them. 4. Cesspits impacts are absent.		
Solutions	1. Controlling the oil ships. 2. Preventing draining the solid and liquid wastes of houses, factories and laboratories into the seas and the fresh water wadis. 3. Keeping the beaches clean and making them more beautiful	Geo.09.08.27	Water Pollution Alleviation Suggestions	It is noticed that the most focus of the water pollution and suggested solutions concepts is on the sea water context.	Mere presentation	The water.27	Yemen Diverse Environments.01
	It is introduced that water is a gift of Allah that we might lose if we do not utilize it well and conserve it. It is supported by a verse of the Holy Qur'an indicating that Allah has sent water down of the sky with balance and settled it in the earth and he has the full ability to get it away again. Hence, it out to: 1. Non abuse for fresh water. 2. Developing the water use from pools, tanks and small dams. 3. Using the modern irrigation methods such as drip and sprinkler irrigation. 4. Treating and using the collected water from the roof top of houses .5. Stopping the flood irrigation and the random wells drilling	Geo.09.09.27-28	Water conservation	1. The presented points are quite good. 2. The concept is supported by two photos of a woman getting the water on the donkey and a rig with its other trucks in well drilling site with a subtext of "difficulty of getting the water". 3. Evaluation has three main sections: a) direct Qs such as (discuss the water resources, uses and saving methods in your own way). b) Thinking card: how to utilize the sea water to irrigate the agricultural crops. c) Enrichment activity: write an essay about the water problems in your area and post it in the school wall magazine.	1. Mis-match between the photos and the presented concepts. 2. Visualization is absent. 3. Evaluation: a) with home to discuss the proposed points, b) it does make sense to desalinate the sea water for agriculture due to the high cost of desalination, so, why to ask for that. c) it is noticed that activities are asking students to write about issues, things...etc. It would be better to propose activities that involve students more and more as groups or individuals, in class and outside the class so they can acquire the responsibility of water conservation	The water.27-28	Yemen Diverse Environments.01
Population growth Impacts	The impacts of the population growth are presented of which water and wastewater services are mentioned	Geo.09.10.39	insufficient water and sanitation		Mere presentation	Population Growth in Yemen. 39	Population and development in Yemen. 02
Agriculture Introduction	Agriculture as one of the main food sources is introduced. Hence, the state quite supports agriculture via dams and converting channels construction and water save means. It is mentioned that agriculture serves as labor market for 74% of the population and contribute with 18% of the GDP	Geo.09.11.50	Irrigation	1. The real percentage of people who work in agriculture is presented in page.44 as 53%. 2. The agriculture does contribute to the GDP with 14% only.	1. Agriculture and dams' encouragement. 2. Wrong figures. 3. "water save means" is not clear enough	Agricultural resources.50	Economical resources of Yemen. 03
Agriculture	It is mentioned that the western highlands receive huge quantities of rains so that coffee, oranges…etc are grown. In plains where the GW is quit available, grains, grapes…etc are grown.	Geo.09.12.51	Water resources	Highlands receive an annual average of rains of 250 mm. Plains are suffering from GW over-extraction so that most of them are considered as critical basins	Mis-conceptualization	Agricultural resources.51	Economical resources of Yemen. 03
Drought problem	The overuse of the surface and ground water and the irrational irrigation are mentioned as causes of deforestation.	Geo.09.13.76	water abuse		Mere presentation	Deforestation. 76	Arab environment and its problems.04
Drought problem	To cope with deforestation, many tools are mentioned like implementation of irrigation projects such as dams and canals construction and modern irrigation system use	Geo.09.14.77	Irrigation	Dams orientation		Deforestation. 77	Arab environment and its problems.04
The Arab Water	It is introduced that the Arab human had established great civilizations around the water resources such as the	Geo.09.15.79-83	Arab water resources	1. The lakes are mentioned as natural water resources in the	1. Confusion by lakes labeling. 2. The figures of the total water quantities need to be revised and harmonized with	Arab water resources. 79-	Arab environment

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	rivers of Nile, Tigris and Euphrates and the Marib Dam in Yemen. Then it is mentioned that the Arab water resources are divided as 1. Natural water resources such as rainfall, rivers, lakes, streams, seas and ground water (wells and springs), and 2. Artificial water resources such as desalination and wastewater treatment. Then rainfall, rivers, groundwater, artificial lakes, desalination and waste water treatment are presented in details			introduction but they are presented as artificial water resources later in details! 2. The presented figures of the total quantities of the water resources do not match the same figures presented later on in level 11th. 3. WWT is briefly presented. 3. As thinking card it is mentioned that huge surface water quantities are lost to the seas or deserts. How to benefit from that water. As enrichment activity, students are asked to collect photos for the water resources of any Yemeni region and to write an essay about the water scarcity there clarifying their suggestions for the solution	the same figures presented in the other levels. 3. Most of the water resources are lost via evaporation not as run-off water to seas or deserts as mentioned. 4. Figure 60 does not match with the side text at all. 5. It is said see figure 61 to determine the GW aquifers....etc. The respective figure is 62. 6. Most of Yemen is presented on the map as receiving heavy rains which is not true	83	and its problems.04
Arab water problems	It is introduced that human might need 50 liter of health requirement. The agriculture consumes a big water portion followed by industry. The water is used for energy production especially by dams and falls	Geo.09.16.84	Water uses		Mere and Poor presentation	Arab Water problems.84	Arab environment and its problems.04
	Four photos are posted together with sub-text "Some of the Water Uses". Then the water abuse problem is presented including flood irrigation, non-utilization of rivers and seasonal spates, leaving the taps opened, cesspits construction, excessive pesticides use and rainfall pollution	Geo.09.17.84-85	Water abuse	1. Sub-text needs to be change as “some examples of the water abuse". 2. The presented photos are poor.	1. Pollution is mixed under the water mis-uses. 2. Mere presentation3. activities do not support the concept	Arab Water problems.84-85	Arab environment and its problems.04
	It is introduced that the Arab states are threatened by the upstream countries water policies and interventions such as dam’s constructions by Turkey and Uganda and Ethiopia that have affected Iraq & Syria and Egypt that are in the down streams. In addition, Israeli policies and raping to capture the Arab water resources in Lebanon, Palestine, Jordan and Syria is presented	Geo.09.18.85-86	Transboundary water issues	1. Good presentation. 2. The attached enrichment activity presents brief background about the artificial river in Libya asking students to write how the water is transferred. Besides, they are asked to mention when was Marib Dam established	1. Mis match between the concept and the activity. 2. Cooperative solution is elided	Arab Water problems.85-86	Arab environment and its problems.04
Water Security	The water security for the Arabic region is defined. Then the available water resources, the water demand and the gap of 2000 and 20120 are presented. Students are required to discuss with the teacher the followings: a) the water resources availability and demand of 2000-2010, b) the gap in 2010, and c) how to reach the Arab water security.	Geo.09.19.88	Arab water security	Thinking card: The Arab water security is non-separable part of the Arab nation security, how that can be reached?	Mis-conceptualization	Water Security.88	Arab environment and its problems.04
	Many tools to conserve the water are presented such as drinking water save, modern irrigation systems, TWW reuse, crops pattern change, water distribution network maintenance, stay away of the random wells drilling, Dams construction, and signing agreements of transboundray water share. The enrichment activity asks the student to share the classmates a field visit to a water stream and then write a report clarifying the followings: a) Flow pattern (permanent or fitful), b) pollution statues qua, c) water conservation options. Then to discuss the	Geo.09.20.88-89	Water conservation	1. It seems to be padded into the lesson. 2. The proposed activity is good. 3. The water security is defined in inappropriate way	There is not distinction between the water conservation tools and the water developments tool	Water Security.88-89	Arab environment and its problems.04

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	report in between with teacher attendance and to submit it to the school library						
Agriculture	It is introduced that most of the agricultural areas in the Arab region are rain fed agriculture. Then comes rivers, dams and GW as sources for the irrigated agriculture	Geo.09.21.105	Irrigation			Agriculture and Food security. 105	Population and develop. 05
Food Security	It is presented that to reach the food security in the Arab region, main two policies have to be adopted: 1) Horizontal Agriculture expansion and 2) Vertical expansion	Geo.09.22.109	Agriculture expansion	Negative impacts on the water resources	Adverse concept	Agriculture and Food security. 109	Population and development. 05
Water is Life	A drawing of water drop containing a scene of lake, fish, trees, human, bird…etc is presented with a sub text of a verse from the Holy Qur'an indicating that Allah made from water every living thing	Geo.09.23. back outside cover	Water is life		repetitive	outside cover	
10th Grade							
Remote Sensing System Applications	It is said that the application of remote sensing is wide in the fields of water particularly in seas water temperature, currents and waves depth measurement and in determining the fish communities' locations. In Continent water, it is used to determine the big rivers basins, water storage in lakes and ponds and for flood control.	Geo.10.01.01.33	Surface water measurement	The unit aims to introduce the visualization importance, however, many parts are either mere presented or poorly visualized	1. Mere presentation 2. it is not reflected that remote sensing is one of the technical tools for water management	Remote sensing applications.33	Human and his geographical field visualization. 02
Human Stabilization and civilization	It is mentioned that human ancients started to grow plants for food; therefore, they always kept living besides the rivers in Iraq, Egypt, Sudan, India, china…etc. Nevertheless, in Yemen people had coped with the nature with will and wisdom. They constructed great dams and constructed irrigation canals to come over the droughts and water shortage standing out of the world civilizations that always kept attachment to rivers or lakes	Geo.10.01.02.56	Dams and canals		It is well known that Yemeni ancients had a lot of indigenous practices for water allocation and management. Nevertheless, only dams are almost presented as a magic solution of that time	World population diversity.56	Human organizes his geographical field. 03
Rural areas features	It is stated that rural areas are characterized by water scarcity, communities diffusion…etc.	Geo.10.01.03.65	Water resources	It is followed mentioning that in the world there are traditional agriculture, intensive agriculture and wide scale agriculture. Many features of each one of the three categorizations are presented; nevertheless, there is neither a sentence nor a single word referring to water, irrigation methods and systems....etc.	Mere presentation	Rural Areas Activities. 65	Human organizes his geographical field. 03
Rural and urban problems	Insufficient water supply services in rural areas and increasing the pressure on water services in urban areas are mentioned between the problems examples in both rural and urban sides	Geo.10.01.04.78	Inadequate water supply		Mere presentation	Relationship between the city and the countryside. 78	Human organizes his geographical field. 03
Floods	Floods resulted by water overflow from seas and rivers and their positive and negative impacts are presented. Besides that, dams as tool to control floods is also introduced	Geo.10.02.01.19-20	Floods impacts and solution			Air pressure and wind. 20	Climate and water. 01
The water in the air	1. The water cycle is presented. 2. Relative and absolute humidity are defined. The formula of calculating the relative humidity is provided as well. 3. Water condensation types such as dew, fug, clouds and frost	Geo.10.02.02.21	Water cycle	Comparing to the previous water cycle presentations, this one is much better but it still have many weaknesses as shown besides	1. It is mentioned that rainfall is converted into snows and falls down on mountains. 2. Illustration figure is poor eliding many elements of the water cycle. 3. Water quantities of the water cycle steps are posted but in a very	The Water in the air. 21	Climate and water. 01

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	are presented. 4. Snow, hail, and rainfall are introduced as the types of precipitation. Rainfall patterns on the earth are generally reflected.				vague way. In other words, their unit is absent and it is known whether they are in million or billion or what.		
		Geo.10.02.03.22	humidity		Mere presentation	Water in the air. 22	
		Geo.10.02.04.22	Condensation Types	Well presentation		Water in the air. 22	
		Geo.10.02.05.23	Precipitation Types		Mere presentation	Water in the air. 23	
Water in the earth	1. Water coverage percentage is mentioned. 2. Salt water resources such as oceans, seas, and lakes are introduced and defined. Two tables has presented the area of the main oceans and lakes overall the world. 3. Fresh water such as rainfalls, ice mountains in the oceans, rivers and the groundwater are presented. Some figures like rainfall total quantities and main rivers length have been posted as well.4. The groundwater permeability, permanent and temporary concentrated layers, wells, hot springs and fountain have been presented as well.	Geo.10.02.06.25-28	Water Resources	A very well presentation, even though some weaknesses are recorded as shown besides	1. The lakes are presented under the salty water category. 2. Springs and streams are not presented 3. Drilled wells are called artesian wells (wrong). 4. Only the hot water springs presentation is reflected on the Yemeni context by mentioning some Yemeni hot springs locations. 5. The table of the most famous rivers in the world is posted within the presentation of the GW. 6. The categorizes label and sequences is poorly formed	Water on the Earth.25-28	Climate and water. 01
Water for human	There are many water uses as follows: 1. House Uses (human needs around 50 L/day to ensure being clean; however, he needs around 400 m3/year for his all uses. This amount differs from place to place after the healthy and economic level). 2. Agriculture uses: it is estimated to consume 62% out of the total water consumption by using traditional systems. Irrigation projects increases yearly especially in the arid regions. 3. Water and Qat in Yemen: studies assert that Qat agriculture represent decreasing the GW levels due to the random wells drilling for getting big amounts of water to irrigate qat which affects the GW storage that has accumulated through thousands of years especially that Yemen is located within the arid and semi-arid regions. The area cultivated by Qat is estimated to 103 ha in 2000. Each hectare of Qat consumes up to 8500 m3/year. Continuing to extract the GW by the current rates will lead to dangerous problems gradually and the GW tables will drop increasingly. And it is noted that springs, which used to supply the drinking water particularly in dry seasons, have disappeared in Qat areas due to the random drillings. 4. Industrial Use: it comes at the second order since water is an input in almost all heavy and light industries. 5. Energy production: Human has utilized dams to produce energy. Hydroelectricity energy has many advantages such as being a very effective, safe, cheap costs and clean energy source. It contributes with 20% of the total electricity overall the world. African and Asia are the most rich continents with hydroelectricity energy but most of it is still non utilized due to the limited technology unlike the northern countries that have invest a lot in energy production from water bodies	Geo.10.02.07.30-31	Water Uses	1. The daily water consumptions of some countries are presented (why not to present the Yemeni one for comparison). 2. Only agriculture use is presented as percentage. 3. The whole discourse is presented on the international level.	1. Water Use priorities are still absent. 2. The domestic use is presented in very poor way. It would be better if the presented uses were reflected on the context of Yemen. 3. Qat was oddly inserted as one of the water general uses worldwide.4. Messy presentation for the part of water and qat. 5. A photo of furrows flood irrigation is used to illustrate the agricultural use, 6. It is not clear what does it mean that industrial use comes at the second order.	Human and Water. 30-31	Climate and water. 01

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
Water Conservation	1. It is said to develop the water resources and save its consumptions, we need to 1. See water desalination. 2. Using the used water after treating it for crops irrigation. 3. Reducing Qat through support the other cash crops and impose water fees for areas of qat. 4 Irrigation methods: Bring the drip and sprinkler irrigation systems to replace the flood irrigation and open canals methods and stop the expansion of constructing dams in the hot regions to avoid evaporation. Active monitoring to prevent random wells drilling of deepening. Constructing dams and dikes for water storage and ground water recharge	Geo.10.02.08.32	Water Conservation	In the evaluation part, students are asked two direct questions. 1. Define the fresh water? 2. What is the importance of dams and the hydrosphere? Since the book this is a used book, the student (the former owner of the book) has answered them as follows: 1. it is the potable water for drinking. 2. Dams (GW Recharge). The hydrosphere: water is the base of life.	Poor, messy and contrasted presentation. There is no a distinction between the terms of water resources development and water resources conservation, what are the tools of each one of them…etc. Further weaknesses are: 1. TWW reuse is presented in a vague way. 2. Qat is also a cash crop and what is needed now is how to save water when irrigating qat by installing modern water irrigation systmens.3. It is odd to present dams' construction under the modern irrigation systems item 4. Random drilling should be clear defined and introduced. Then it is also odd to present it under the modern irrigation systems item. 7. In one statement, it is said not to construct big dams to avoid evaporation, however, in the last statement it is mentioned to construct storage dams. Furthermore, it is supported by the photo of the huge dam in Marib. This is case of confusion	Human and Water.32-331	Climate and water. 01
Erosion	Soil erosion and sedimentation happened due to spates, floods, rivers, groundwater, snowy rivers and waves movements are presented in details	Geo.10.02.11.53-56	Spates effects	It is mentioned that GW is existed in the gaps and pores of the rocks. And due to the movement and sedimentation of the dissolved materials in water, caves are formed in beautiful shapes. The student (the former owner has written a note: this part will not be included in the final exam). This indicate that the topic is hard or maybe too advanced that the teacher has excluded it from the final exam	1. Economic and environmental advantages and disadvantages of wadis erosion and sedimentation are absent. 2. conceptualizing that GW movements create caves might instill that GW resources are huge which might negatively impact the perception to GW as finite resources	Erosion.53-56	Human and Earth dynamicity. 05
Natural resources Running Out	It is mentioned that resources that can be renewed faster than their consumption are called renewable resources such as wood, food and water. However, within a limited geographical context some resources might not be renewed in the short period of human life as it is happening for the ground water in arid and semi-arid regions like Yemen.	Geo.10.02.12.66	Ground water depletion	The whole lesson is dealing with the natural resources utilization, problems and conservation. It is all focused on oil, coal, minerals and stones. Water is only inserted here as add-ons to the topic		Human and Earth Resources. 66	Human and Earth dynamicity. 05
Environmental Systems characteristics	The surface water flow patterns in tropical, seasonal and arid environments are presented. In tropical forests, deforestation helps water flowing faster resulting in soil erosion. In seasonal areas, water flow is irregular that increases in summer and decreases in winter. In addition, its ability to erode the soil is week since the most of its load are fine materials. In dry areas, the water flow is timely and scattered along the year due to the limited rainfall	Geo.10.02.13. 77, 79,80, 86	floods and spates			Hot, moderate and cold environmental systems. 77, 79,80, 86	Human and Environmental Systems. 06
Desert Environment	In side box, drought is defined as water scarcity i.e. its imbalance between creatures needs and precipitation quantity	Geo.10.02.14. 79	Drought		Mis-conceptualization	Hot environmental system. 79	Human and Environmental Systems. 06
Environmental problems	It is presented that gases emissions resulted in climate change effects such as the natural disasters like floods and droughts as the one happened in Europe in 1995 where floods covered wide areas of Europe due to the	Geo.10.02.15. 91	Floods	Mere	Climate change impact is presented exclusively to floods	Environment Conservation is a common responsibility.	Human and Environmental Systems. 06

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	heavy rains and ice melt.					91	
International Efforts for environment protection	1. The 1969 principles and 1982 agreement related Regional and international water are presented. States and international superiority, duties and rights on the regional and international water are briefly mentioned.	Geo.10.02.16. 92-93	Regional and international water	The introduction is almost focused on climate change, its causes and effects while the core of the lesson is mainly dealing with the international efforts on organizing and defining the regional and international water bodies	The topic is environment protection while the core is about the international agreements on regional and international water utilization	Environment Conservation is a common responsibility. 92-93	Human and Environmental Systems. 06
11th Grade							
The Geological Structure and the water resources	In a side box, the GW is defined as the water percolated from the surface water to inside the earth through soil pores and stones cracks and positioned on the solid impermeable stony layers. Then it is introduced that sand stones are one of the best stones storage water for its relatively-big pores size, while the volcanic stones represent the poorest ones. It is said that GW is utilized via wells drilling and its quantities are limited in Yemen according to the imparity of the earth constructional shapes. Therefore, you notice some cities located on rich GW regions like Dhamar city while the others are suffering from the GW shortage like Taiz city (Why?). It is added, that although some cities located in plains which are rich with GW, the water over-use exposes the GW storage to the over-extraction and the inability to be recharged within the coming years such as Sana'a city. So, have look on figure no. 12 and determine the GW storages and the main regions of irrigation in Yemen. Finally it is mentioned that to conserve the water you have to avoid water abuse because the GW storage recharge is much less than extracted or consumed quantities. And you have to avoid exposing the GW to the pollutants of oils, pesticides and wastewater. In addition we should follow our ancient path by constructing dams, dikes and tanks and to work on utilizing the top houses roofs to collect the water for the daily water use	Geo.11.01.01.19-21	Ground Water	1. The presented contents do not have any background within the stated unit objectives. 2. The GW forms are not visualized. Nevertheless, according to NWRA documents, many peoples still believe that the GW forms lakes or pure basins inside the earth. Hence, visualization illustrating the limited real GW existence is strongly needed. 3. The activity mentions that scientific studies have indicated that the GW storage in some Yemeni governorates are subjected to be depleted so that they will suffer a big water crisis in the future if the GW storage over-extraction continuo. So, write an essay about that determining the possible means to develop the GW storages in those governorates and discuss it with your colleagues and teacher	1. Dhamar and Sana'a are mentioned as having rich GW storages. Nevertheless, both are considered as very critical basins. 2. The said "The constructional shapes of the Yemeni earth" is not clear. 3. The posted map no. 12 of GW distribution is very poor. It only presents one GW storage which located on the boundary with Saudi Arabia. 4. Water not abusing must be adopted in all conditions not only under the gap between recharge and extraction as mentioned. 5. As usually the water conservation and management is almost excluded to constructing dams and dikes. 6. The requested activity is focusing on developing new water resources and neglecting the water demand means that are the first priority and option for the IWRM in Yemen. This can be justified du to the dominant tune of dams construction importance	Geological Structure of Yemen. 19-21	Yemeni Human and its natural Environment. 01
Water Resources in Yemen	The title is the water resources in Yemen, however the contents are about resources can be get from seas such as fisheries, minerals...etc. Therefore, fish and aquatic beings, minerals and salts, energy production by seas' currents, the possibility of getting fresh water from the seas via desalination and the surface water resulted by seas through the water cycle are all presented as the water resources of Yemen .	Geo.11.01.02.33	Yemen Water resources	Mis-conceptualization	1. Increasable mis-match between the title and the contents. 2. Poor and odd presentation.	Water Resources in Yemen.33	Yemeni Human and its natural Environment. 01
	It is mentioned that two Yemeni power plants are producing energy using the seas currents power	Geo.11.01.03.33	Energy Production	In reality both power plants in Al-Hudaida and Al-Makha are operated by diesel to heat the water producing steam pressure that turns the turbines. The sea water is used mainly for cooling	1. False information. 2. Adverse concept	Water Resources in Yemen. 33	Yemeni Human and its natural Environment. 01
	Then the surface water is introduced as a result of evaporation and rainfall that drops in many imparity	Geo.11.01.04.33-34	wadies and spates	A map is presented showing the wadis directions. Student are asked	1. Poor and odd presentation. How can students identify the groundwater basins from a map that presents the wadis	Water Resources in	Yemeni Human and its natural

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	conditions of quantity, time and rates. It is said that run-off water flow in many Yemeni wadies that finally and mostly pour into the red and Arabic seas.			to determine the flowing and ground water basins on the map	directions	Yemen.33-34	Environment. 01
	It is then presented that letting this water in Yemen to flow in such a way is a very important water abuse since most of the water is not utilized. From here the intendancy has come to construct dams, dikes and tanks to store the rains water for irrigation and GW recharge. One of the main examples of the constructed dams is the Marib Dam that has been re-constructed lately in a very water scarce region. Constructing Marib dam in the past eras represented the genius ancient Yemeni human for his contribution establishing one of the greatest civilizations at that time	Geo.11.01.05.34	Dams	1. According to NWSSIP, less than 10% of rains go as run-off to the seas or desert. Despite the hug efforts and investments in constructing 1000 dams in Yemen, the total amount stored does not exceed 80 million m3 which is around 30% of the annual GW abstraction in Sana'a basin only. 2. The activity is asking the student to collect suitable and clear data about the water resources in area where s/he lives, to write it down on the notebook proposing some means to conserve them and then to discuss it with colleagues and teacher	Dams oriented concept	Water Resources in Yemen.34	Yemeni Human and its natural Environment. 01
Population Growth Impacts	It is mentioned that population growth impacts many issues. One of them increasing the pressure on the water services	Geo.11.01.06.43,45, 67	Insufficient water services	repeated three times	Mere presentation	Population growth. 43,45, 67	Population and the social development in Yemen. 02
Population Concentration	It is presented that water resources and services are factors among others that affect the population distribution in Yemen. For instance, people are concentrated in Maur, Surdud, Tuban, Hadhramut wadies where spates and springs flow and in areas where rainfall quantities are much, meanwhile, they decreases in dry areas like the desert. On the other hand, the increases in cities due to the water, health...etc services	Geo.11.01.07.49-50	Water Importance			Population Distribution in Yemen. 49,50	Population and the social development in Yemen. 02
Urban and rural	It is presented that Yemen suffers from fresh water crisis due to the increasing population growth and lack of the flowing water resources so that 50% of the people are not covered by the public network in addition to that the vast numbers of people do not have access to clean drinking water. Then the drinking water service coverage and growth percentages, beneficiaries and the water consumptions of both urban and rural areas are presented in details. Regarding the sanitation services, it is mentioned that coverage percentage of urban reached 66% covering only 6.2 % of the population while the rural areas still not covered by sanitation services. It is added that reports indicated that only 6 million m3 of the WW is treated and reused and that there are constrains face the WWT and reuse due to the water consumption and urbanization increase and that resulted in environmental pollution problem on the fresh GW	Geo.11.01.08.68-69	Drinking water supply and sanitation services	1. A photo of rural women transferring the water on their heads and on donkeys is posted to support the concept. 2. The concept shows up as stand-alone concept. 3. presentation language is very poor	1. Mis-conceptualized and mixed up presentation. The data of the drinking water supply services are adversely presented. In other words data of rural were given to the urban and vice versa. 2. The sanitation coverage percentage and beneficiaries percentages is overdrawn.	Rural and Urban. 68-69	Population and the social development in Yemen. 02
Agricultural regions and	1. It is presented that the coastal areas grow many crops such as mango, banana, cotton…etc irrigated by	Geo.11.01.09.72,73,75	Irrigation Use	It is good to focus on Qat as one of the main drivers led to over-use the	1. Poor formation for no.1 pa. 72. 2. Agriculture expansion encouragement. 3. It does not make sense to appreciate	Agriculture resources in	Economical resources of

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
importance	groundwater, spates and springs that are stored by dikes alongside the seasonal wadies. 2. Mountain areas where qat is the dominant crop and over-extract the huge GW quantities. Finally it is mentioned that we Yemen has a high gap in grains production which required preparing of agricultural policies raising the grains production via adopting modern cultivation technologies, getting rid of the water shortage and eliminating Qat that consumes much of the GW			water resources. Although banana, mango, cotton consume more water than the qat do, it is noticed that they are appraised and student are encouraged that Yemen should produce such high water-intensive consuming crops	banana, mango and cotton in water scarce country. 4. it lack to explain how to come over the water shortage	Yemen.72,72,75	Yemen. 03
Climate and flora life in the Arab Region	Rainfall is presented within the Arab regional climatical conditions	Geo.11.02.01.16-19	Rainfall	Well presentation		Topography linkage with climate and plant. 16-19	Natural Geography of the Arab Region. 04
Water Resources in the Arab Region	The water resources in the Arab region are presented and categorized into three main resources. 1. Rainfall: it is mentioned that rainfall is the main water resource in the region. It is written that total amount of rains is 2228 Billion CM/year from which 90% is evaporation, 1.8% is recharge, and 8.2% goes as run-off. It is added that rainfall quantities and patterns vary from place to the other in the Arabic countries according to the climatical conditions. 2. Surface Water: it is mentioned that it represent the core portion of the available water resources in the Arab region with 225 Billion CM. It is mentioned that around 46% of the Arab water comes from outside the region via rivers. Then the main rivers, regional small rivers and seasonal wadies are presented including their main features. It is attached that Yemen depends widely on seasonal wadies water and therefore many dams have been built. 3. Ground water: It is said that GW is an important water source for many countries in the Arab region. Then it is classified as a) Shallow GW (39 Billion m3): it is said that this type of GW is a renewable source, subject to climate change impacts and over-extract and to be polluted due to the wastewater. b) Deep Ground water: it is mentioned that this type of GW had been formed before 4000-44000 thousand years and is existed in deep and large aquifers that its quantities is huge but it is considered as nonrenewable water sources	Geo.11.02.02.20-25	Water resources	The concept is supported by 1. A graph represents the classification of the Arab water resources as surface, ground and non-conventional water resources. 2. A map illustrates the rainfall rate and GW existence within the different Arabic countries. 3. The groundwater aquifers, available water resources, seasonal wadies and Sabkhah are briefly defined in a side box. 4. As a group activity, students are asked to draw a big map for the Arab Region highlighting the locations, start points and the end let of all rivers existed in the region		The water in the Arab Region. 20-25	Natural Geography of the Arab Region. 04
Population Increase	To come over the disadvantages of the increasing population in the Arab world, it is proposed to expand the agricultural vertically by using the modern tools such as fertilizers and pesticides, horizontally by cultivating new areas, and to wisely use the available resources and to develop alternatives for the non-renewable resources	Geo.11.02.03.32	Agriculture expansion	Vertically expansion is mis-defined.	Negative concept especially for the water scarce country like Yemen	Population Features in the Arab region. 32	Arab region population and economical resources. 05
Bases for agriculture	It is mentioned that most of agriculture in the Arab world is rain fed agriculture while the irrigated agriculture exists in Egypt, Sudan and Iraq since they have big rivers. But in Oases the agriculture depends on the ground water.	Geo.11.02.04.35	Irrigation	Ground water is used widely for irrigation in many Arabic countries not only in Oases as it is written	Mere and mis-conceptualization	Food Resources in the Arab World. 35	Arab region population and economical resources. 05

(Ax. 3. B) **Context**	**Description**	**Concept ID**	**Concept**	**Remarks**	**Gaps/weakness**	**Topic**	**Unit**
Energy Resources	It is presented that the Arab region depends on Oil, Gas and or water to produce the electricity. The latter one is mentioned to be the cheapest one. In side box, the hydro-electricity is defined as the electricity produced by water falls (natural and man-made) using the water fall power to move the turbines generating the electricity	Geo.11.02.05.49	Hydro-Electricity	It is presented within the lesson introduction. Then all other energy sources and their production process are presented somewhat in details except the hydro-power	Mere presentation	Electricity and Energy Alternatives. 49	Arab region population and economical resources. 05
Mining industry constrains	A) On page 54: (The natural factors led to develop the industry are presented as follows, 1. Availability of skilled labor forces….etc. 2. Availability of energy sources….etc. 3. Water: it is used to cool the production machines and as an input for the industry process) B. on page 57: I (t is mentioned that one of the constrains faces the investments in mining industry is the huge water quantities required in such field since most of the Arab countries lack the sufficient water quantities to meet the water needs for their populations. Nevertheless, the scientific progress in mining technologies offers good opportunities to get ride over the need for huge water quantities as it used to be which encourage for new relies to establish modern mining industry)	Geo.11.02.06.54, 57	Industry use	On page 54: (It is implied that water availability in the Arab region is one of the factors led to develop the industry in the region.). On page 57: (1. It was presented in page 54 that water availability in the region is one of the main factors led to develop the industry in the region. Nevertheless, it is mentioned that most of the Arab countries lack the sufficient water quantities for the population needs! 2. In the last unit, Agriculture is highly encouraged although it is the sector that has the lion share of the annual use and the lowest water use efficiency and economical return. However, it is never mentioned there that water shortage is a constrain facing agriculture development, nevertheless, it is presented to expand the agriculture through cultivating new areas)	(54): Messy presentation because when it came to water, the explanation has deviated to introduce how water is used in industry while it was supposed explicitly to mention that water availability is one of the factors …….etc. which in reality is not true. Hence, this is case of mis-conceptualization. (57) : Students might get confused to link such mis-matched discourses	Arabic Industry. 57	Arab region population and economical resources. 05
Water Problems Introduction	As introduction for the water problems in the Arab region, some water terms are explained as follows: 1. The water problem: it is the weak ability of water resources to meet the population water needs whether they are natural or industrial. 2. Water Balance: is the comparison between the water available resources and the required water quantities to meet the needs. So, if the required water exceeds the available one, the gap happens. 3. Water Poverty Line: it is a rate endorsed internationally referring to the individual annual water share from the consumed water as 1000m3. 4. Water Investment Efficiency: it is the statues of the water investment according to a lowest level of water abuse and a highest level of effectiveness	Geo.11.02.07.65	Water terms	Very important terms to be introduced, nonetheless there are some weakness in the stated definitions	1. Mis terminology: the stated definition of the water problem is exclusively belongs to the water supply shortage. 2. The stated water balance definition should be specified and down scaled as water balance between demand and supply. Because the general meaning of the water balance is known as the difference between all input and output water resources for a specific geographical area. 3. Water Poverty Line: it is not the individual water share of the annual water consumption as mentioned, rather than it is the individual annual water share of the available water resources regardless it is utilized or not. 4. Water Investment Efficiency: the stated definition might fits better to " the effective water investment" since it is already defined as having the lowest level of water losses and the highest level of utilization	Water Problem in the Arab region. 65	Present Problems and Issues in the Arab Region. 06
Water problem features in the Arab region	The stated problem is the water balance in the Arab region. The figure no.1 presents the water share/cap.year of the annual available water in the Arabic countries recorded in 1996 and the estimated values for 2025. The Poverty line appears at 1000 m3 while the extreme water poverty line appears at 500 m3. It is written to students to study the figure, compare the water shares of	Geo.11.02.08.65	Arab Water Balance	The extreme water poverty line is not correct since it is 200 m3/cap.year rather than 500m3/cap.year. 2. The presented contents and details does not reflect the water balance reality in the Arab world at all	Very odd presentation. There is a total of mis-match between the stated title of the problem and the presented contents. To adjust that either the title must be changed to "water scarcity in the Arab worlds" or the contents must be changed to present the annual available resources compared to the annual water use the region and the countries as well	Water Problem in the Arab region. 65	Present Problems and Issues in the Arab Region. 06

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	Yemen, Egypt, Iraq and Lebanon and their closeness to the extreme water poverty level						
Water problem features in the Arab region	It is presented that the water shortage in the Arab region happens due to the extreme draught and scarcity, the difference in precipitation rates and to the difference in surface water storage from year to year due to the consumption and evaporation	Geo.11.02.09.66	Water Shortage	The concept is supported by figure no. 2 which is a table presenting the available water amounts, the water demands, the gaps and the food security percentages of the Arab region for the years of 2000, 2010, 2020 and 2025	1. Mere presentation. 2. Mis-conceptualization: the contents of this presentation and the preceding one has been mis-posted by a mistake	Water Problem in the Arab region. 66	Present Problems and Issues in the Arab Region. 06
Water problem features in the Arab region	Increasing the water demand is presented as result to the population growth and the accelerated expansion in urbanization, agriculture, industry and services sectors. All that led to creating a gap between the demand and supply to critical limits in many Arabic countries a companied by water quality degradation. Hence most of the Arabic countries have entered the area under the water poverty line except Sudan, Iraq, Lebanon and Morocco.	Geo.11.02.10.66	Increasing the Water Demand	Well presentation	Title need to be adjusted as " Increasing the water demand"	Water Problem in the Arab region. 66	Present Problems and Issues in the Arab Region. 06
Water problem features in the Arab region	It is presented that water uses are agricultural and domestic. 1. Agriculture: it is mentioned that it consumes about 90% of the available water resources and most the Arabic countries depend on using the traditional flood irrigation system and groundwater consumption which is almost unwise and random. For instance, Saudi Arabia has drilled a vast numbers of artesian wells which led to drop the water levels in many wells and deplete many other wells. The same is happening in some parts of Yemen where wells are drilled and GW extracted randomly to meet the expansion of Qat. Qatar is suffering from the salinity happening due to interfere of the sea water into the groundwater. In addition, huge water quantities that are useable for agriculture are lost due to the evaporation, wastewater disposal into rivers like such as happening in Iraq and the excessive use of fertilizers and pesticides in irrigated lands. 2. Domestic use: increasing the consumers' numbers and the water abuse on the individual level suffers a lot of the water quantity and quality degradation. In addition, 30-50% of the water is lost in the public networks due to lack of maintenance and networks depreciation. Furthermore, wastewater networks depreciation threats the water quality as well	Geo.11.02.11.66-67	Low efficiency	The illegal wells drilling and the GW over use are happening in almost all parts in Yemen not only in some as presented. Poor language formation for the domestic part	1. Odd transitions. 2. Introducing the water losses concept in the public network might negatively affect the students to act careless when to ask them to save water. 3. Domestic use mis-use has mere presentation 4. Title need to be adjusted to indicate the contents properly as " Water low use efficiency"	Water Problem in the Arab region. 66-67	Present Problems and Issues in the Arab Region. 06
Water problem features in the Arab region	It is presented that most of the Arabic rivers come beyond the boundaries from other non-arabic countries such as Turkey in the case of Tigris and Euphrates rivers and from 9 other countries in the case of Nile river so that the Arabic countries in the downstream of those rivers are restricted by the decision of the upstream countries that might take water policies preventing the downstream Arabic countries from the needed water requirements. The same problem is with Israel that is occupying many water resources in Lebanon, Syria and	Geo.11.02.12.67-68	Water Conflicts	Well presentation	visualization is absent	Water Problem in the Arab region. 67-68	Present Problems and Issues in the Arab Region. 06

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	Palestine in addition to sharing the big portion of the Jordan and Yarmulke rivers. It is added that Israel is planning to withdraw the water from the Nile to the Al-Naqab desert.						
Non-Conventional Water Resources	It is stated that to come over the water shortage in the Arab region, many Arabic countries, especially those located in extreme arid conditions, worked to provide artificial water resources which are non-conventional water resources induced by water demand increase. In a side box the non-conventional water resources term is defined as " It is the water induced by increasing the water demand in some Arabic countries like desalination and wastewater treatment"	Geo.11.02.13.68	Non-Conventional WR introduction	The definition of the non-conventional water resources is not appropriate and need to be reformed	Mis-conceptualization	Artificial water resources. 68	Present Problems and Issues in the Arab Region. 06
	It is mentioned that it is the water resulted by desalinating the seas water and the salty groundwater to be potable for drinking, agriculture and ** some food industries. It is operated by very expensive technologies and equipment, sometimes needs distribution networks for long distances and requires qualified workers and experts to operate it. It is added that the total estimation of the desalinated water in the Arab region in 1996 is about 201 billon m3 and that the gulf states are taking the lead in water desalination in the region	Geo.11.02.14.68	Desalination Water	2. A photo taken from the air for a desalination plant site is posted. ** 2.An editing mistake changes the discourse so that it is understood as that some food industries are made by expensive technologies and equipment.	Poor presentation due to the followings: 1. It is not practical and does not make sense to present that desalination is used to produce water for irrigation due its high costs comparing to agriculture returns. 2. It should be mentioned that it is a practical option for coastal areas or some others near the seas. 3. It does not always in need of long distribution networks as stated. 4. It would be much fruitful to clarify why it is not suitable for remote highlands 5. The presented figure of the total desalinated water is incredibly presented as 201 billion m3. 6. It is not presented or inquired why gulf states are leaders in desalination	Artificial water resources. 68	Present Problems and Issues in the Arab Region. 06
	It is mentioned that some of the Arabic countries have built dams on rivers so that lakes are created. Those dams are used mainly for irrigation and sometimes for energy production such as Aswan dam, Euphrates Dam, the artificial river in Libya and Marib dam in Yemen	Geo.11.02.15.69	Dams	Dams are not non-conventional water resource as presented	Mis-conceptualization	Artificial water resources. 69	Present Problems and Issues in the Arab Region. 06
	It is mentioned that many countries in the world went to treat the wastewater to eliminate the wastewater problems facing the Arabic countries especially with urbanization high growth. Deposing the wastewater into seas without treatment increases the pollution problem for water, flora, soil and the shallow groundwater. Therefore, some states have treated the wastewater to ensure the safety for reuse in agriculture. Furthermore, TWW includes many fertilizers that make its use more beneficial and cheap. The total TWW in the Arab region 106 billion m3. Then the industrial wastewater treatment is presented but in very mere way. Finally, it is mentioned that agriculture drainage water can be used again after reducing its salinity	Geo.11.02.16.69,70	Wastewater and drainage water Treatment	1. How it comes that international countries started to treat the wastewater to eliminate the wastewater treatments problems in the Arab region. 2. How ground water and soil will be affected by pouring the wastewater in seas without treatment! 3. The stated total quantity of the TWW is a vague figure. It is not mentioned whether it is annually, monthly or something else and to which date does this figure belong? 4. The presentation of the industrial WW and agricultural drainage water are mere and not reflected	Messy presentation and need to be reformed	Artificial water resources. 69, 70	Present Problems and Issues in the Arab Region. 06
Problems face the Arab Region	The water security is defined as the assurance and ability to secure the fresh water from its natural and artificial resources by following polices and development plans for the water resources and providing international legislations and laws that ensure the Arabic citizen's rights to get the water. Then it is introduced that	Geo.11.02.17.70-72	Water Security	1. A lot of repetition. 2. The activity of this lesson asks student to write a report about how Arab deal with the issue along the historical stages and then to discuss its results with the teacher. This is	The water security definition needs to be reformed. 2. Awareness should not be excluded/focused on the water save in domestic uses, rather than it has to be more and more focused on water saving in agriculture that consumes 90%. 3. It is not clear what is meant by to construct big basins? 4. The concept is not clear enough and poorly	Artificial water resources. 70-72	Present Problems and Issues in the Arab Region. 06

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	attaining the water security requires regional comprehensive plans, local grand programs and removing constrains facing the regional development plans by adopting the common work between the Arabic countries. Some of the needed handlings are: 1. Preparing national plans for sustainable water use and conservation. 2. Making people aware people about the importance of saving water at houses, hotels, hospitals....etc. 3. Constructing dams, dikes and big basins. 4. It is a must to have strict legislations and laws for eliminating the random consumption of the GW before wells drilling without studies and regulations. 5. Encouraging the use of modern irrigation systems like drip and sprinkler systems and the conveyance systems to avoid evaporation in hot areas. 6. Establishing forestations since it conserve the water and reduce the evaporation. 7. Preparing a unified arabic strategy to face the disputes with upstream countries on the main rivers and encouraging the cooperation opertunities not only on the regional level but on the international level in order to solve the water conflicts and singe agreements ensuring the Arabic rights on having the water of the rivers passing throughout the Arabic countries. 8. Implementing regular maintenance for the water supply networks in cities especially in the hot ones. 9. Preparing national and regional strategies aim to conserve the GW strategic storage and conducting the sufficient hydrological studies to estimate the water quantities and how to protect them.			one clear example of the vast ad hoc activities given to students. Which water issue should the students write a bout? Each Arabic country has his own issues, managements, approaches, priorities...etc, how can the student harmonize all of those parameters within the suggested report? Then from which historical period should they start? Should they start from the very Arab old ancient and civilizations for e.g.? Finally, knowing that in most schools the class contains between 30 -70 students. SO, does the teacher have the time to discuss this activity individually with his students as proposed by the activity? 3. The lesson evaluation Qs are asking students pure direct Qs that require students to memorize and re-write the information given in the lesson which is not proper way if we want to instill concepts in minds and ensure a realistic acquiring that can stay in minds for long period of time. Nevertheless the fourth last question asks students what are the features of the water problem in Yemen and what are the possible solutions from their point of view to eliminate the water problem? It is really unexpected to ask students such question since the whole context was applied on the Arabic level and barely some indications were mentioned to Yemen. Hence, if students are going to answer this question, they are in need of additional information sources such as library books, reports...etc. If so, it is really wondering how can the majority in rural areas and even in most schools of urban areas get access to the mentioned sources.	formed. 5. Using modern irrigation is not excluded for avoiding evaporation.		
Hunger Causes	It is mentioned that hunger has many causes such as agriculture production degradation due to drought, rainfall decrease for following years, floods, soil erosion….etc.	Geo.11.02.18.76	Draught and floods impact	The already stated causes are almost out of the hand of human. Nonetheless, what about the man-made negative impacts that mostly will lead to hunger such as the ongoing unsustainable GW over-	Mere presentation	Food Security. 76	Present Problems and Issues in the Arab Region. 06

(Ax. 3. B) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
				use, mis-management tools such as constructing dams in upstream which deprive people in downstream form water they used to get for food production and other purposes			
Food Security	It is mentioned that to achieve the food security in the Arab countries, it needs to have enough coordination between the agriculture policies in each country and to have regional agricultural policies. Those polices should include the following important intendancies: 1.Horizanal Agriculture expansion by cultivating new areas and protect the existed ones against the deforestation, urbanization....etc and to provide enough and stable water resources from the natural and artificial surface and groundwater resources. 2. Vertical agriculture expansion that increase the agricultural production through enhancing the seeds, using the appropriate and adequate fertilizers and pesticides, to increase the import the agricultural and irrigation modern machines and pay more attention to Livestock and fisheries.	Geo.11.02.19.77-78	Food Security Policies		1. Encouraging the horizontal agricultural expansion will lead to deplete the remaining unsustainable groundwater resources in many Arabic countries such as Yemen. 2. Vertical….: the green houses and their benefits as one of the most effect tools for the vertical expansion is absent. It is not clear and logic how can livestock and fisheries lead to expand the agriculture vertically.	Food Security. 77.78	Present Problems and Issues in the Arab Region. 06
Food Security	Earth and water resources development by utilizing the rainfall water via irrigation, and Dams and dikes construction are examples of the agricultural policies to eliminate the instability in agricultural production	Geo.11.02.19.77-78	Dams	repetitive	Mere presentation	Food Security. 77.78	Present Problems and in Arab Region. 06
12th Grade							
nothing							

Annex 3.C. Water Concepts in History Subject in grades 05-12

(Annex. 3.C) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
5th Grade							
Yemeni Ancient Settlement	It is mentioned that the Yemeni Ancients had settled in near of the wadies and plains where the water is available. They constructed dams and dikes to store the spates water in wadis for longer period to be used for agriculture	His.05.01.09	Dams and Dikes	Dams focus	Repetitive	Yemeni Ancient States. 09	Yemeni Ancient States. 01
Economy Activity	It is said that Sheba kingdom paid attention to agriculture for which dams were constructed. Marib Dam is a big evident that Sheba Kingdom attained a developed agriculture civilization. So did Qataban and Himmiarr States via dams and canal construction and wells dug	His.05.02.20,23,28	Dams, canals	Two photos for the old and new Marib dams are presented but in very bad of printing quality. 2. Wells were used mainly to supply the drinking purposes not for agriculture as mentioned	Agriculture and dams encouragement	Sheba, Himmiarr and Qataban States. 20,23,28	Yemeni Ancient States. 01
Agriculture	It is introduced that agriculture in Yemen had developed in the very past due to the heavy rains, GW availability and soil fertile. Then it is presented that Yemeni Ancient had realized that seasonal rains and spates are not sufficient to irrigate their crops throughout the whole year so that they invented earthy dikes, wells, dams and water tanks for irrigation. Dams are the most famous tool for irrigation....etc	His.05.03.32-33	Irrigation management		The surface water allocation and management tools are always absents	Agriculture.32-33	Yemeni Ancient Civilizations Features. 02
6th Grade							
Islamic Cities Construction	Establishing and constructing cities has some criteria in the Islamic historical states that the Caliph or Governor should follow. The first one is to ensure a safe and easy accessible drinking water source within the city	His.06.01.104	Drinking water supply	Stand-alone concept	It could be reflected in the evaluation Qs on the current situation of drinking supply services…etc	Islamic Architecture. 104	Islamic Art.4
7th Grade							
Old Yemen	It is mentioned that Yemen was known as the Arabia Felix for having many advantages, one of them that it has abundance of seasonal rainfall. Another reason is according to its dams and terraces construction	His.07.01.01.21	Water abundance	Yemen is always known as a water scarce country. The annual average rainfall is 200 mm. Hence, Yemen is water scarce country. However, there is a good opportunity here to present how the Yemeni ancient adapted to such the high water scarcity and how they could succeed to manage and allocate the scarce water resource	Mis-conceptualization.	The Arab ancient civilizations. 21	Civilizations concepts. 01
Arab civilizations	It is said that Mesopotamia, Levant, Nile wadi civilization established due to the availability of water mainly in rivers and fertile soil	His.07.01.02.22-23	water availability		Mere presentation	The Arab ancient civilizations. 22-23	Civilizations concepts. 01
Arab civilizations	It is said that the water resources availability was one of the most important factors based on the old arab civilization had established. The existence of the rivers and the other	His.07.01.03.28-29	Water resources		1. How the ancient Arab succeeded to manage the resources is still absent. 2. The	The Arab ancient civilizations	Civilizations concepts. 01

(Annex. 3.C) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	water sources helped to stabilize the life around the following water resources : 1. rainfall and spates in the summer and the winter. 2. Dams, pools, and dikes construction to utilize the rainfall water during the whole year. 3. Utilizing the rivers, streams, springs and wells. 5. Developing good irrigation methods and systems				mentioned irrigation systems are vague presented and mistakenly presented as water source	establishment features. 28-29	
Arab old migrations	It mentioned that the climate changes happened in Yemen during the third and the second century before Jesus born resulted in rainfall stoppage, drought, wells and springs depletion…etc which had affected the population too much so that many of them migrated to another places looking for better sufficiency of water sources	His.07.01.04.35	Climate change		It is not reflected that the same can be happened nowadays due to the climate change impacts and the water abuse practices	Yemen position within the Arab ancient civilizations. 35	Civilizations concepts. 01
Urban life activities in the old Yemen	Yemeni were known for dam constructions	His.07.01.05.44	Dams and dikes		Mere and repetative	Yemen as arab civilizations. 44	Ancient Yemen Civilization. 2
Economical features: Agriculture	It is presented that Yemen is known by agriculture since millennia. The productive lands and the abundance of water gained by the dams, pools and canals construction are reasons helped to develop agriculture at that time. Then it is asked in which Yemeni cities do the famous dams and cisterns are located?	His.07.01.06.54	Water abundance	Yemen is always known as water scarce country. The water harvesting systems such as pools and tanks were mainly used to cover the domestic water needs and rarely have been used to complete the irrigation needs. Dams construction was one tool Yemenis adopted but it was not as wide as it is presented repetitively in the textbooks	Mis-conceptualization.	The political and economic features of the Ancient Yemen Civilizations. 54	Ancient Yemen Civilization. 2
Urbanization features	As one of the ancient Yemeni urbanization features, dams construction is presented. It is said that Yemeni ancients used to build dams everywhere they found it useful to do so that they had not left any wadi unless they covered it by a dam or dike. Those dams were used to raise the water level in the wadis to be able to irrigate the lands that are higher than the wadi itself.	His.07.01.07.63	Dams construction	Dams construction is extremely exaggerated in this presentation	Repetitive and exaggerated presentation	The Civil features of the Ancient Yemen Civilization. 63	Ancient Yemen Civilization. 2
Mesopotamia	As a thinking card: it is mentioned that Tigris and Euphrates rivers represent the economic lifeline for Iraq and Syria at present. Then it is inquired: Is it in the interest of the two countries to take a unified position towards the potential threating dangers of any other party on both rivers?	His.07.01.08.77	Water conflict		1. it is a stand-alone concept that seems to be advanced for such age	Evaluation activity. 77	Mesopotamia .03
Arab old Civilizations' establishment	It is stated that the water availability in Egypt, Morocco and the northern countries of the Arab peninsula helped establishing many civilizations along the history	His.07.02.01.10,34,41,57	water importance	Mere	Mere presentation	10, 34, 41,57	
8th Grade							
Islamic civilizations	One of the main reasons by which the agriculture in the former Islamic State has been developed is the water	His.08.02.01.08	water resources	The same region today is a water scarce region		The economic life in the	The economic and

(Annex. 3.C) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	availability in wells, rivers and springs					Islamic civilization. 08	social life in the Arab Islamic civilization. 04
Islamic civilizations	One of the main evident that Muslims cared much about improving the agriculture is irrigation tools providing, dams and channels constructing, ponds repairing, bridges and arches construction, water save and establishing a water office at that time	His.08.02.02.09	Irrigation management		1. Mere presentation. 2. what kind of water save they did , where was the mentioned water office established and how did it manage the water are not presented	The economic life in the Islamic civilization. 08	The economic and social life in the Arab Islamic civilization. 04
back cover	A photo of a huge abundant waterfall is presented and supported by a verse from the Holy Qur'an as "Say, ye thought become your water disappeared, who can come up with fresh water for you? "	His.08.02.03.back	water is life	It is wondering how can such abundant water view help to encourage students for water saving	1. Repetitive, 2. Mis-match between the message and the selected photo	back outside cover	
9th Grade							
nothing							
10th Grade							
Agriculture As an economical feature of the Old Yemen	It is presented that agriculture was one of the main three economical activities and was mainly dependent on rainy seasons (summer and fall). Therefore, Yemeni ancients have concerned much about rainfall water save and drainage so that they have constructed dams, dikes, pools and canals so they can utilize it later on in the dry seasons	Hi.10.01.04.39	Water Harvesting		Water allocation and distribution practices are still absent	Old Yemeni Civilization Development Features. 39	Old Arab Civilization. 02
Social Features of Yemeni Society	It is mentioned that cooperation is one of the many characteristics of Yemenis. They were known for their cooperative work constructing dams and terraces and facing crises such as re-building and maintaining dams	Hi.10.01.05.40	Participation	to some extent, it is a good presentation	but it presents the participation exclusively to the dam construction and maintenance	Old Yemeni Civilization Development Features. 40	Old Arab Civilization. 02
Art and Construction feature	As an evident of the old Yemeni capabilities in art and construction, it is mentioned that Yemenis have built hundreds of dams such as Marib and Al-khanig dams	Hi.10.01.06.41	Dams construction		repetitive	Old Yemeni Civilization Development Features. 41	Old Arab Civilization. 02
Greek and Roman civilization establishment	One of the main factors led to establish and develop the Greek civilization is the water availability	Hi.10.02.01.10, 24	Water availability		mere presentation	The Old Greek Civilization. 10, 24	The Old European civilizations. 01
Agriculture as an economical feature of Greek	It is presented that Greek ancients were mainly dependent on agriculture as a main economy of life. Hence, they cultivated wherever is accessible to grow, constructed small dams around the water wadis to control floods and they dried pounds	Hi.10.02.02.11	Dams	It is not clear why did they dry ponds?	mere	The Old Greek Civilization. 11	The Old European civilizations. 01
Kindah and Nabati Civilizations Development	It is said that canals construction and wells were drilled for agriculture in kindah civilization	Hi.10.02.05.56,66	Irrigation		Mere	Kindah civilization.66	The Old Arab civilizations before Islam. 06
11th Grade							

(Annex. 3.C) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
The Islamic Arabic Civilization	It is mentioned that the Islamic Arab Civilization has experienced from the Old Arab civilizations many things in many fields such as…….. ….., Dams, irrigation systems	His.11.01.01.14	Dams		Mere presentation	Islamic Arab civilization development reasons. 14	The Islamic Arab Civilization. 01
Development features at the prophet Mohammad PBUH era	It is mentioned as one of the development features at the Prophet Mohammad PBUH that drinking water was secured by buying a water well that belonged to a Jewish guy who used to monopolize the drinking water with high prices'	His.11.01.02.14	Drinking Water		Indirectly it seems to encourage the principle that drinking water should be provided for free	Development features at the prophet Mohammad PBUH era.14	The Islamic Arab Civilization. 01
Economical Features at the Khulfa'a era	It is said that Islamic Khulafa'a (fellows who ruled the Muslims after the prophet Mohammad PBUH) have paid attention to expand the agriculture by constructing canals and to supply the drinking water to cities via well digging and channels constructing. It is added that the second Khalifah Omar bin Al-Khatab instructed the Muslims to construct the canal linking the Nile with the red sea	His.11.01.03. 30,31	Drinking water		Mere	Development features at the Muslims' Khulafaa era.31, 32	The Historical development of the Islamic Arabic Civilization. 02
Economical Feature at the Islamic Amawee era	It is presented that agriculture in the Islamic Amawee era had widely become an economic activity of the people life at that time. The reasons behind were Amawee's efforts in maintaining the old irrigation canals and constructing new ones in …….., dams constructing in areas where there is not rivers and constructing some measurements tools to measure the water depth in rivers and to determine the wet and dry seasons	His.11.01.04. 37	Irrigation use management	some details are provided		Development features at the Islamic Amawees era.37	The Historical development of the Islamic Arabic Civilization. 02
Economical Feature at the Islamic Abbasees era	It is mentioned that Abbassees have focused on developing the economy sources especially the agriculture. Hence they encouraged agriculture adoption via irrigation systems improvement for which they established a management department that continuously supervised maintaining and cleaning the irrigation systems and constructing new canals financed by the state at that time	His.11.01.05. 51	Irrigation use management	It is well to present that water management is not a new businesses but a practice with deep roots in the history	It instill the perception that the state should construct and even maintain the irrigation services such as dams, dikes, canals…etc which is totally against the sustainable services management that beneficiaries should participate at least with the operation and maintenance	Development features at the Islamic Abbassees era.51	The Historical development of the Islamic Arabic Civilization. 02
Economical Feature at the Islamic Fatimees era	It is mentioned that Fatimees had realized the importance of agriculture in Egypt so that the paid high attention to support it via canals construction	His.11.01.06.67	canals	A sketch of a traditional water pump design developed at that time to be operated by an oxen for river water delivery to the higher canals is presented	Mere	Development features at the Islamic Fatimees era.67	The Historical development of the Islamic Arabic Civilization. 02
Agriculture	It is mentioned that Yemenis were high skilled in agriculture and dams, canals and drains construction that still existed till today showing their greatness	His.11.02.01.28	Dams and canals		Surface water allocation system, community participation in constructing and maintaining the water harvesting systems such as pools and terraces, irrigating in the early morning and in the late of evening....etc were the key indigenous tools and practices by which Yemeni ancients could adapt to scarcity conditions and succeeded managing	Islamic Civilization features in Yemen. 28	Yemen position within the Islamic Arab civilization. 01

(Annex. 3.C) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
					their water scarce resources, however, dams construction is always emphasized as the magic tool Yemeni ancient use for water management		
Economical Features	It is presented that Muslims in Andalusia have developed the irrigation systems via canal and drains construction	His.11.02.02.67	canals		Mere	Islamic Civilization in Andalusia. 28	Islamic Civilizations outside the Arab region. 05
12th Grade							
nothing							

Annex 3.D: Water Concepts in Science Subject in grades 01-09

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
1st Grade							
Plants	A photo presents a child irrigating a plant by small container. Subtext is " we irrigate the plant"	Sci.01.01. 71	Irrigation		Mere	We grow plants.71	Plant around us. 04
	A caricature presents a child holding the hole and pouring the water heavily on a plant	Sci.01.02. 78	Water Abuse	It would be better to add an X symbol to label as a bad practice	Stand-alone presentation	2nd semester entrance.78	
Health	A photo for two children who are drinking from water container. The subtext says " I do not drink water unless from a clean container. Then two drawings present two persons; the first drinks from a bottle while the second drinks from a pond. The evaluation question asks student to mark the figure illustrating the water or the clean drink	Sci.01.03. 83,84	safe drinking water	Well presented	Both figures present water. The question need to be better reformed	I keep my food and drink clean. 83,84	Body health.05
Health	A drawing presents a person washing fruits by a tap whose water flows heavily	Sci.01.04. 83	Water abuse	It would be better to encourage learners to wash fruits, vegetables…etc by using a pan	It does not encouarge the water save	I keep my food and drink clean. 83	Body health.05
water	A water drop is drawn to present its uses that are illustrated inside it. Then a verse from the Holy Quran is posted that indicates " from water we made every living beings"	Sci.01.05. 87	Water importance			entrance.87	Water in our life. 06
Water	Where do we find water? Then photos with subtexts answered: rainfall is Allah's grace to us, flowing from the mountain, collected in the dam, existed in the well, river and sea	Sci.01.06. 88-89	Water resources	Well and simple presented. In the evaluation part, it is asked to match the photos of a river and sea with the words of salt and fresh water	Mountain is introduced as water source!!!	Where do we find the water?88-89	Water in our life. 6
Water	Photos reinforced by subtexts are used to illustrate the type of water which is potable. 1. Small treatment unit (we treat water to be potable). 2. A cook in the kitchen (water we drink and use for cooking). 3. Potable water does not have color, smell and taste. 4. We do not drink the sea water. 5. We do not drink spate water.	Sci.01.07. 91-92	Potable water	well	It is too advance to introduce the drinking water treatment	Potable water. 91 - 92	Water in our life. 6
Water	Photos supported by subtexts of "no human nor any animal and plant can live without water" are presented	Sci.01.07. 94	Water importance	Well presented		Water Importance for creatures lives. 94	Water in our life. 6
Water	Photos supported by subtexts of "we use water for showering, putting off the fire, cloth washing, navigation, refreshment and producing electricity" are presented	Sci.01.08. 95	Water Uses	Well presented	It is too advanced to introduce the electricity generation by water. Furthermore, the photo used to illustrate the energy production from the water is meaningless	Water Importance for creatures lives.95	Water in our life. 6

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
water	Some photos illustrating the right and wrong water use way by washing the face , car and irrigation. The students are asked to choose the right behavior	Sci.01.09. 97, 100	Water conservatio n		The photos used to illustrate the wise and miss-use of water for irrigation were miss-taken. Because one shows a pump pressure test and the other one was very zoomed-in so that it shows the sprinkler device	Water Importance for creatures lives.97	Water in our life. 6
2nd Grade							
Plants irrigation	It is mentioned that plants are irrigated by many methods such as rainfall, water hole, sprinkler and drip irrigation. Then four photos of drip, basin flooded by a hole, sprinkler and spate irrigation are presented with subtexts indicating the methods names. It is said we irrigate plants and do not abuse water. Finally, it is asked which does irrigation method save the water?	Sci.02.01. 44	Irrigation methods	1. It is very well presentation from principle however it has somewhat miss-match between the contents. 2. The photos have high resolution and good printing quality. The photo of the drip irrigation is well selected. This improvement in presentation might be resulted according to the cooperation between MOE and LSCA in revising this book in 2010. 3. To form or measure the attitude, the student are asked to state their attitudes towards a family that does not care and plant its garden. 4. Noting that very few Yemenis in cities have a house garden, the majority of population and water abuse are existed in rural areas, it would be better to identify and form students attitudes (especially rural) towards somebody who is abusing the water in irrigation instead of the existed one regarding the garden cultivation importance. 5. It might be too advance to introduce the sprinkler irrigation systems	1. The irrigation by using the water hole of gardens is used to conceptualize the flood irrigation system. Nonetheless, it does not reflect that inefficient flood irrigation that Yemenis do and student might find it not easy to recognize that it is a way that abuses the water. 2. The photo used to illustrate the called rainfall irrigation does not match well since it has been directly taken for huge floods resulted by heavy rains so that it shows floods and a resulted pool rather than fields have irrigated by rainfall. Hence, this photo should be replaced by a photo for farms or terraces that are irrigated by rainfall. 3. It does not make sense to present the rainfall which is a water source as an irrigation method and to ask to compare it with other irrigation methods. 4. The photo used to illustrate the sprinkler system is one for very modern and complicated motile track system and the spray can hardly be notice. Furthermore, it is still never used in Yemen. Therefore, it is too advanced and not clear presentation that it would be better to replace it by photo/illustration drawing for simple sprinkler system. 5. For more fruitful, it can simply present that modern systems make the crops better, 6. The unit objectives does not include any indication related the modern irrigation methods and water save importance. This case is known as "contents are not reflected on the learning objectives"	Plant Care.44	Plants around us. 03
Hot Weather, The Summer	Within the introduction of the summer, it is mentioned that we mostly take shower, Why?	Sci.02.02. 78	Domestic Use	Neither the contents nor the teacher instructions refer to avoid the water abuse due to the mentioned many shower times	Hence, it would be better to draw the students attention to save the water and avoid its abuse	The Year four seasons.78	Earth Rotation and The four seasons.05
Hot Weather, The Summer	It is said that" in Yemen one Allah's grace is that our rainfall comes in the summer.	Sci.02.03. 78	Rainfall season	1. The rainfall seasons in Yemen are two. The first comes in the spring season while the second comes in the summer. 2.The cause behind	Single-minded discourse	The Year Four Seasons.78	Earth Rotation and The four seasons.05

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
				such statement might be that rainfall alleviates the "hot" conditions and make the weather much nice. However, having the rains in the summer means also more evaporation (water losses) and less recharge (benefits).			
3rd Grade							
Unit Entrance	One versus explain that Allah sends down water from sky to earth to be stored as springs…etc and then to be used for irrigation. It is supported by a drawing for river, trees, clouds, rain, houses…etc	Sci.03.01.74	Rainfall	It is used as an introduction for the fifth unit that contain two lessons of water forms (Liquid, solid and Gas) and water cycle	stand-alone concept	Unit Entrance.74	The Water around us.05
Introduction	A photo of Marib dam and simple background about the historical dam that was built thousands of years ago and renewed in the 1980s. It is mentioned that Marib Dam is an evident of the Yemenis Ancient wisdom in the field of agriculture and irrigation. Then it is mentioned that dam has a high importance in collecting water and GW recharge. additionally, it is used for irrigation in the dry seasons	Sci.03.02.75	Dams	The headline for this introduction is "water is our responsibility" and the remaining parts of the unit is about the water physical states	This concept seems irrelative to be used as an introduction for the unit. Furthermore, it is just a response to dams focus policy	General Information. 75	The Water around us.05
Water Physical States	Introduction to the water physical states (Liquid, Gas and Solid). A figure is used to illustrate the water transformation from stage to the other.	Sci.03.03.76-79	Water Physical States	The whole concept is presented mainly by using inquires and an illustration figure.	The first two inquires mention the water without its identification article and need to be reformed. Evaluation activities is designed as questions to complete and choose the right words that rely on the need for memorization	Water States and transformation.76-79	The Water around us.05
Water cycle	A drawing is presented introducing the concept of the water cycle and its steps. Then student are required to describe what they see in the picture. Finally, inquires such as where does water exist on earth? From what are the cloud formed? What do we call water in the ground? Where does the evaporated water from earth surface go? What are the different steps of water cycle? What is your role to save water at your home. Finally, the evaluation activities are questions to complete and match the words with definitions	Sci.03.04.80-81	The Water Cycle	1. The picture presents the rainfall as the first step of the water cycle, the evaporation from the sea as the second one and the clouds as the third step which is not correct. The first step is well known as the water evaporation from seas, oceans…etc. 2. The picture was poorly designed so that it is very hard to recognize the see and the evaporation simulation. 3. The second evaluation activity of this lesson was mistaken since it belongs to the previous lesson	1. The other parts of the water cycle such as infiltration, ground water, transpiration ...etc are totally excluded by the presented model. 2. Only one page is allocated to illustrate the concept which is not enough to cover its different sides. 3. The steps order presented by the model is wrong. 4. The whole lesson depends on the teacher capability to be explained which is risky since many teachers might not be familiar with water cycle terms, steps, interlink ages...etc. Finally, it would be better to simply refer that most of our rainfall in Yemen is lost due to the high evaporation rate	Water Cycle in the Nature.80-81	The Water around us.05
Water cycle	One inquiry is written as "what is your role to save water at your home"?	Sci.03.05.80	water save	It would be better to replace it by more in-depth activity	Stand-alone concept	Water Cycle in the Nature.80	The Water around us.05

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
4th Grade							
Agriculture Production	As an introduction of the fifth unit titled "Plants Producing and Importance", a photo of flood irrigation is used to introduce the agriculture production importanc. It is supported by a verse from the Holy Qura'an indicating "to eat from what Allah has supplied to earth and to aprais him for that. Yemen is a good land and Allah is the merciful lord"	Sci.04.01. 01.111	Irrigation	The irrigation method and convyince system applied in the presented photo are the flood irrigation and the earthy channel	1. Flood irrigation and unlined open channel are the main causes of the water low use effecincy that does not exceed 35%. It is a disaster, to use such photo to encoarge the agriculture production. Such photo for sure will instill an image that such irrigation method is right resulting negatively on learners' attitude twords the water uses. 2. Mis-use for the religious values	Plants Producing and Importance. 111	Plants Producing and Importance. 05
Cultivation Equipment	At the last part of the fifth lesson titled "Equipment Help Us in Agriculture", a small photo (4*6 cm) of farm that contains big trees of peach supplied for irrigation. Besides the photo, it is written " Observe the supplied pipes through the trees". Then, many inquiries were given as follows: What is the benefit of this irrigation method? What is called? Look for such system in area where you live (If there is)? There are many other irrigation methods, state them? Compare between these methods speaking their role in saving water? And why? On the next page, this definition was put " The irrigation method that uses pipes which pass by each tree is called the Drip Irrigation.	Sci.04.01. 02.132	Modern Irrigation	The allocated space for the concept is not sufficient at all.	1. The concept presented in a very poor and useless way. The photo is very small that it is difficult to recognize the irrigation system (whether it is drip or poplar). 2. The allocated area for the whole concept is less than half of page (even the irrigation is one of the main inputs/processes of producing the plants that is the core of the unit).3. The whole concept is presented in a way that totally depends on the teacher to explain and answer the very comprehensive inquires. It really risky to that since the modern irrigation systems are still a new technology that Yemenis rarely have and use. I could not imagine how many teachers can answer such specialized questions. Furthermore, can teachers highlight the social and economic benefits of using such systems? 4. The concept was not assessed by the activities following the lesson. 5. The stated definition of the drip irrigation is poorly formed. 6. The lesson was put as the last one in the book. And according to the ME report, 2010, schools are barley finish the books. Hence, it is not sure whether students will reach it or not	Equipment Help Us in Agriculture. 132	Plants Producing and Importance.05
Materials Features	An activity asking students to take a stone, a cup of water and a bag of air. Then they are requested to examine the three materials, write down their properties in a table. They are supposed to recognize some physical features of the water the color, state and the shape.	Sci.04.02. 01.12	Water physical properties	well presented	Visualization is absent	Materials features.12	Knowing things around us.3
Water States	A simple activity of observing the condensation of steam around a cold water in glass is presented to introduce how water is existed in the air	Sci.04.02. 02.33	Humidity	well presented		Air is a mixture of Gases.33	Knowing things around us.3
Temperature Effects	Two activities are proposed to melt ice in a cup and to freeze it again to teach that temperature changes the water states	Sci.04.02. 03.58-59	Water states	well-presented and can be applied without need to labor		Temperatur e changes the material staue.58-59	Temperature Measurement and Impacts.08

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Temperature Effects	Activity no.05 propose for students to take two glasses of water, to put one under the sun and the other inside a house and to leave them for two days. It is asked will the water quantities in the glasses remain equal as they were?	Sci.04.02. 04.64	Evaporation	Then it is reflected by some inquires on the sea water and food salt production from the seas	Visualization photo is poor. The whole concept is presented through inquires	Temperatur e changes the material staue.64	Temperature Measurement and Impacts.08
Earth surface erosion causes	Earth surfaces erosion due to the spates and rivers flow is introduced.	Sci.04.02. 05.150	Water flow impacts		Visualization photo is poor.	Natural factors eroding the rocks and change the earth topography. 150	Earth Surface has diverse shapes.11
5th Grade							
No life without Water	The lesson is initiated by a verse from the holy Qur'an (From water we made every living things). Then its inquired why there is no life on the moon? Marib is one of the old cities in Yemen, Why? Few living creatures live in the desert, why? Then students are requested to observe what remains after crushing the fruits for getting juice? This is to reflect that the large part of fruits, vegetables and animals is water. Then it is asked, how much water does exist in your body? (Students are asked to seek the answer). Then to be quite sure of the water importance for life, students are to do a simple experiment. They are requested to bring three plastic tans, label them by 1,2 and 3, fill them by soil, put three seeds of beans, to irrigate the tans 1 and 2 every second day, and to observe the plants growth. Then to stop irrigating the tan no.3 and to observe the three tans answering the following questions: 1. In which tan no plant has grown? 2. In which tan did the plant grow and then died? After that, students are requested to complete a prepared drawing containing the three tans filled with soil only. Finally, it is generalized" For sure you realized that there is no life without water, so from where does the water come?"	Sci.05.01. 01.111-113	Water Importance	It is very well presentation	1. In absence of research facilities in the schools such as libraries, can the students get the right figure of how much water exists in the human bodies that they are requested to search about? 2. The time needed to implement the proposed activity might exceed 7-10 days by which the students may finish the remaining lesson in the book and get off for holiday. so, how to ensure the application? What is expected to be happened that students will complete the posted drawing theoretically	No life without water.111-113	Water in our Life. 06
No life without Water	1. Following the generalization of " For sure you realized that there is no life without water, so from where does the water come?", three figures are posted as follows: A) a drawing hardly illustrates clouds, a stream	Sci.05.01. 02.113-115	Water Resources	Messy and poor presentation. The definition of the water resources is not that appropriate	1. Figures A and B are poorly presented so that it is very hardly to recognize that there is rainfall in the figure A and that figure B is a water kiosk (Myself, for first I did not notice that there is rainfall in figure A and only according to previous	No life without water.114-115	Water in our Life. 06

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	flowing on scrap and a cross section of GW well, B) A photo for a water kiosk, C) drawn bottle, and D) drawn tap. 2. Students are requested look at the figures and mention what they consider as a water resource and to search which of the presented resources supply your house with water. 3. Again they are asked the same question of what they consider as water resources and why?. 4. Then it is conceptualized that water resources means the natural places on which the rainfall water get together . 5. Then an activity is proposed asking students to use a cup to estimate how many cups of water does each domestic water use at home consume? and to put the results in a table of two columns of the use item and number of cups. After that it is mentioned that before tens of years the water of springs and the collected water into wells by the people were sufficient to meet their needs. 6. However, nowadays people numbers have increased and the water decreased resulting that these resources became insufficient so that people went to drill artisan wells and to desalinate the sea water				experience I could anticipate that figure B is for a water kiosk. 2. There is repetition of the question, which of these you consider as water resources? 3. The proposed activity is odd-looking to the presented where it is. It seems that suddenly jumps in. Furthermore, does it make sense to ask students to count how many cups will they use for cloth washing, which kind of cups they are supposed to use and will they compare the results? How since the cups are not equal? Anyway, it needs more clarification and instructions of how to benefit/compare the recorded results. 4. The term "well" is mentioned as people used to collect water in. This is an odd use. Yemenis usually, if not always, used the term of "pools". 5. The term "artisan wells" is noticed to be used for labeling the bore wells which is totally wrong. 6. The spatial context of the mentioned water shortage and resources deterioration is not determined. 7. In the self assessment questions, dams are introduced as a sole tool for water harvesting		
Self assessment questions	The third part presents the following question: If you have a broken tap from which the water is leaking with a rate of one cup/minute, calculate how many cups you can get in 30 minutes?	Sci.05.01. 03.115	Water loses	1. It is very simple calculation for this age	Very weak and fruitless Qs. It would be better to ask the students to reflect and compare the water leaking of certain period with the needed water amount for drinking for example. Or to ask them to calculate how much money can the save if they prevent the water leakage by tap repairmen or replacement. A comparison to the cost of replacement would be also much more persuasive tool	No life without water.115	Water in our Life. 06
Water pollution Risks	It is introduced that we heard a lot about water, air and food pollution. What do we mean by water pollution? Activity no.1 introduces that potable water is colorless and does not have taste and smell by putting pure water in three cups and adding salt, drop of red ink and drop of perfume in the three cups separately. Accordingly, conceptualization of water pollution is made. Then it is introduced that even sometimes water get polluted without changing his appearance features such as the surface water in ponds and streams due to the invisible creatures and insects that might polluted the water and	Sci.05.01. 04.117-120	Water pollution	The introduction and the beginning of the conceptualization is presented well. Nonetheless, the remaining parts are poorly presented	1. The conceptualization of potable water, its characteristics and pollutions is very odd formation. It is totally need to be reformed. 2. What is the use to scan the drawing of the pond (which is poorly drawn) to answer the proposed question. There is no relation at all.	Polluted water harms the living creatures.117-120	Water in our Life. 06

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	make it harmful for health. In figure no.2 (hand draw for pond edge and some solid wastes on), students are requested to scan the figure and describe how the uncovered water gets polluted? Activity 2. follows, requesting students to bring the third still living plant of the last lesson and to irrigate it with the salty water of the firs cup of activity one for two days and to observe what happens? Then it is said that student now can ask weather non potable water harms the animal and plants or not? They are asked to look again at the presented drawing and answer the following Q: nominate things that pollute the water and make it non potable for drinking and nominate things that pollute the water and make it non useable for plants irrigation.						
Water conservation	1. A verse from the Holy Qur'an is presented warning from the water abuse. 2. It is said to describe the family once the water cut off. 3. Two photos for a girl brushing her teeth while the water continues flowing out into the sink and a boy washing his face and hands by another sink. Student is asked like whom he does wash his teeth and face in the morning? 4. two hand drawings present two women, the first pouring the washing waste into the wastewater hole in the kitchen while the other one is pouring it into stream. Students are asked to select the right behavior. 5. A photo present flood irrigation and a drawing illustrates a modern irrigation system are presented. Students are asked to mark the best method. 6. It is inquired again which of the previous figures helps in water conservation.7. The water abuse is then defined. It is said that potable water reaches houses, it is already passed by the responsible people who clean and treat it in plants called treatment plants that get ride or the water pollution. 8. Activity one is presenting the water treatment through using the infiltration of paper.	Sci.05.01.05.121-122	Water abuse and conservation	1. The girl is explicitly wasting water; however, the boy's tap is pouring the water in a rational way. But it is not clearly stated whether both are wrong or the girl only. 2. The flood irrigation that students are supposed to mark as a bad method is the same photo used in another book to encourage the agriculture production and expansion. 3. The modern irrigation method picture is explicitly fictional combined a hand drawing with some make up.	It is well presented, however, the mentioned remarks need to be modified or improved.	I conserve the water. 121-122	Water in our Life. 06
		Sci.05.01.06.122-123	Drinking Water Treatment	The activity is a good idea, however, all his instructions are in the form of inquires that request students to observe and conceptualize	Some inserted hints or explanations need to be added to help students attaining the right conclusion. Otherwise, it is a stand-alone concepts that they might be misunderstood	I conserve the water. 122-123	Water in our Life. 06
Evaluation	A flow chart is drawn so that students fill in the blank boxes from the given words. In one branches the students are requested to fill in the main water resources of Yemen into three blank boxes. The given words to be selected	Sci.05.01.07.125	Water resources	"Rivers" is given as main water resources in Yemen	Mis-conceptualization. There is no rivers in Yemen at all	Unit Evaluation. 125	Water in our Life. 06

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	and filled in are rainfall, wells and rivers						
Temperature Transmission	Explanation of how temperature is transmitted through water from dawn to up	Sci.05.02. 01.3-5	Water properties		Although the concept is well and empirically presented, the proposed equipments which used in the experiments such as the glass-tube, metal holding bar,…etc are not available in almost all schools except some schools in the big urban cities	Temperature Transmission has many ways. 3-5	Temperature Transmission and Uses. 7
The weather	Humidity is introduced by conducting a simple yet applicable activity. It is presented to bring a very cold water or ice, to put it in a glass/bottle and then to observe the formation of some water drops on the outside surface. Why did this happen and how? Then it reflected to the sea water evaporation that is the main source of humidity	Sci.05.02. 02.70	Humidity	well, simple and applicable presentation	1. Applications of humidity in real life is absent. 2. The concept is not evaluated within the exercises	What Impacts the Weather. 70	The Weather in our Life. 10
The weather	Many inquiries supported by some photos of Fug and Dew are used to introduce that both of them happen due to the humidity conditions. As conclusion, The fug and the dew are results of humidity that disappeared once the temperature rises.	Sci.05.02. 03.71	The fug and the dew	It is teacher-centered introduction. It is well reflected by mentioning some examples of the formation of both	1. Applications of humidity in real life is absent. 2. The concept is not evaluated within the exercises	What are the impacts of the Weather? 71	The Weather in our Life. 10
The weather	A simple simulation is drawn to illustrate the device used to collect the precipitation for measurement. The main three parts were labeled from up to down respectively as receiver pan, collecting bottle and the earth (earth is mis-typed). It is sub-texted as the Hydrograph (A device used to measure the precipitation amounts). Then an activity follow to simulate and apply the concept by using a glass tube, a receiver pan and a spray bottle filled with water. The students are required to spray the water above the collector pan for a period of 10, 15 and 20 seconds and measure the water depth after each time. By recording the results, they are also required to draw a simple graph	Sci.05.02. 04.78-79	Rainfall Measurement	Besides the presented Hydrograph, some inquiries are presented such as what are the parts formed the device? How do we measure the rainfall? When does it rain in your area? Dose the precipitation falls by the same amounts in each time and place?	1. it seems as a bit advanced concept to be taught for this age. 2. Almost in all rural schools and in many urban schools that lack a laboratory, it would be difficult for them to apply the simulating activity. 3. It would be better to reflect the application of the introduced concept. In other words, to refer to the importance of rainfall measuring	Weather Measurement Tools (devices).78 -79	The Weather in our Life. 10
The weather	As conceptualization for the second activity of the weather change impacts, it is said that the floods affect people life and behaviors by damaging the houses, eroding agricultural lands and stopping the agriculture travel activities. Hence, weather predictions is important for people's life to avoid such unexpected weather changes	Sci.05.02. 05.84	Floods impacts	The concept is presented in a vague way.	1. Even it is well distinguished in the previous semester what is the deference between the terms of weather and the climate, the presented concept of the weather change impacts has somehow mixed up with the impacts of climate change. 2. It is said that weather predication will prevent such changes in the weather which is totally wrong. The weather changes can not be stopped, however, predicting that might help people to avoid the costs/losses they were supposed to pay.	Weather Impact in our life.84	The Weather in our Life. 10

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
6th Grade							
Energy	It is mentioned that dams and water falls are sources for energy. Then many inquiries are presented to present the energy production by dams	Sci.06.02. 01.70-71	Energy Production	The whole concept is introduced by many inquiries and two photos of a dam and turbines inside the dam body	It is totally a dependent concept on teachers capability to be explained	Energy Sources. 70-71	Energy in our life. 9
Awareness Instructions	The Yemeni consumer Association posted many instructions about safety, health and environment. The last one says " do not abuse water, it is the right of the future generation"	Sci.06.02. 02. last empty page	Water not Abuse		Stand-alone is a reparative concept	last empty page	
7th Grade							
Particles	Water as a combination of H2 and O is explained	Sci.07.01. 01.10	water properties	Well		Particles and atoms. 10	Material Combination.01
Materials Treatment	An activity explaining to students how to get rid of the turbidity (water mixed with sand) using a piece of cotton, layer of gravel and layer of sand combined in half bottle turned over another water container.	Sci.07.01. 02.50	Water Turbidity	The used equipment are made of the glass. It would be better to mention how students in rural areas can implement the activity using the available materials such as used water bottles, a normal pan….etc. This will remove the obstacles hinder simulating such simple concepts.	How to use such method in real life for treating the harvested water in rural areas (by pools and tanks) should be introduced	Material Isolation and Treatment Methods. 50	Pure and Tainted Materials. 3
Materials Treatment	How to get fresh water out of sea water is introduced by conducting an experiment in the laboratory. It is simply explained how to evaporate the water and collect it again without the salt that used to be mixed with. Then the students are asked to replicate the concept by using the infiltration method used before to treat the water turbidity or by boiling a mixture of water and salt till all water being evaporated.	Sci.07.01. 03.51-52	Water Salinity	The illustration picture is very poor so that it is very hard to distinguish the labeled processes and materials. Furthermore, only schools that have laboratories can apply the concept	The concept is not linked to the real life example of how the water cycle is the biggest ALLAH-made desalination plant on the earth providing the water balance overall the world. It is a risk to ask student in this age to boil the water at home, Instead, ask them to tell the father or the mother to do that in presence of them.	Material Isolation and Treatment Methods. 51-52	Pure and Tainted Materials. 3
Water treatment application	The title is Applications of drinking water treatment. At its end, the students are expected to describe how the water is being treated at home? How the water is being treated in the cities? And what should it be done before drinking the water? Then the activity #1 is explaining how some houses use a devise that treat the water by infiltration (cotton filter) and disinfection (U-ray). Then it is inquired how can we treat the water of pools, wells and wadies simply at home?. Activity #2 asks students to visit the desalination plant in Aden or any bottled water factory near from their areas and write a	Sci.07.01. 04.55-56	Drinking Water Treatment	The concept introduction expectations are supported with a photo of rural woman using her donkey to supply the home with water. The presented source she uses is a ground water poured out of pipe to flow through a long and somewhat wide conveying open unlined channel. The treatment chart illustrating the treatment steps presents the Cholera addition as the second step and the Florid as the final	1. The photo used to support the concept is misused and does not support the concept at all. Rather, it seems that installs other wrong concepts. For instance, the water source in the photo is the ground water which is known to be best clean and safe source for the presented rural areas. Instead, a photo of bringing the water from the old open pools might be more reflective and useful. On the other side, presenting the open unlined channel and bringing the water as a duty of the women might result in instilling wrong concepts by learners unless the teachers are smart enough to draw the learners attention that such practices are water problems we should get rid of 2. The	Applications on Drinking Water Treatment. 55-56	Pure and Tainted Materials. 03

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	report about that illustrating the water source. Then they are asked to discuss the water treatment steps and stages in those plants. Then it is explained that water comes in the plant via very fine screens (what is its use?). Then Chloride is added as next step (what is the benefit?). Afterward, Aluminum sulfate and calcium hydroxide are added to adhere to the suspended materials and get them settled. Finally, the water passes through the filters to be delivered to the storage tanks.			step.	illustrated water treatment at home is a presentation of a very expensive technology that only rich people can afford. Hence, presenting another simple and cheap expensive might have a better yield of learning. 3. It is inquired how we can disinfect the water killing the harmful biological pollutants by using simple methods at home. The inquiry is not answered within the lesson. It is really wondering how students themselves can or many teachers in rural areas response to such technical Qs. 4. On the other hand, why not to introduce some traditional methods such as boiling the water and pour it through a clean piece of cloth (side effects of hardness should be addressed). In addition, today we have the silver filter which is made of the dried fried clay and has a reasonable cost that a lot of villagers can afford. 5. The presented water treatment chart introduces two wrong mistakes (a) Chloride is not the second step of the treatment rather than it is the last step before delivering the water to the network. b) It is a big mistake to teach that the florid addition is used disinfects the treated water as a final a step. 6. The possibility to experience the concept by the suggested visits is very low since the limited capacities the public school have. Instead, simulation might be one solution to come over such constrain. 7. There is a gap of transition in page 56 before starting to explain the treatment process. 8. Almost all Yemeni cities are supplied by the deep ground water which has a high quality that does not need any kind of treatment. However, the water received at houses is of a very bad quality due to the rusted network. So, the presented treatment plant does not reflect the drinking water treatment in the Yemeni cities at all.		
Temperature effects	Water density under the different temperature conditions is introduced.	Sci.07.01. 05.99	Water Properties		reflection and application is absent	Temperatur e effects. 99	The Temperature. 05
Environmental systems	In an activity, students are asked to simulate a natural water system by bringing a basin, filling it with sea water, putting one or two fishes, adding some aquatic creators and some grass. Then they have a water system and are being asked to draw the nutrients...etc and how such system can be conserved.	Sci.07.01. 06.120	Water environmen tal system	Unnecessary concept	The majority of students living in highlands. Do, it is not applicable activity	From which does the environmen tal system consisted? 120	Environment and Living Creators. 7
	Water is the secret of the life, save it	Sci.07.01.	water is life		repetitive and mere presentation	back cover	

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
		07.back cover					
	Water physical features (color, smell and test) in its three conditions are introduced	Sci.07.02.01.11-12	Water properties	mere	repetitive	Two Types of Materials' characteristics. 11-12	Materials Characteristics. 1
Planets	It is mentioned that the earth looks blue from the space due to the water coverage of 75%. In addition, water is one of the main factors making the life possible for all creatures.	Sci.07.02.02.68	Hydrosphere	The exact percentage is around 71%	mere	Planets. 68	Space Parts. 12
	Water is the secret of the life, save it	Sci.07.01.03.back cover	water is life		repetitive and mere presentation	back cover	
8th Grade							
Transmission in Plants	Water absorption by roots and transpiration is well presented	Sci.08.01.01.123-126	Water Absorption and transpiration		To be able to practice the presented experiments, laboratory equipment should be available	How materials be transmitted into the plant. 123-126	Transmission in living creatures. 07
Nutrients	It is mentioned that water forms around 70% of our body weight and the body has to get its need of water since it is the media in which many internal bio-process happen. No one can live without water as Allah says "from water we made every living things"	Sci.08.01.02.153	Water Importance			Balanced Food. 153	Food and Health. 09
Qat Impacts	Students are asked to discuss the social and economic adverse impacts of Qat and record them in the given table. However, the required impacts are already put in a presented table from which "consuming large water quantities" is posted as one of the economical adverse impacts of qat	Sci.08.01.03.161	Water for Qat		1. A fruitless activity since the requested task is already solved. 2. it is important for the students to recognize how much water does Qat consume? How to save the water in irrigating the Qat at least as mid-term solution of dealing with Qat issue	Qat Chewing Adverse effects. 161	Food and Health. 09
	on the back outside cover, a photo of an abundant water view (Negara) is presented supported by a sub-text of a pray "Oh Allah, keep the grace of water "	Sci.08.01.04.back cover	Water is a gift	repetitive	Stand-alone concept. The photo has miss-selected. The need is to orient fruitful messages supported by photos coping with the critical water issues, problems, pragmatic solutions…etc	back cover	
Chemical interactions	Water as H2O and its chemical formation, formulas are presented	Sci.08.02.01.11	Water chemical properties			Chemical interaction. 11, 16	Chemical interaction and formulas.01
Water cycle	The water cycle is introduced using a picture and some inquires. Then activity 1 is simulating the evaporation by putting water in a pan, leaving it under the sun for 6 hr and measure the water depth before and after (what do you observe). Activity 2 simulates	Sci.08.02.02.81-83	Water cycle	In the evaluation Qs, it is asked why water not permeates from earth. (Unclear question).	1. The groundwater is totally dropped out from the presented concept and the used illustration model. 2. Infiltration and run-off are not illustrated in the presented draw of the cycle. 3. It is said that the large part of precipitation flows as surface water till it gets back into the seas and oceans which is	Water Cycle in the Nature. 81-83	Natural Cycles. 15

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	the Condensation process by boiling water in cattle, putting a cup on its pouring hole and collecting the steam as drops. It also simulates the steam transferring by putting a fan in front of the outgoing steam. Then it is conceptualized that water evaporates from water surfaces (seas, oceans, rivers...), rises up, gets cold and condensed and falls down as rainfall. It is added that the big part flows over mountains and slops, gets in rivers and lakes and eventually pours into the seas and oceans which is the end of the cycle from which it starts again				not always true. For example, in Yemen the large part of the precipitation is lost as evaporated water		
	on the back outside cover, a photo of an abundant water view (Negara) is presented supported by a sub-text of a pray "Oh Allah, keep the grace of water "	Sci.08.01. 03.back cover	Water is a gift	repetitive	Stand-alone concept. The photo has miss-selected. The need is to orient fruitful messages supported by photos coping with the critical water issues, problems, pragmatic solutions…etc	back cover	
9th Grade							
Solvents Preparation	Water as solvent is introduced	Sci.09.01. 01.13,14,2 0	Water properties	well presentation		Solvents and their preparation methods. 13,14, 20	Solvents and their preparation methods. 01
Acidity and alkalinity	Water PH is introduced	Sci.09.01. 02.46	Water properties		mere	Acidity and Alkalinity Power Grade. 46	Acidity and Alkalinity. 02
Acidic rainfall	Acidic rain formation and impacts are presented	Sci.09.01. 03.65-68	Acidic rainfall	well presentation	The majority of schools can not practice the activities and experiments proposed to introduce, prove and conceptualized the concept due to the lack of the laboratories and needed materials	Acidic Rain. 65-68	Acids and Alkaline interactions roles in the life. 03
Acidic rains	Water Hardness is introduced as an entail attached to the acidic rains lesson	Sci.09.01. 04.69	water hardness		mere presentation	Acidic Rain. 69	Acids and Alkaline interactions roles in the life. 03
Chemical pollution	The pollution resulted by the chemical industries on environment is introduced. Then it is asked what are the damages induced by factory wastes on air, soil and water?	Sci.09.02. 01.28	Water Pollution		Mere reflection on water	The Pollution of Chemical Industries. 28	Elements and Compounds Interactions. 09
Materials properties	Surface Tension, Cohesion and Adhesion Forces and Capillary action of water are introduced	Sci.09.02. 02.53-64	Water properties	The first lesson seems to be irrelative to the unit entire contents	Practice depends on the availability of the laboratory	Surface Tension, Cohesion and Adhesion	Materials Properties. 11

(Annex. 3.D) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
						Forces and Capillary action. 53-64	
Liquids flow in pipes properties	Water flow through pipes, its velocity…etc is introduced	Sci.09.02.03.65-66	Water flow properties	It seems a bit advanced to teach the water flow properties, formula…etc	Practice depends on the availability of the laboratory	Water flow through pipes. 65-66	Materials Properties. 11
Viscosity and diffusion in liquids	Viscosity and Diffusion of water are presented	Sci.09.02.04.68-73	water properties		Practice depends on the availability of the laboratory	Liquids Viscosity and Diffusion. 68-73	Materials Properties. 11
Pressure in liquids	Pressure in Liquids like water is introduced	Sci.09.02.05.84-85,92	water properties	Dams construction is reflected as an application example of water pressure increase after the increasing the depth. It is said that dam's body thickness at the bottom is larger than at the top. A photo of small water tank is used to support this discourse with a subtext of "dam for water reservation"	There is miss-match between the photo, its sub-text and the explanation for which it is posted	Pressure in Liquids. 82-85	Pressure in Solid and Liquid Materials. 12
Agriculture expansion	How to increase the cultivated area? What did the government do to protecte the Agriculture against the sand movement and water shortage?. Agriculture expansion is represented as increasing the cultivated area through the govermental efforts twords the water shortage, Dams construction, wells drilling, Channels maintainance and lining..etc	Sci.09.02.06.108,114	Governmental efforts	messy presentation	The concept has negative impacts on water management through the agriculture expansion encouragement, wells drilling…etc	Utilizing Environmental Resources. 108, 114	Utilizing Environmental Resources. 14

Annex 3.E: Water Concepts in Biology Subject in grades 10-12

(Annex 3.E) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
10th Grade							
Transportation in Plants	Water absorption and transfer throughout all parts plant , transpiration and Forces of Surface Tension, Cohesion, Adhesion and Capillary action are presented	Bio.10.01.104-108	Water absorption in plants	well	The concept is theoretically presented unless the school has laboratory to apply its activities	Transport in Plants. 104-108	Transport in Living things. 04
Water and salts organization	Maintaining process for the water balance in the human body is presented	Bio.10.02.170	Water balance in body			Excretion in human. 170	Excretion. 06
Plants	Transpiration and cutting in plants are presented	Bio.10.03.175	Transpiration and cutting			Transpiration r in plants. 175	Excretion. 06
Geology science Importance	It is mentioned that one of the geology importance is to explore the groundwater as additional water resources for drinking and irrigation	Bio.10.04.185	Groundwater Exploration		Mere	Geology study importance. 185	Earth structure. 07
The Hydrosphere	The hydrosphere and its main information are presented such as the percentages of the hydrosphere, the salty and fresh water and the minerals salts in seas and rivers. It is presented that seas and oceans play an important role in clouds formation since it is the main source for evaporation. In addition, it contains many other resources such as mineral slats and flora and fauna that is expected to solve the problem of food sufficiency	Bio.10.05.192-194	The hydrosphere			Hydrosphere.192-194	Earth structure.07
11th Grade							
Environment Systems	Water as abiotic media supporting other lives and some of its characteristics such as its reaction towards temperature and light and its density at 4 C° degrees are mentioned.	Bio.11.01.123	water properties		Mere presentation	Ecosystem components. 123	Environment and ecosystems. 03
	A drawing of a pond containing some figures of birds, fish, grass, plants…etc is presented as a fresh water pond represents an ecosystem. It is said, if we take a sample form the water or from the pond's bed and examine it, what will you find in? You will be clear, that these samples are consisted of mixture of many aquatic creators, organisms, organic and non organic compounds that is hard to separate them. And this is an evident of the environmental systems unity and interaction	Bio.11.02.124	The pond as aquatic ecosystem			Environmental systems types. 124	Environment and ecosystems. 03
12th Grade							
Biotechnology Uses	It is introduced that micro-organisms like Bacteria is used to treat the wastewater and convert it to harmless materials that can be used for different purposes such as fuel. However, much important is that dissolving the wastewater helps the environment to gets ride over one of its major pollutants. Then it presents roughly and merely the role of the two types of sludge treatments, aerobic and non-aerobic.	Bio.12.01.156-157	Sludge treatment	The concept is supported by a photo for the aerobic basins while its subtext states " Figure 10: illustrates Methane Gas production from the waster water". This is kind of mismatch between the explanation and the illustration tools	Poor presentation.	Biotechnology use for polluting wastes treatment. 156-157	Biotechnology. 06
Agriculture and	It is introduced that human had started to grow plants for	Bio.12.02.163	Water			Environment and	Environment

(Annex 3.E) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Human Stability	first time before 12,000 years and accordingly he started to establish communities and civilizations especially in places around the water resources such as the rivers in Iraq and Eygpt and the dams in the ancient Yemeni Civilization		Importance			it problem. 163	and it problem.07
Air Pollution	Acidic rain formation and its impacts on human, environment and construction are presented	Bio.12.03.164	Acidic Rain	Well		Air Pollution. 164	Environment and it problem.07
Water Pollution	As an introduction for the mentioned context, it is said that the water is the base of life for all living things as ALLAH says in the Holy Qur'an (From water we made every living beings". It is added that water is an input of the living things bodies, an important media for interactions happening in the living bodies and forms a very suitable system for flora and fauna in rivers, seas, oceans...etc. However, nowadays it is subjected for various pollutants	Bio.12.04.171	Water Importance	Well		Water Pollution. 171	Environment and it problem.07
Water Pollution	It is said that water is subjected to many different sources of pollutions. The most important ones are 1. Wastewater produced by houses, schools, factories and commercials. It contains treatable pollutants such as the organic compounds and the biological micro-organisms that cause diseases. 2. Chemical materials and water produced by industrial activities. 3. Oil and petroleum wastes that produced poisoned wastes polluting seas, oceans and the other water resources. 4. Fertilizers and Pesticides excessive use especially the ones containing Mercury which is a poisoned element, which might reach and pollute the ground water. 5. Acidic rain in the industrial areas. 6. Thermal pollution that resulted by using the water for energy production in steam and nuclear plants and subsequently reducing the O2 amount in the water affecting the flora and fauna various systems. Then It is explained how seas and oceans water get polluted either by the big oil transportation ships or by the chemical wastes of different types of fuels used by ships and what are the impacts in both cases. After that, the ground water is considered the main source for the drinking water supply; however, lately it becomes a subject to the over-extraction and pollution in many countries such as Yemen. Some of the pollutants are: 1. Human and industrial wastes. 2. Used oils by transportation systems. 3. The random use of chemical fertilizers and pesticides since the nitrogen fertilizers leads to increase the Nitrate in the groundwater which might be converted to some poisoned solvents	Bio.12.05.171-173	Water Pollution		Pure informative presentation	Water Pollution. 171-172	Environment and it problem.07
Water Pollution	It is mentioned that water conservation against the	Bio.12.06.173	Water	Poor formation	Other conservation legal, social,	Water	Environment

(Annex 3.E) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	pollution is an essential condition for maintaining human, plants and animals safety. To ensure preventing the water pollution, the followings have to be done: 1. treating the waste water before releasing it back to the water resources. 2. Treating the chemical wastewater of the chemical and petroleum factories before releasing it again into the seas and soil to prevent GW pollution and to ensure the safety for the aquatic life		Conservation		technical and institutional tools are totally elided	Pollotion.173	and it problem.07
Food pollution	Preventing the reuse of wastewater and treated wastewater for plants irrigation especially for vegetables	Bio.12.07.179	Wastwater Reuse	why to prevent the TWW reuse for irrigation. TWW is considered one of the main renewable water resources that help to allivate the water scarcity in poor water countries like Yemen. What is needed is to regulate the use to be restrickted for some plants accorging to the reuse standards	Mis-conceptualization	Food Pollution. 179	Environment and it problem.07
Natural Resources	It is presented that natural different resources are categorized to three parts: 1. Permanent resources that cannot be run out due to the human consumption whatever he consumes. Examples, solar energy, air and water. 2. Renewable Resources: are the resources that have the ability to renew themselves like soil, plant and livestock production. However, it is under critical pressure of human consumption. 3. Non renewable resources: are the resources that barely or slowly could be renewed such as oil, gas and coal. Then it is added that according to the ability of human to use the modern technologies and equipments today, he is utilizing and overusing the various environment resources quickly creating imbalance and degradation for the environmental system.	Bio.12.08.181	Water Resources	Water is defined as permanent natural resources which are not all true. Some of the water resources like the ground water in many regions are non renewable resources. However, resources such as rainfall, TTW, most of rivers…are considered as renewable resources. Only, seas and oceans can be considered as permanent resources	Miss-conceptualization and information	Environmental Resources Over-extraction.181	Environment and it problem.07
Water Overuse	It is mentioned that Yemen suffers from the water over-use led to deplete the ground water resources like Taiz City Basin. And it is expected other basins such as Sana'a and Sa'da Basins are going to be depleted if our negative behaviors against it continue as they are. Then it is said, that the studies indicated that the main reason for the GW levels drop is the water over-use which is not recharged by rainfalls. The GW levels drop has started during the second half of the 20th centery and to to this moment according to the expansion in artizian wells drilling for qat irrigation. For instance, the number of wells in Sana'a Basin has reached more than 13,000 wells at the moment. The critical over-use of the groundwater basins,	Bio.12.09.182-183	Ground Water Depletion	The concept is supported by activity 1. It says that if the remaining in Sana'a basin in 2000, for example, 10 Billion CM of water and the annual extraction continue by 800 million m3, and if the recharge is 265 m3/year, in which year the basin water is expected to be depleted?. .2. Activity no. 3 suggests to have a group discusion about the most important treatments	1. Very poor language and miss-terminology (artesian wells, water states as item for the water balance table! 2. Messy presentation. 3. It is remarkable that whenever it comes to talk about the ground water over-extraction, it is always presented exclusively as an impact of Qat rather than the low efficiency in irrigation sector. 3. The presented table of the water balance is miss-conceptualized.	Environmental Resources Over-extraction.182-183	Environment and it problem.07

(Annex 3.E) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	nowadays, do not get recharged leading to have an annual gap that results in decreasing the groundwater basins and eventually to their depletion. The table below shows annual gap.*			could be adopted to conserve the water resources in our country	4. Regarding the activity, the presented figures are delusive. So, it is not practical that students acquire such fictional figures. Furthermore, it is not pragmatic and useful to ask students to calculate when the Sana'a basin will be totally depleted for the following reasons: i) People in sana'a basin have been informed in the 1980s that the basin will be depleted within maximum 20 years, however, now more than 30 years passed and the water still there. As result people, lost the trust on the formal sector. ii) Bringing people to the hopeless point affects their intentions so that they take things carless whenever they deal with them like the case of water here		
Water Overuse	It is said that water over-use danger is much worse due to the fact that Yemen is one of the water poor countries. For instance, the annual water share is 137 m3/cap while the water poverty line is determined by 1000 m3/cap and the essential water requirements is determined by 1400m3/cap.year.	Bio.12.10.182-183	Water scarcity	The concept is supported ba a activity no. 2 that illustrate a table containing the annual available water resources presented as the annual water consumption per cap. Then students are asked to compare the Yemeni water share to the average of Asia and Egypt and to justify why Egyptians has more water than Yemenis. And to compare the average of the Arab region to the average of the developed countries?	There is a clear miss-terminology to the annual available water resources per cap and the annual water consumption/cap	Environmental Resources Over-extraction.182-183	Environment and it problem.07
Water Overuse	As final conclusion for the water over-use, it is mentioned that "it became clear that 90% of the annual use goes to agriculture of which the most goes to irrigate Qat	Bio.12.11.183	Agriculture share	1. Qat consumes around 40% of the agriculture water share (90%). There is no doubt that it is one of the main drivers affecting the water resources; however, to totally hang the water problems on Qat is not proper way to conceptualize the real situation	Very poor conclusion	Environmental Resources Over-extraction.183	Environment and it problem.07

Annex 3.F: Water Concepts in Chemistry Subject in grades 10-12

(Annex 3.F) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
10th Grade							
nothing							
11th Grade							
Ozone uses	It is mentioned that Ozone is used for drinking water disinfection for killing bacteria and micro-organisms. It is added, that ozone is better than chloride since the latter is a poisoned gas	Ch.11.01.58	Water Disinfection		It is stated that chloride is a poison gas even it is still used for drinking water disinfection overall the world. This might result in students confusion	Ozone O3. 58	4
Dynamic Balance	it is mentioned that almost all systems of life are dynamically balanced such as nitrogen cycle, water cycle…etc	Ch.11.02.95	Water cycle		mere presentation	Dynamic Balance in universe. 95	7
Aqueous solutions Features	Water solutions (aqueous) features and PH are presented	Ch.11.03.112 -123	Aqueous solutions			Ionic balance in Aqueous. 112-123	8
12th Grade							
Temperature Changes	Water conversion form solid to gas and its curve are presented	Ch.12.01.30	Water evaporation			Temperature change. 30	Thermo chemistry. 02
Nuclear Energy	Sea water desalination is mentioned as one of the nuclear energy usage's benefits	Ch.12.02.83	Desalinatio n		Mere presentation	Nuclear energy. 83	Nuclear and Energy. 04
Pesticides' industry	it is mentioned that excessive use of pesticides impacts the water and soil negatively	Ch.12.03.148	Water pollution		mere	Chemical industries. 148	Chemical industries. 08
Air Pollution	Acidic rainfall, its formation and impacts are presented	Ch.12.04.170	Acidic rain	Well to some extent		E. Pollution .170	Environment. 09
Water Pollutants	1. Pollutants affect the O2 in water: including the organic compounds that need Oxygen to be biologically treated such as the ones in wastewater. 2. Temperature Pollutants: resulted by using the water for cooling in factories which reduce the O_2 in the water. 3. Chemical pollutants: Oil leakages in seas and oceans, cleaning chemicals that flow into the wastewater to the seas and oceans, pesticides and fertilizers which pollute the surface water resources, industrial wastes like acids and heavy metals and sedimentations resulted by soil erosion. 4. It is mentioned that GW is less threatened by pollutants due to its deep levels that the above soil layers prevent many pollutants to reach it. However, some pollutants are threating the GW such as : a) The huge amount of pesticides and fertilizers. b) Wastewater and Cesspits. c) Industrial and traditional wastes injection wells. d) Storage ponds used for solid and liquid wastes	Ch.12.05.172 -173	Water pollutants	Sedimentations is not a chemical pollutant	1. Messy presentation. 2. It is located at the end of the book. According to the Education assessment report, most of the schools do not manage to finish the textbooks	Environment Pollution.172-173	Chemistry and Environment. 09
Solutions for environment pollution	One of the suggested solutions for eliminating the environmental pollution is treating the waste water. The three stages of waste water treatment are very briefly presented that each phase was explained in 3-4 lines	Ch.12.06.175 -176	Waste Water Treatment	1. The first primary stage is somehow well presented while the secondary is incorrectly presented. 2. It is labeled as one of the suggested solutions to protect the environment	1. Very poor, confused and useless presentation. 2. it is already and widely used overall the world rather than being as a suggested solution as it is mentioned	Proposed solutions pollution eliminating. 175-167	Chemistry and Environment. 09

Annex 3.G: Water Concepts in Physics Subject in grades 10-12

(Annex. 3.G) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
10th Grade							
Kinetic Theory of Matter	Water is used as an example of fluids. Its practical diffusion and movement within its three phases of solid, gas and liquids is presented using some activities. As an application activity, students are asked to search how the salt is abstracted from seas and if possible they are requested to visit Aden city to see how salt industries are working and how drinking water is produced by the desalination plant of Aden	Phy.10.01. 64-65	water states		Students outside Aden, might find it very difficult if not impossible to apply the visit activity	Kinetic Theory of Matter. 64-65	Prosperities of solids and floids.03
Statistical Prosperities of Fluids	Surface Tension, Cohesion and Adhesion Forces and Capillary action of water are introduced	Phy.10.02. 73-76	water physical properties	Theoretical presentation		Statistical Prosperities of Fluids. 73-76	Prosperities of solids and floids.03
11th Grade							
nothing							
12th Grade							
Renewable Energy Resources	The renewable energy is introduced as to be produced by many natural sources such as the sun, rivers and water falls, hot groundwater springs, seas and oceans…etc. It is added that it is known as the clean energy since it does not pollute the environment	Phy.12.01.187	Energy production			Unite Introudction.187	Solar Energy. 08
Solar Energy Applications	It is mentioned that it means to convert the salty sea water to fresh water that are potable for drinking and irrigation. A pyramidal simple model is presented on the side as figure no.7 illustrating briefly the desalination processes. It is mentioned this method has many disadvantages that it is slow and the water production depends on the size of the pyramids basins. It is added that there are modern methods that are more efficient in desalinating the sea water	Phy.12.02.194	Sea water Desalination	The illustration model is simply drawn and easy to understand. 2. Of course, if the desalinated water is potable for drinking, it will be useable for irrigation. In addition, the desalination is expensive and rarely used for agriculture. Hence, it does not make sense always to mention that it is useable or used for agriculture	However, it lacks the followings: 1. some parts of the model are not labeled such as the bottom basin and the fresh water collecting channels. 2. The process path is not visualized. It would be better to visualize the whole process in the model by showing the evaporation lines rising up, fresh drops condensing and flowing in to the side collecting channels. The process path steps order could be visualized by using arrows with numbers. 3. The figure does not have a title or subtext.	Thermal energy Generation. 194	Solar Energy. 08
Solar Energy Applications	It is presented that water can be heated by the sun and pushed in small metal pipes to warm the houses.	Phy.12.03.194	water for house warming	The illustration figure no. 8 is presented to support the concept. However, it is such kind of irrelevant presentation for the following reasons: 1. It is a photo for a house only. 2. Neither the heating solar system neither the warming pipes are presented. 3. No labeling at all and it does not have a title even.	Poor and mere presentation. It is not visualized and conceptualized that it is an easy system that can be implemented easily by the houses. Furthermore, it worth to mention that in Yemen the concept is not needed for house warming but can be applied to heat the water for domestic uses such as shower, cooking...etc that will save a lot of electricity consumption	Thermal energy Generation. 194	Solar Energy. 08

Annex 3.H: Water Concepts in Arabic Subject in grades 01-12

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
1st Grade							
The Sea	Some drawings for sea, fish, ship…etc are presented	Ar.01.01.01 .130	The Sea	It is just introduction for the sea as an environment feature	It needs to indicate that it is a water source that is salty	The Sea.130	3
On the beach	A drawing of a family sitting on the beach, drinking and eating…etc. Following, two pictures of boat and fishing net are placed	Ar.01.01.02 .142	Sea use		It needs to refer to keep beach clean	On the beach.142	4
Water	Rainfall, a pump on well and Marib dam are introduced	Ar.02.01.01 . 28,65, 142	Water resources	The presented pump pour the water hugely in a tank for agriculture	The pump on the well is presented in line with planting which might instill the wells drilling tradition	Rainfall, planting and Marib Dam.28,65,142	
Cooking	It is presented that the girl wash the vegetables under the open tap	Ar.02.01.01 .48-50	Water use	The photo is repeated three times	Adverse concept. It instills the culture of cleaning vegetables under the open tap which abuses the water	In the Kitchen.48-50	7
2nd Grade							
Agriculture	A drawing for a boy and girl in their uncle farm where bananas and oranges are presented. The boy irrigates the tree by pouring the water from a hole. It is written under " Mahyoob is irrigating the tree".	Ar.02.01.01 .53-58	Irrigation	1. The abuse drawing is repeated four times in the lesson from which one in large scale is used as an entrance for the lesson. 2. The presented drawings do not encourage the water saveing since they instill the culture of flood irrigation method.	Adverse concept	In my uncle farm. 53-58	2
	The whole lesson is presented as converstation between two boys. It starts to state that in Yemen many types of fruits such as bananas, grapes…etc are grown and that they like to have these fruits locally produced in Yemen	Ar.02.02.01 .37-40	Food security	What is the use to instill in learners that Banana (heavy water consuming crop) should be produced in Yemen. It has high adverse impact on the scarce water resources of Yemen	Adverse concept	My country Fruits. 37-40	7
Agriculture	A boy tells a story about his active grandfather who gets up very early to prepare his land, put the seeds and be back. Then Rainfall water falls down and sequently the trees grow up and produce fruits for people's food	Ar.02.02.02 .46,50	Rainfall benefits	Indirectly tells the students that rainfall is behind the trees growing. As an exercise, students are required to answer the Qs of Who sends the water down from the sky? And what is the benefit of rainfall?		The active farmer. 46,50	7
Rainfall	A song about the rainfall water as the gift of the sky sent dawn to irrigate the land, create streams and putting off the thirstiness	Ar.02.02.03 .51	Rainfall	It is mentioned that rainfall in Yemen results in a lot of streams	Knowing that, PP average in Yemen is 200 mm/year, there is no chance to have such abundance of streams	Rainfall Song. 51	7
Allah, the creator	In a conversation between a farmer and his son, the father says that Allah (the God) is the one who creates water, sends dawn the rain and makes the plants and crops grown	Ar.02.02.04 .61-64	Allah creates Rainfall	Indirectly, it reinforces the previous concepts of rainfall for agriculture		Allah, the Creator.61-64	7
Sea Benefits	An introduction that Sea is used for navigation and fishing	Ar.02.02.05 .74-75,78	Sea water use	The students are asked to do an oral expression about the seas and its graces provided by Allah	Simple indication to the importance of seas water conservation	Seas Benefits.74-75,78	8
3rd Grade							
Mosquitos	It is presented that to fight the Mosquito's, we	Ar.03.01.01	Pesticides Use	It teaches student to pollute the water	Adverse concept	Food health	1

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
fight	pour the pesticides into the stagnant water	.39		resources. It should be removed		39	
Agriculture	It is presented that two relatives children went to the countryside and saw a pump raising out the water out of the deep well to irrigate the fields in the wadi. They stated that water is important for agriculture and beauty of nature. Then a verse of the Holy Qur'an indicating that "|every living thing is made from water by Allah" is presented. One of them confirmed that water is a grace given by Allah and it is forbidden to abuse it. Within the evaluation Qs, it is stated that water is necessary for agriculture and it is instructed " do not abuse water but save it"	Ar.03.01.02 .47-49	Water importance		Importance of water is focused on agriculture	In the Village.47-49	My beautiful country. 02
		Ar.03.01.03 .49	Water not abuse		Mere presentation	In the Village.49	My beautiful country. 02
Water Harvesting	A free reading passage supported by a hand drawing is used to explain the concept of water harvesting. It starts to tell that water has seasons and harvesting that a lot of people benefit from. In my village there are tanks/storages beside the houses. When it rains, our people convert the water from the roofs and clean places to their tanks from which they benefit the rest of the year for themselves, their animals and farms. Whereas, some other people in other villages do not care with water harvesting so that if the next rainfall season comes late and drought increases, their animals and farms get thirst and they go there and there looking for water regretting what they have done. the passage is followed by the statement of " rainfall water is a gift from Allah (God) which we should concern and reserve by tanks and dikes to benefit from"	Ar.03.02.01 .94-95	Water Harvesting	It shows the tanks as they are open and directly attached to the house which is unreliable at all (because water harvesting tanks for drinking is always covered).	1. The picture is poorly drawn and does not attract to look at. 2. It is said that the harvested water is sufficient for people, livestock, and farms for the whole of year which is not true. 3. activities and evaluation are absent	Water Harvesting.94-95	The Workers. 04
Aswan Dam	Within the Arabic World unit, Aswan Dam in Egypt is introduced as the biggest water storage located on the Nile River. It is mentioned that floods were damaging farms and houses there. Hence, Egyptians have constructed the Aswan dam to control the floods which used to cost Egypt a lot and to storage the water for irrigation and energy production	Ar.03.02.02 .106	Floods impacts	1. Terms mis-use such as (Aswan dam is a big water tank. 2. It is mentioned that in front of the dam is the largest man-made lake which is not true. The dam lake always locates behind the dam.	1. The passage formation is weak and needs to be reformed well. 2.The allocated area for the concept is too much	Aswan Dam.105-110	My Arab World. 05
		Ar.03.02.03 .105-110	Dam Uses				
4th Grade							
Sun benefits	The passage is talking about the benefits of the sun. It is mentioned that the sun evaporate the seas water which rises up and condensates	Ar.04.01.01 .86	rainfall formation			Sun benefits. 86	Universe Marks.

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	to fresh water that falls down again by the ability/power of ALLAH as rainfall watering human, animals and plants.						05
Grammar	The girl drinks clean water	Ar.04.01.02 .86	drinking water	grammatical example	stand-alone	grammar.98	
Grammar	The boy saves the water	Ar.04.01.03 .86	water save	grammatical example	stand-alone	grammar.105	
Agriculture	A song describing the countryside and the active farmer. In the second line, it is mentioned that water is poured flooding the farms. In the unit assessment, there is some statements given to students as options to write about. The first one is " what is your opinion about the one who abuse the water when he irrigates his farm?. The second one, what is your opinion about those who leave their villages and agriculture and work in cities?	Ar.04.01.04 .171,175	Irrigation	Adverse concept	Totally confusing. 1. The song encourages the flood irrigation practice, 2. The first activity instill the water save by irrigation whereas the second one encourages the agriculture expansion	Farmer and the Village.171, 175	10
		Ar.04.01.05 .171,175	Water not abuse	good but stand-alone reflection		Farmer and the Village.171, 175	10
Grammar	When did the Yemenis build the Ma'rib Dam?	Ar.04.01.06 .203	Dams	it is given as an example of grammar	1. Dams Focus	Grammar.203	12
Safety	Oh my son, you should not eat the fruits and the vegetables before washing them well. Furthermore, do not drink the polluted water	Ar.04.02.01 .21	Clean water		Mere and stand-alone concept	Unsecured Food. 21	1
Grammar	Do not abuses the water	Ar.04.02.02 .26	Water not abuse		mere	grammar e.g. 26	1
Grammar	Do not abuses the water	Ar.04.02.03 .70	Water not abuse		mere	grammar e.g. 70	
Working in Agriculture	A presented irrigation method is flooding a basin of around 1.5 m dimeter while the depth appears to be more than 30 cm.	Ar.04.02.04 .73,74	Irrigation	The photo is mis-selected so that might result in instilling the flood irrigation habit . Furthermore, such concept encourage working in agriculture which means more water consumption in the future	Adverse concept	Encouraging the work.73.74	5
Agriculture Encouragment	The students are taught that Cotton is planted in many wadis in Yemen and exported abroad returning money to Yemen. Hence, we should expand the Cotton agriculture	Ar.04.02.05 . 100	Agriculture expansion.100	such encouragment leads to more water consumption and more water extraction	Adverse concept	Cotton Tree.100	7
5th Grade							
Introduction	The whole lesson is about the water as the base of the life. It is presented on the context of Yemen. The story starts when a girl named "Samah" has visited his grandfather in the village and saw his grandfather while he was praying for Allah to send the rainfall. Then in a while, it started to rain dogs and cats so that the grandfather face has delighted telling Samah that the farms are going to watered and villagers will benefit of that. Afterward, Samah went out and saw many "rivers" and	Ar.05.01.01 .126-127	rainfall	Mis-conceptualization	1. It is presented that rainfall in Yemen results in rivers which is not correct	Water is life.126-127	Allah's Graces .08

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	streams flowing as results of the rainfall.						
Introduction	Then she saw the farmers diverting the water to irrigate farms and to the "wells" and tanks. she asked her grandfather, why do people do so? He answered her that the rain comes only in the summer; therefore, they utilize this season to plant crops and harvest the surplus water for the rest of the year and this is what our Yemeni smart ancient found out and consequently constructed the dams.	Ar.05.01.02.126	Water Harvesting	Mis-conceptualization	due to the following: 1) The rainy seasons are two instead of one (two months in the summer and two other months in the spring), 2) Wells are not used to harvest the rainfall. 3) It is mentioned that the harvested water is sufficient to meet all uses for the whole remaining period of the year	Water is life.127	Allah's Graces .08
Insuffiecent drinking water supply	Samah Asked, do people rely on the rainfall only? he answered her, we use the springs and wells as well but they started to decrease day by day and became insufficient to meet the people water needs. Then it continued to highlight that rural areas do not have drinking water supply (rather than they bring it manually), the urban areas have access to the supply network which became insufficient services due to the water shortage resulted by the followings: population increasing, limited rainfall which are not utilized and dammed, Groundwater over abstraction and agriculture and industry expansion. Based on all of that, our Government has started to act towards saving the water consumptions (The grandfather said).	Ar.05.01.03.128	Water shortage		1.the suffering of women and children for getting the daily water needs to be clearly emphasized. 2. which tanks that pipes did not transfer the water from?. 3. the main reason for the mentioned water gap and crises is the low efficiency by irrigation, nevertheless, it is not even mention. 4. The presentation's sequence is poor.	Water is life.128	Allah's Graces .08
water importance	Then she asked him, is it a problem to have a water shortage? He answered, Yes. The water is a gift from Allah without which no humans nor any animal and plant can live. Unless the water drop, trees, flowers, fruits can not grow nor does our planet have a life. This fact is already outstood by ALLAH's say in the Holy Quran: (from water we made every living thing)	Ar.05.01.04.128	Water Importance	Mis-match between the question and the answer. He was supposed to answer her what are the impacts of the water shortage instead of mentioning the importance of water	Mis-conceptualization	Water is life.128	Allah's Graces .08
Solutions for water crises	So, what are the solutions to meet this problem? (she asked). all people should cooperate with the government to construct the dams, drill the wells and to construct the underground tanks for water harvesting and to keep its quality clean (he answered). So what is my role then? (She asked). You should use the water wisely, not to abuse it and in case you see a water tape is leaking, you should close it to save the water (he answered). This is your role which is important as well as the construction of dams and tanks. (he added).	Ar.05.01.05.129	Cooperative management	It is very good to present such concept	1. It is really weird to deviate the participatory cooperative management of states and people towards dams' construction that is always presented as the sole magic solution for the water problem in Yemen. 2. It does not make sense to present wells drilling as solution for Yemen that has more than 100,000 random wells. 3. The role of individuals is presented exclusively to close the taps and not abuse the water Furthermore; its importance was compared to the importance of dams' construction. 4. Demand management tools that are first adequate interventions to deal	Water is life.129	Allah's Graces .08

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	the end				with the water crises are totally elided.		
Evaluation Section	Two oral presentations are proposed for students as follows: 1) What would you do If you see the water is leaking from the tap? 2) If you had stored some water in your tank and you knew that your neighbors were run out of the water, what would you do?	Ar.05.01.06.136	Individual Role	Excellent presentation. However, whatever will be stated by students this does not mean that they expressed the real attitudes they retain in minds	The evaluation section from page 130-136 is almost requesting students to repeat the presented information via different styles of grammatical, writing and direct questions except the two mentioned questions besides	Water is life.136	Allah's Graces .08
Rainfall Song	A presented song explains the rainfall, its fall down and benefits.	Ar.05.01.07.139	Rainfall			Rainfall Song.139	Allah's Graces .08
	A presented song explains the rainfall, its fall down and benefits. Nevertheless, the activity asks students to do a research by any dams reference-book for some Yemeni dams and to write their names and locations	Ar.05.01.08.140	Dams	What would be the added value of knowing some dams names and locations.	1. Mis-match between the presented concept and the required activity. 2. Too advance to ask students in this age to do such kind of research. 3. Even if not, almost all students especially in rural areas will not be able to do this activity due to the lack of the rewuired technical reference-book	Rainfall Song.141	Allah's Graces .08
Unit Evaluation	Within the unit evaluation, this concept is presented in a form of completing the missing words as follows: "Rainfall falls down, then disappears …… the earth to recharge ……water.	Ar.05.01.09.141	GW recharge			Unit evalution.141	Allah's Graces .08
Unit Evaluation	As hand-writing enhancement exercise, the following statement is requested to be written twice by students: Any Muslim gives the water to put off another Muslim's thirst, ALLAH will compensate him in the Second life giving him "Al-Raheeq Al-Makhtoom" (on of the best drinks Muslim believe to have in the heaven)	Ar.05.01.10.142	Water share		It would be better to reflect this concept by using and participating activity such as role play…etc	Unit evaluation.142	Allah's Graces .08
Rainfall	Within the context of describing the country by one historical scientist called IbnBatotta, it is said that he noticed the heavy rates of rains in Yemen especially in the summer resulted in having a green cover, streams and rivers	Ar.05.01.11.217	Rainfall	Maybe spates but not rivers. Again there is no rivers in Yemen	Mis-conceptualization	Ibn Batotta's Trip to Yemen. 217	Sea Fishing. 11
lesson Introduction	Yemeni Ancient were known by their capabilities to construct dams and dikes to store the rainfall water especially in areas that do not have springs or rivers	Ar.05.02.01.58	Dams	1. dam focus. 2. Again there is no rivers in Yemen	Mis-conceptualization	Aden Cisterns.85	Our Immortal traces. 04
the core	The example of Aden cisterns that were used to harvest the rainfall to supply the city, farms and protect the city of Aden from floods is the core of the topic. It is even explained how the system keep the pools free of the sedimentations by using some sediment traps in advance. Such traps are called in the lesson dams	Ar.05.02.02.58-59	Cisterns	The evaluation Qs are formed in a way that require to memorize the information presented in the lesson	How did Aden is managed the system is at the most importance, nevertheless, it is not mentioned? It is stated that those pools were used for irrigation which does not make since due to their limited storage capacity	Aden Cisterns.58-59	Our Immortal traces. 04

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Evaluation part, oral expression	It is inquired why does the state drill wells everywhere?	Ar.05.02.03.67	Wells Drilling		Mis-conceptualization. Such discourse might impact on the learners adversly encouraging them to carelessly consider the wells drilling as a negative driver leads to GW depletion	Aden Cisterns.67	Our Immortal traces. 04
6th Grade							
Allah graces	Some verses from the Holy Quraan presents some of the rainfall and sea water benefits such as drinking, planting, navigation, fishing…etc. Then it is reinforced by some direct and grammatical questions	Ar.06.01.01.50-52,59	water importance		Mere presentation	Allah's graces.50-52,59	Allah's graces are non-countable.04
Grammar	In once grammatical Q, student are asked to complete the blank word for " You say: in the rainy seasons, the water pours heavily in the plains and Wadis"	Ar.06.01.02.73	spates		Mere presentation	With Allah in the sky. 73	With Allah in the sky. 5
Grammar	In once grammatical Q, student are ask to complete the blank word for " You say: water is a great gift appreciated by the wise people	Ar.06.01.03.74	water is gift		Mere presentation	With Allah in the sky. 74	With Allah in the sky. 5
Environmental pollution	In the context of mentioning the environmental problems, the water pollution and some impacts are mentioned	Ar.06.01.04.200	water pollution	it is mainly confined to the sea water pollution due to chemicals thrown by ships and factories	Mere presentation	A live TV program. 200	Modern Inventions. 11
Introduction	The lesson title is the water scarcity impacts. It is mentioned that a small meeting attended by five young has hold in one club of the youth to discuss the water scarcity and its impacts on humans, animals, and plants. The meeting was initiated by mentioning a verse from the Holy Qur'an which indicates that Allah sends the water from the sky to the earth growing the heavens, corns, dates...as life source for the people and by the water the dead lands being alive again. The first speaker started to mention some of the water sources and its importance as the base of life such as participating in forming the large portions of the different parts of human, animal and plant bodies.	Ar.06.02.01.38-39	water importance and resources	relatively well. But again rivers are not a water source in Yemen	Since the topic is water shortage impacts, it is supposed to have the introduction about the shortage and its drivers	Water Shortage Impacts.38-39	Water is Life. 03
the core	The second speaker followed to talk about an x area which used to have abundant of water; however, due to the delay of the rainfall season the springs and wells dried resulting in a drought which impacted losing some people and properties. Most of the people migrated while the remaining struggled a lot then came back to ALLAH praying and asking for his	Ar.06.02.02.39	Water shortage impacts	It does not reflect the human negative influences on water resources that lead to the water shortage	1. This content is the core of the topic however it does not cover and reflect the topic in-depth. It is expected to know more about the scarcity causes and much more detailed about the impacts. The mentioned impacts are merely and generally presented. 2. The intention is that rainfall delay is the sole reason for the water scarcity and one season delay led to that big drought (illogic	Water Shortage Impacts.39	Water is Life. 03

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	relief. Then the rainfall fallen and the dried village became alive again.				discourse).		
Solutions for water crisis	The third added to face such bad circumstances we should also take some actions and I can propose some such actions : to save water when by ablution, shower, cleaning and irrigation reminding them that Islam forbidden the water abuse even when have a river for example. The fourth added some suggestions such as closing the tope hole of the water tanks and the water containers to keep it free from the leakage and pollution, farmers should use the modern irrigation methods such as pipes and should utilize the rain water.	Ar.06.02.03 .39-40	Water Conservation	1. In the evaluation Qs, there is a significant focus that abuses the water at home is the major cause of the water scarcity. 2. Presenting the water container coverage seems to be as insertion	1. Textual presentations that is difficult to be retained for much of time in minds. 2. No visualization at all	Water Shortage Impacts.39	Water is Life. 03
	Finally, the last speaker emphasized the importance of the rainfall to recharge the ground water and the need of dams construction to utilize the rainfall water and the spats in irrigation, cleaning and GW recharge which requires a realistic cooperation between the citizens and the state to avoid the scarcity impacts	Ar.06.02.04 .40	Dams	The conclusion of the whole lesson is drawn to dams construction as the key magic solution for the water shortage in Yemen	1. There is significant focus on dams' construction as solution so that its advantages were detailed while the modern irrigation systems were labeled as the method of "Pipes". 2. The incentives introduced to save the water are always nominal presented in some repetitive statements. Hence, there is a high need to focus on the economic benefits/loses of saving/abusing water as useful incentives might affect the intention and the behaviors.	Water Shortage Impacts.40	Water is Life. 03
Evaluation grammar	The water is a gift; if you save it you bring the well-being for yourself and for others. However, who abuses it will get what he deserves. So, do not be abuser	Ar.06.02.05 .47	Water is gift, save it			Water Shortage Impacts.47	Water is Life. 03
Evaluation, Oral speaks	Five questions are directed to students to investigate their attitudes as follows: 1) If the water flows strongly out of the tap while you are doing the ablution, what would you do?, 2) If you see somebody opens the tap so that the water flow strongly, what would you do to him?, 3) What do you think about somebody who opens the tap for ablution and then turns to do something else while the water is flowing out of the tap without use? 4) what would you do if you see a tap is leaking?, 5) Allah describes the abusers as the brothers of devil, aren't they?	Ar.06.02.06 .50-51	Water not abuse	Very good type of presentation	Almost all questions are about abusing the water by ablution? It would be better to reflect some of them on flood irrigation, unlined canals, illegal wells drilling….and so on	Water Shortage Impacts.50-51	Water is Life. 03
Evaluation, grammar	"Ground water is limited in our country, if the Yemeni citizen attempt to save the water he will alleviate the impacts on himself. Whereas who neglects the water issue, he will be affected for his mis-action	Ar.06.02.07 .53	Ground water		mere and repetitive	Water Shortage Impacts.50-51	Water is Life. 03
7th Grade							

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Food Security	The food security is defined as the ability of the state/community to meet the food requirements and or needs. It is mentioned that the food crisis in any time and place is not a result of resources scarcity. Nevertheless, it happens due to the reluctance of human to explore and extract the earth resources or due to people harm to each other. Then it is followed to say that many countries in the third world are suffering the hunger. On the other hand, it is said that Yemen population is still an outside-dependant importer of food even Yemen has many resources. It is also mentioned that " There is no a hope for a country that cannot produce its food and cloth". Furthermore, it is written that there are many resources that Yemenis should utilize to ensure the food sufficiency. 1. Agriculture: It is presented that Yemen has invested in planting the fruits and succeeded to achieve not only a self-sufficient production but exportation as well. The main reason behind that successful was the ban policy for fruits importation and subsidizing fruits agriculture locally. So, why not to have a self-sufficient production of corns? (It is said). 2. Water resources: Yemen has many water resources such as springs, wells, seas...etc that contain many benefits and need to be utilized. Yemen should construct dams and develop the irrigation methods	Ar.07.01.01 .88-91	Food Security	It is really increadable to teach such concept to students in such single minded approach	1. It is not reasonable to state that resources scarcity is not a cause leading in food gaps is not logic. 2. The overuse of resources which is one of the most factors affecting the resources and resulting in crisis was not presented as one of the reasons affected the food production. 3. The concept does not encourage the cooperation and integration between all countries; rather than, it encourages resources depletion. 4. It is presented that Yemen succeeded to have self-sufficiency of fruits and that is true. But they did not realize that what we are eating and exporting today is our finite and vulnerable ground water resources. 5. There is a clear encouragement to have food security policy particularly for corns. 6. It is said that Yemen has many rich water resources that need to be utilized!!! . 7. The concept of constructing dams is repeated here also. 8. The concept of developing the irrigation methods has a vague presentation	Food Security. 88-91	Food Securit y.0 7
back over	The back outside cover presents a repetitive photo for abundant water view in a wadi supported by the sub-text of "Water is life, save it"	Ar.07.01.02 . Back cover	Water is secret of life	The presented logo seems to belong to the GSCP project that might be the one who supported incorporating those shallow repetitive photos and messages	It is poor and repetitive concept. Why not to present different water concepts using much better diverse photos and oriented messages	Back outside cover	
Women Duties	In the context of the rural woman roles in development, many tasks for the rural woman are presented. It is mentioned that bringing the water for home is also a side work that rural women do.	Ar.07.02.01 .141	Drinking water Fetching	mis-conceptualization	It instills the principle that bringing the water is a task of the woman. Hence, this should be criticized in the lesson and changed to be presented as one suffering/constrain the rural women face	Role of the rural woman in the development. 141	Role of the rural woma n in the develo pment. 10
Problems facing the rural woman	Water pollution is mentioned as one of the problems affecting the rural woman	Ar.07.02.02 .141	Water Pollution		It is merely presented (2 words)	Role of the rural woman in the development. 141	
Grammar	Rainfall falls in Yemen in the summer	Ar.07.02.03 .148	Rainfall	The rainfall seasons are two in Yemen	Mis-conceptualization	Grammar.148	
Grammar	Dams are full with the rainfall water	Ar.07.02.04	Dams		Mere and repeated presentation	Grammer.149	

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
		.149					
	The back outside cover presents a repetitive photo for abundant water view in a wadi supported by the sub-text of "Water is life, save it"	Ar.07.02.05 . Back cover	Water is secret of life	The presented logo seems to belong to the GSCP project that might be the one who supported incorporating those shallow repetitive photos and messages	It is poor and repetitive concept. Why not to present different water concepts using much better diverse photos and oriented messages	Back outside cover	
8th Grade							
Introduction	A dialogue between a father and his daughter (Olaa), while they were on trip discuss many water issues. The start is where does the rainfall water go? (Olaa asked). One part for irrigation, the second flows to the coastal plains and the third part infiltrate into the ground as ground water on which our country mainly depends due to the limited rainfall rate and lack of rivers (the father answered).	Ar.08.01.01 .38-39	rainfall	Unlike all previous presentations of grades 1-7, it is presented that Yemen does not have rivers and that rainfall rate is little which is totally true. However, students might get confused accordingly.	1. Evaporation represents more than 90% of the precipitation in Yemen; however, it is not mentioned.	Water Development . 38-39	Water Development. 03
Introduction	Is the ground water sufficient for long periods of time? (Olaa asked). No it is not. The studies proved that the dependence on the GW has increased due to the increasing population rate that increases the water consumption, the existence of agricultural development, rigs and modern pumps importing that led to drill many wells randomly and the studies proved that water has already been depleted in many water basins such as Rassian basin in Ta'az (The father replied). What you said worn that we have a water crisis in our country? (Olaa inquired). That's right. Our country is one of the water scarce countries and more dependence on the GW might lead to critical water crisis (the father said).	Ar.08.01.02 .39	Ground Water	Presenting the problems, causes and effects has a poor sequence	1. It is said that many water basins in Yemen are already depleted (This is not accurate). 2. The father admitted that there is a water crisis then after awhile he said that more rely on GW might led to a water crisis. Firstly this is a kind of contrast. Secondly, it is sure that it leads to a water crisis. 3. What we gained in Yemen is an agriculture expansion not development. 4. The low use efficiency especially by the irrigation sector which is the main cause behind the GW over-extraction is still not emphasized.	Water Development .39	Water Development. 03
the core	So, what to do against this problem? (Olaa asked). Since the water is essential for life and a right for the generation, we have to condensate our efforts to develop the water resources. In addition, the coordination between the sectors that are responsible about the water resources development is important. And the state is already prepared a national strategy which includes water conservation against over-extraction and pollution by conducting researches, having enough capacities for water resources assessment, Dams and Channels construction in the wadies, storages and conversion small dams for utilizing the rainfall in developing the	Ar.08.01.03 .39-40	Water development	1. It is well to mention the necessity of the coordination between the different water sub-sectors in developing the water. 2. Unlike the problem presentation, solutions and roles are poorly presented. 3. There is no any distinction between the water development and water conservation nor between tools belong to each. 4. the main presented incentives for developing and conserving the water are: a) water as a base of life, 2) the right of the future generations in getting the water	1. Dams construction is presented on the top of the proposed list as usual. Furthermore, what is mentioned regarding the national water strategy proposed solutions is deviated. The strategy stated that there is no feasibility for dams' construction since the run-off does not exceeds 10% of the total little annual rainfall. 2. Legal Incentives such as law application empowerment is still absent. 3. Economic incentives of water saving is absent. 4. Modern irrigation systems as key tool of raising the use efficiency and reducing the gap between the water demand and supply is not presented. 5. Visualization is totally absent.	Water Development .39-40	Water Development. 03
		Ar.08.01.04	Participation in	4. The proposed activities as usual asks	1. The role of individuals and communities are	Water	Water

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	water resources (the father answered). AlhamduLilah, I'm comforted now (Olaa said). This is not enough to protect our country from the water scarcity (the father replied). The cooperation must be ensured between the official sectors, public bodies and the whole community. (The father added).What do you mean by saying that? (Olaa asked). If the present water utilization continues to abuse the water either by the flood irrigation or by abusing the water at home, we will continue suffering from the water shortage. Therefore, our role can be represented as conserving the water for us and our generation by consumption saving and not abusing following the instruction of our prophet Mohammad PBUH telling Saad not to abuse the water. The state role is to disseminate the awareness within the citizens to not abuse the water and conserve its resources against the pollution. And we should be a good image when we use the water, since the water conservation is a responsibility of all.	.40	water conservation	students to re-mention what they already took or to write about what they think or see.	presented exclusively to some mere phrases about not abuse the water or save it. It still lacks the essential necessary participation roles in regulating, controlling and managing the resources. 2. It is mentioned the awareness spread is a task of the state only which does not make sense at all. 3. In general, there is a need to change the title in order to match and cover the presented discourse. Hence "water resources conservation and development" might meet the various presented concepts. 4. Encouraging learners to participate in changing some of the misbehaviors via some activities or projects is much more practical and useful .	Development .40	Development. 03
Agriculture expanstion	Agriculture is widely presented as the back bone for the Yemeni economy and the sole food source for people overall the world. Additionally, it is said that no population can live without agriculture. Then many constrains threating the agriculture are presented, however, there is no any refer that scarce water resources is the most limitation faces agriculture expansion in Yemen. Nontheless, as side action to come over the mentioned challenges, giving attention to the water and regulating the irrigation methods will convert Yemen to green heavens and Yemenis will be converted from consumers to agricultural producers and even exporters for all types of corns and fruits	Ar.08.01.05 .100	Food Security	High encouragment for agriculture production and food security policy	1. it is said that agriculture is the back bone of Yemeni economy which is not true since it does contribute with 14% only of the annual GDP. 2. there is no admition that the limited water resources and the low water use effecincy are on the top of challengaes facing agriculture. 3. teaching such concepts have very negative impacts on the water resources.	Risks threat Agriculture.100	Risks threat Agriculture. 07
back cover	on the back outside cover, a photo of an abundant waterfall view is presented supported by a sub-text of pray "Oh Allah, keep the water grace for us forever"	Ar.08.01.06 . Back cover	water is gift	It is fine to pray for Allah to help and support. However, individuals should not rely on their pray forgetting their actions, roles, responsibilities…etc helping and saving themselves.	stand-alone concept. The photo has mis-selected. The need is to orient brief messages supported by photos/illustrating draws of water issues, problems, solutions…etc	Back cover	
Allah's Miracles and	Allah is the one who sends down the rainfall after it has formed from the water steam which evaporated from rivers and seas	Ar.08.02.01 .68	Rainfall		Mere presentation	Allah's Miracles and Graces.68	Allah's Miracles and

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Graces							Graces .05
Evaluation	Students are asked to answer: How can we save the water?	Ar.08.02.02 .74	Water not abuse		stand-alone	Allah's Miracles and Graces.74	Allah's Miracles and Graces .05
Agriculture development	Agriculture is widely presented as the back bone for the Yemeni economy and the sole food source for people overall the world. Additionally, it is one of the most important source for the foreign currencies. Yemen can produce many many agricultural products around the year in case we ensure providing sufficient water quantities for irrigation. Since issuing the decree which prevented importing fruits and vegetables, the local investements in agriculture have been widely increased which achieved a self-sufficient production of both. However, Yemen is still importing rice and wheat. Having self-sufficiency of food production has become a dream for each Yemeni citizen and an aim for all agriculture development plans in Yemen.	Ar.08.02.03 .88-89	Food Security	1. High encouragement for agriculture production and food security policy. This discource is a big evident of the national political policies for agriculture subsidiary and expansion encouragment that lead eventually to deplete the remaining finite water resources.	1. it is said that agriculture is the back bone of Yemeni economy which is not true since it does contribute with 14% only of the annual GDP. 2. It is said that agriculture is one of the most important for gaining the foreiner curruncies (however, if it is true, what we gain is little for huge water amounts sold outside) . 3. Teaching such concepts has very negative impacts on the water resources. What is the wisdom to have a self-sufficient quantities of rice in a very water poor country	Agriculture Development .88-89	Agriculture Development. 07
Agriculture development	However, Yemen still lacks the potable water resources for irrigation such as the rivers. Hence, the state lately has given more attention to dams constructions which is the real startpoint for the agriculture development. Around 327 dams have been constructed and the efforts are still going on to cover the whole country by dams which enable us to cultivate new agricultural lands and to have agricultural seasons around all the year.	Ar.08.02.04 .90	Dams	1. Here it starts to admit that the dream of the food security will not be attained unless to come over the lack of adequate water quantities for agriculture. 2.Dams are always on the top of the water solutions list provided throughout the textbooks. It seems that Agriculture sector has highly influenced the curricula contents	1. According to the national water strategy, the total number of dams are around 1000 dam storing around 80 million m3/year which is less than 20% of the annual water use in one of the yemeni 14 basins, Sana'a basin. Furthermore, the national strategy has highlighted that dams are not the option for the future water managment exept in very limited and specified context. 2. Ineasted and for much usefulness to be gainded, it would be better to propose solutions like using the modern irrigation systems, inigeniouse best practices, crop pattern change...etc	Agriculture Development .90	Agriculture Development. 07
Drinking water supply	Jabbreen Palace in Oman has a special water transportation system called Falij, a semi-ground water channel Duggan into mountains, rocks…etc. This Falij provide the palace with water from a surface water pool	Ar.08.02.05 .120	Falij		Very mere	Jabbreen Palace in Oman. 120	Jabbreen Palace. 09
Environment Pollution	It is presented that environmental pollution is increasing due to the accelerated development of science and technology. For instance, water pollution happened due to human dirt and wastes, poisoned and mineral materials wasted by industries and oil accidents and radiation materials caused by ships. All that	Ar.08.02.06 .129	Sea water Pollution		mere and repetitive	Environment pollution. 129	Environment polluti on. 10

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	threat the aquatic creators and fisheries and cause many diseases for humans						
	on the back outside cover, a photo of an abundant waterfall view is presented supported by a sub-text of pray "Oh Allah, keep the water grace for us forever"	Ar.08.02.07. back cover	water is gift	It is fine to pray for Allah to help and support. However, individuals should not rely on their pray forgetting their actions, roles, responsibilities…etc helping and saving themselves.	Stand-alone concept. The photo has mis-selected. The need is to orient brief messages supported by photos/illustrating draws of water issues, problems, solutions…etc	Back cover	
9th Grade							
Agriculture Encouragement	The main water resources supplying wadi Maur are mentioned to be the surface water and the groundwater which get recharged from the spates that flow from the western highlands.	Ar.09.01.01.95	Water resources		Mere	Wadi Maur. 95	Wadi Maur. 07
Grammar	In the grammar part, one statement is "when you abuses the water, it is very bad"	Ar.09.01.02.98	water not abuse	mere		Grammar. 98	
City description	The historical city of Shibam-Hadhramaut is presented. It is mentioned that there are fresh springs, wells and dams for water reservation.	Ar.09.01.03.119	Water resources	mere		Shibam City, Hadhramaut. 119	Shibam City, Hadhramaut. 09
Grammar	In the grammar part, some statements mention rich water springs flows from the top of Marrarah mountain in Al-Maharah and some hot-mineral water springs flows from the mountain bottom. It is said, how great would it be if such locations can be utilized for tourism	Ar.09.01.04.128	Hot springs Use	good reflection		Grammer. 128	
	On the outside back cover, a draw for water drop contains figures of human, fish, tress, lake, fish…etc is presented. It is supported by a verse from the Holy Qur'an "from water we made every living thing"	Ar.09.01.05.back cover	Watre is life	stand-alone, repetitive	So, what to do?	back cover	
	On the outside back cover, a draw for water drop contains figures of human, fish, tress, lake, fish…etc is presented. It is supported by a verse from the holy Qur'an "from water we made every living thing"	Ar.09.02.01.back cover	Water is life	stand-alone, repetitive	So, what to do?	back cover	
10th Grade							
Souqatra Island	Describing Souqatra island, it is said that a lot of wadis and small rivers spread throughout the island.	Ar.Re.10.02.01.08	Water resources		Yemen has no rivers. May be in Souqatra some streams are existed but there is no any rivers at all	Happiness Island.08	
Environment Pollution	Pollution is defined as to decrease the purity of the air, water and soil by the wastes and the harmful materials on health. It is added, that human has polluted the soil, the air and the water during the last few decades of the 20th century as it did happen before at all. Then it is said that the human has polluted the water by the wastewater and industry. For	Ar.Re.10.02.02.21	Water Pollution	The focus was hugely on air pollution	Messy presentation	Environment Pollution and its Risks. 21	

(Ax. 3.H) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	instance, tons of cleaning materials ends up into rivers and seas resulting in increasing the Phosphate to critical limits						
Grammar	As a grammatical example, it is said where the water exists, human accommodates	Ar.Gr.10.02 .03.20	Water importance		Repetitive	Grammar. 20	
11th Grade							
Environment Pollution	It is mentioned that pesticides usage results in polluting the water surfaces and wadies	Ar.Re.11.01 .01.51	Water Pollution	Although the lesson has very elaborative presentation, impacts on water were indicated very briefly through the mentioned sentence	Mere presentation	Pesticides and its Impacts on Environment. 51	
	As one grammatical statement, it said "the base of life is water"	Ar.Gr.11.01 .02.33	Water is life		Mere, repetitive and simple presentation	33	
	It is said "the sea has salty water while the river has fresh water"	Ar.Gr.11.01 .03.45	Water features		Mere, repetitive and simple presentation	45	
	It is mentioned that plants grow where rainfall drops down	Ar.Gr.11.01 .04.57	water is life		Mere, repetitive and simple presentation	57	
Grammar example	The much the water is the more green the grass becomes	Ar.Gr.11.02 .01.62	Irrigation		Water abuse encouragement	62	
Grammar example	Unless rainfalls, the rivers would dry	Ar.Gr.11.02 .02.62	water importance	simple	useless compared to the age	62	
12th Grade							
ALLAH is the Creator of the whole universe	Many versa of the Holy Quran stating that Allah is the creator of the universe. The first one states that Allah sends the water down from the sky to relief the dried land ….)	Ar.Re.12.01 .01.07	Water Importance		Mere and repetitive	Allah's Evident in the universe. 07	
The Old City, Sana'a	Sana'a city is presented and elaborately described. It is said that rainfall rate is too heavy in the summer season	Ar.Re.12.01 .02. 19	rainfall	The annual average is 250 mm/year. It is not that heavy as presented		Sana'a in the memory. 19	
The Old City, Sana'a	At one part of the article, it said that urbanization has damaged the springs that used to flow and supply the city	Ar.Re.12.01 .03.22	GW depletion	In fact, GW over-extraction is the main reason behind springs depleting		Sana'a in the memory. 22	

Annex 3.I: Water Concepts in the Holy Qur'an Subject in grades 01-12

(Annex 3.I) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
1st, 2nd, 3rd, and 4th Grades							
nothing							
5th Grade							
Probity on Islam	It is said that keeping the probity on Islam is the way to get Allah's graces like the sufficient rains.	Qu.05.01.118	Rainfall		It is not utilized and or reflected from water management point of view	Surat Al-Jinn.118	Interpretation. 02
Back outside Cover	A photo of Marib Dam filled by water is presented with a message says "Water is a grace from Allah and grace's praising is to maintain and conserve it, therefore, do not abuse water	Qu.05.02.back cover	Water is a grace	To present such abundant water view and then to request student to save the water is not matched	Repetitive and mere presentation	Back outside cover	
6th Grade							
Graces provided to people by Allah	In the context of criticizing the disobeyed people for their worship to others except ALLAH, Allah reminds them with graces, supplements…etc he provides them with. One of those gifts is water. Allah says to the prophet Mohammad PBUH " reminds them with the water and tell them what would be happened if their water dropped deeply inside the ground, how can provide them with fresh water then?!". Then, within the lesson it is written “Water is one of the greatest useful races that people should appraise to Allah". The activity requires students to write 5 lines about the importance of the water and to read it in front of the teacher and colleagues	Qu.06.01.24, 25	Water is a gift	the concept is a good opportunity to reflect and apply many water concepts of water conservation, sharing, GW as limited source	1. Mere presentation. 2. It is not clarified how to appraise the grace of water	Surat Al-Molk.24, 25	Interpretion.01
7th Grade							
Allah Greatness Marks	As one mark of ALLAH's existence and Greatness, Water as blessing grace that has made to be the base of the earth life is presented. It is said that the water is the main reason by which plants, crops, fruits…etc can live.	Qu.07.01.15	water is life	So, what to do then?	Mere and stand-alone concept	Surat Qaff. 15	
Back outside cover	A photo of an abundant water wadi is presented and supported by a verse from the Holy Qur’an as "We made from water every living thing"	Qu.07.02.Back cover	Water is life	So, what to do then?	Repetitive and mere presentation	Back outside cover	
8th Grade							
back cover	A photo of a huge abundant waterfall is presented supported by a sub-text of a pray "Oh Allah, keep the grace of water for us forever"	Qu.08.01. back cover	Water is a gift	1. How can such abundant water photos be helpful to encourage the water save?. 2. The need is to oriented brief comprehensive and meaningful messages supported by photos of water issues, problems, solutions…etc	Mere and repetitive presentation	Back outside cover	
9th Grade							
Allah graces	It is mentioned that to keep people, their livestock and the whole life on the earth, Allah sends the rainfall down from the sky to the earth by which the earth grows every kind of plants	Qu.09.01.16, 18	water importance	So, what should human do?	Mere	Surat Logman. 16, 18	1
Allah graces	Some of the supplements provided by Allah to human are presented. One of them is the compelling of the seas water for navigational use to transfer people and deliver goods from place to place all over the world	Qu.09.02.38, 40	Navigation	So, what should human do?	Mere	Loqman Sura 31. pages 38, 40	1

(Annex 3.I) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
Allah graces	Allah criticizes disobeyed people that he is the one who sends the rainfall to the dried lands, relief them again, makes them very green and fruitful lands and pours springs throughout them. However, they denied all of that and went on the wrong path	Qu.09.03.118, 120	water is life		Mere	118, 120	2
back cover	A drawing illustrating water, trees, birds, human, fish….is presented and supported by a verse from the Holy Qur'an as "We made from water every living thing"	Qu.09.04.back outside cover	water is life		Repetitive presentation	back outside cover	
10th Grade							
	Don't they see that we send the water to the dried land and grow the plants	Qu.10.01.01. 41, 44	Rainfall		Mere and repetitive	Lessons nations.41, 44	
Allah's graces	Some verses from the Holy Qur'an present that Allah is the one who sends rain water down, prepare seas for navigations, creates rivers …etc. All has done those so that humans drink, grow and navigate. It is added that water represents the lifeline for humans, animals and plants	Qu.10.02.01. 09-11	water resources		It is not reflected how humans should praise those gifts	Allah's Gifts are non-countable. 9-11	8
Allah's graces	Allah is the one who sends the water from the sky relieving the dried lands	Qu.10.02.02. 46	Rainfall			Allah's Greatness. 46	14
11th Grade							
nothing							
12th Grades							
nothing							

Annex 3.J: Water Concepts in Islamic Education Subject in grades 01-12

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
1st Grade							
Body and Cloth Purification	A drawing shows a woman washing her address under opened tap. Its subtext says "I do not abuse the water". On the next page, it is written " The Muslim does not abuse the water".	Is.01.01.38, 39	Water not Abuse		the presented drawing does not match with its statement	Body and ClothPurification.38,39	1
The pure water	Three drawings of rainfall, sea water and dug well are presented as pure water sources. The fourth drawing belongs to a dog that is drinking from a pan. It is labeled as tainted water	Is.01.02.77-80	The pure water	On the next side of the lesson, those three sources in addition to river were mentioned as pure water that we use. The student are asked at the last page to rematch the same pictures for the pure water sources with their names	Distinction between the terms of "clean" and "pure" water is not introduced	The pure water.77-80	2
The pure water	It is stated that a) water is important for our life, b) we thank Allah for the given grace of water, and c) I do not abuse the water	Is.01.03.79	Water importance and abuse		Mere	The pure water.79	2
Ablution	I do not abuse the water	Is.01.04.111	water not abuse		repetitive and mere presentation	Ablution.111	2
Ethics of defecation	A drawing illustrating some children around a pond. It is stated that I do not defecate in the stagnant water. It is stated again that the Muslim do not defecate in the stagnant and flowing water	Is.02.01.32	water conservation	well presentation		Ethics of defecation.32	4
2nd Grade							
Behaiviours excercises	On one exercise two photos are presented for students to recognize and choose the right behaiviour. The first photo shows a student who damages a tree branches while the other photo shows another student who irrigate small plants	Is.02.01.26	Irrigation	The students are supposed to choose irrigating the small plants as the right behaiviour. But, the stupid thing is the photo that present the right behaiviour is for "flood irrigation" which is the main cause of water worsening situation in Yemen	Hence, inistade of instill the positive behaiviours/practices; the mis-selection of the photo will instill the culture of flood irrigations. So, it is recommended to make the comparsion between the modern and flood irrigation systems and instruct the teacher to highlight water effecincy/saveings in both systems	Keep tounge and Hand harmless. 26	Hadeeth
Ablution	I do not abuse the water by ablution	Is.02.02.36	water not abuse	Repetitive	Mere	Ablution.36	Fiqh
3rd Grade							
Toilet Ethics	It is presented that we do not urine or defecates in …,…,…, and water resources	Is.03.01.01. 33, 118	Water conservation	good to teach that		Toilet Ethics. 33, 118	Fiqh
Marks to Allah	Allah sends the rainfall down by which he grow the plants and make the earth alive. In addition, the rainfall forms rivers and springs	Is.03.01.02. 115,117	water importance			Allah's Features. 115 , 117	Iman
Ablution	Some photos present a boy doing ablution by an opened tap. It is stated that “I use the water that I need and do not abuse". However the photos show the water flows out of the tape in a way that might instill the water abuse culture	Is.03.02.02. 120-123	water not abuse	To encourage students to do ablution using a pre-prepared quantity of water in a pand would result in much efficient water use	Bad printing quality. Repetitive and mere concept	Ablution.141-143	Fiqh

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
4th Grade							
Water Purity	As a brief introduction posted for the topic of type of water suitable for ablution, it is mentioned "water has a big importance for life. Humans, animals and plants cannot live without water". This discourse was supported by a verse from the Holy Quran ‘‘From water we made every living thing’’. Therefore, we should save it	Is.04.01.33	water importance		Mere presentation	Types of Water.33	Fiqh
Ablution	Types of water are divided into three categorizations based on their usability for ablution (1. Clean Useable water for ablution such as rainfall, seas, rivers, wells, lakes 2. Clean but non useable water for ablution: water that is potable for drinking but non useable for ablution such as Tea, flowers water, juice. 3. Dirty Water is not useable for ablution: the water that has gotten a change in the color, smell or test.	Is.04.02.33-35	Water Purity		It highly worth to illustrate and visualize the water quantity used by the Prophet Mohammad PBUH for ablution. It is estimated as 0.75 L while most of the people today use a lot of water for ablution	Types of Water.33-35	Fiqh
Showering	Muslim uses the water as he needs and does not abuse the water when he uses it	Is.04.03.101	water not abuse		Mere and repetitive	Showering in Islam. 101	Fiqh
5th Grade							
Nothing							
6th Grade							
Water Save	One day the prophet Mohammad PBUH passed by his fellow "Sa'ad bin Abi Waqas" while he was doing his ablution for pray. He told Saad “do not abuse the water. Saad replied: Oh, Allah's Messenger, it is just water. Is there any abuse by using water? The Messenger PBUH replied: Yes, there is. Even you have a river". The prophet Mohammed PBUH has instructed Saad not to abuse the water even in the abundance conditions. The meaning of abuse is defined as to use more water that you need. Finally, many statements that might shape the attitude are presented under the part of I understand: 1. water is importance for life. 2. It is a must to follow the prophet Mohammad PBUH in saving the water. 3. Muslim does use what he exactly needs. 4. Man should not abuse the water. 5. Muslim should not overuse the water. 6. It is necessary to conserve the water resources. 7. I should keep the water clean and not being a cause of polluting it.	Is.06.01.36-38	Water Conservation		1. There is a need to visualize the water quantity the prophet Mohammad PBUH used to do ablution with. It is estimated not to exceed 2/3 L. the concept should be reflected on the other water use fields such as the irrigation which is the main water abuser in Yemen. 2. the other forms of water abuse in irrigation and other uses are absent	Water Save.36-38	Hadeeth
Back outside cover	On the back outside cover, a photo of a dam filled with water is presented and supported by the sub-text of "The water is a gift from ALLAH. And appraising the gift is to maintain and conserve it, So, do not abuse the water"	Is.06.02.Back outside cover	Water is gift, do not abuse it	Repetitive	It would be better if the used photo was for any kind of the water usages instead of presenting such abandon view of water	Back cover	
7th Grade							
Features of Allah	It is presented that Allah is the one who puts the laws of rainfall formation via evaporating the sea water and	Is.07.01.01.47	the water cycle	the concept is merely presented since the context is not technical. A	other parts of the water cycle such as run-off, infiltration to GW…etc are	ALLAH. 47	Believing in ALLAH. 02

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	transferring it to another places to irrigate the plants			picture of the water cycle is presented to support the concept. The picture labels and subtext are almost adequate.	not presented		
Features of Allah	If you observe the earth, you will find that it is divided into land and water. The water surfaces area is as four times as the land area.	Is.07.01.02.48	Hydrosphere	It is wrong Info	water coverage is around 71% percent.	ALLAH. 48	Believing in ALLAH. 02
lesson introduction	Water is a very important element for life. No one can live without water. Allah say "from the water we made every living thing". So, water is a gift from Allah to us for drinking and purification. Allah is the one who gears the access of the water from rainfall, springs, wells, seas, rivers..etc for us, therefore, we should appraise Allah for that by conserving the water and not abusing it	Is.07.01.03.77	Water importance		repetitive concept	The Water and its catogrizations.77	Fiqh, Purification. 01
Water Purity	The types of water for purification are divided into three types from an Islamic perspective. 1) Absolute pure water: It is the water that remains as the original water and nothing has changed (ex. rainfall, wells, springs, ice, sea...etc in nature). 2. Changed water by another pure substance such as tea, juice, coffee. 3. Polluted water that has mixed with a pollutant so that its color, smell, taste have changed.	Is.07.01.04.77-78	Types of Water for Purification			The Water and its catogrizations.77-78	Fiqh, Purification. 01
Urination	It is presented that the prophet Muhammad PBUH has forbidden to urine in the stagnant water resources	Is.07.01.05.81	Water conservation			Outside Urination curtseys.81	Fiqh, Purification. 01
ZamZam Water	ZamZam well in Mecca is a kind of blessing water since many thousands of year. The story of how ZamZam well was re-operated and used for supplying the Muslims with the drinking water during the Hajj season is presented.	Is.07.01.06.179-180	ZamZam water	The story could be reflected on sharing the drinking water with others especially those who do not have any access to safe and enough water resources.	It is not utilized to reflect any water principle	ZamZam Well re-drilling. 179-180	Human status quo before Mohammad PBUH. 02
Back outside cover	Water is the secret of life, so save it	Is.07.01.07. Back outside cover	Water is life	repeated		Back cover	
Occasional reason-based Prays	In Islam, if the rainfall has delayed resulting in a water shortage, Muslims go outside their villages/cities and pray the "Istisqa' Pray" and ask Allah (God) to relief them by the rainfall and announce their regretless for being disobeyed believers.	Is.07.02.01.80	Istisqaa		Such spiritual values should be also linked to the misbehaviors and miss-practices. For instance, students should layer that they should save the water and do not abuse it at all and meanwhile they can do Istisqaa' and pray. If not, they should know that even Allah might not accept their pray while they are abusing the resources	Occasional pray. 80	Fiqh. The pray. 02
Water Abuse	Some quoted Says of Allah and the prophet Mohammad PBUH preventing the water abuse are presented. It is mentioned that Allah has put the water resources in the earth which human used to utilize wisely. However, the	Is.07.02.02.99-102 Is.07.02.03.99-102	Water scarcity and depletion water abuse	the concept is supported by some photos as follows: 1) student doing ablution with written message (do not abuse the water, Allah does not	1. The presented photos have very bad quality so that it is hard to distinguish their parts especially the one related to the flood irrigation. 2.	Water Abuse Forbiddance. 99-102	Hadeeth section

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	expansion of the water use led people to extract the ground water and pumping and overusing its water till the wells get depleted and people then migrated. The prophet Mohammad PBUH said to Saad “do not abuse the water even you have a river". It is explained that the abuse prevention is not only under the water scarce conditions but also even under the water abundance conditions. It is reflected that if it is forbidden to abuse the water when you do ablution for pray, so it must be forbidden to do that at home, streets, farms...etc. It is added, that Yemen has water scarcity and face difficulties to supply the water to many regions. Hence, we should use the water wisely, advise the others and introduce them to the different types of water abuses. Some water abuse examples are as follows: water abuse by showering, ablution, cleaning and flood irrigation. Leaving the water tap open or neglecting its maintenance is also one example of water abuse	Is.07.02.04.99-102	awareness	like the water abusers). 2) a farm irrigated by flood irrigation method. 3) a farm supplied by poplar irrigation system. The activities ask students to suggest some methods to save the water to be discussed with their family and to prepare awareness signs and hang them in mosques.	The presentation is somehow mixed up. 3. The focus still on the domestic use as a main field for abusing the water which is not true at all. 4. Yemen is presented as water scarce country while during the other subjects is introduced as having water suffecncy. Hence, students might get confused. 5. The evaluation Qs are dealing with many issues from which some have not been introduced before such as the water use priority and ground water propriety. There is a good chance to involve students participating in some activities observing the water use in farms, houses, and mosques and to record their observations. Another thing to do is implementing some simple statistics of how people using or believing in water save		
Back outside cover	Water is the secret of life, so save it	Back outside cover	Water is life	repeated		Back cover	
8th Grade							
	on the back outside cover, a photo of an abundant water view of waterfalls is presented supported by a sub-text as a pray "Oh Allah, keep the gift of water for us forever"	Is.08.01.01. Back cover	Water is a gift	It is fine to pray for Allah to help and support. However, individuals should not rely only on their pray for getting their actions, roles, responsibilities…etc helping and saving themselves.	Stand-alone concept. The photo is mis-selected. The need is to orient brief messages supported by photos/illustrating draws of water issues, problems, solutions…etc	Back outside cover	
Living fundaments	Water is the base for life. It is necessary for all living creatures without which life disappears. A verse from the holy Qur’an followed as "from water we made every living things"	Is.08.02.01.17	Water Importance		Mere and Repetitive	Human Life Bases. 17	Believe. 1
Living fundaments	It is mentioned that Allah has provided the fresh water resources such as wells, springs, rivers and rainfall to the earth for human. This water in the earth is balanced. So, if the water percentage on the earth would exceed, the lands will be flooded and all kind of life will ended. The same would happen if the water quantity was reduced, we will die of thirst and so will crops, fruits and animals. Therefore, Allah sends down the rainfall with determined balances and enough quantities for his creatures in order to sustain life. Furthermore, Allah has made the earth as storage for this water	Is.08.02.02.17,18	Water resources		It should be reflected that humans are the ones who misbalance the water resources creating many water problems	Human Life Bases. 17,18	Believe. 1
	on the back outside cover, a photo of an abundant water view of waterfalls is presented supported by a sub-text as	Back cover	Water is a gift	It is fine to pray for Allah to help and support. However, individuals	Stand-alone concept. The photo is mis-selected. The need is to orient	Back outside	

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	a pray "Oh Allah, keep the gift of water for us forever"			should not rely only on their pray for getting their actions, roles, responsibilities…etc helping and saving themselves.	brief messages supported by photos/illustrating draws of water issues, problems, solutions…etc	cover	
9th Grade							
Back outside cover	On the outside back cover, a draw for water drop contains figures of human, fish, tress, lake, fish…etc is presented. It is supported by a verse from the holy Qur'an "from water we made every living thing"	Is.09.01.01. Back cover	water importance	stand-alone, repetitive	So, what to do?	**Back cover**	
Back outside cover	On the outside back cover, a draw for water drop contains figures of human, fish, tress, lake, fish…etc is presented. It is supported by a verse from the holy Qur'an "from water we made every living thing"	Is.09.02.01. Back cover	water importance	stand-alone, repetitive	So, what to do?	**Back cover**	
10th Grade							
Agriculture and Irrigation Delegation	Muslims are encouraged to share their lands to some one els in some cases such as having surplus of lands, disability to cultivate, low efficient use…etc. The same is applied to irrigation. Muslims are allowed to hand over their farms to somebody who can irrigate it in a better way. The concept, its conditions, benefits...etc are presented as well.	Is.F.10.01. 131-134	Irrigation	The aim of this religious principle is to maximize the benefits for both parties and the society as well.	Yemenis have applied this principle in wide range in rural areas. But, today the main issues in agriculture are the low efficiency in irrigation and the disability of farmers to afford the relatively high costs of modern irrigation systems. Hence, this principle could be applied that farmers give a portion of their annual return for some years to a company, factory or a project which purchase and install the modern irrigation systems for the respective farms.	Partnership in agriculture and irrigation. 131-134	Fiqh. 02
Allah Graces	Some verses of the Holy Qur'an introducing that Allah is the one who sends the water down from the sky and creates the rivers, springs ….etc. Then people are asked to contemplate in this grace of water which is the secret of life provided by Allah	Is.Im.10.02.01.17,18,23	Water importance		repetitive and mere	Do not you contemplate in yourself.23	
11th Grade							
Charity	It is mentioned that People at the first period of Islam in Al-Madina used to get the drinking water from a well belongs to a Jewish man against specific money paid by people individually. Nevertheless, since it was the only well that has potable water, the Jewish man was doing a kind of monopoly that people hardly could afford their daily payments. Hence, a rich Muslim called "Othman bin Afghan" has bought the well from the Jewish man with the price he asked for so that Othman owns the well every second day. Then Othman started to give the drinking water to people free of charge. Accordingly, poor people started take more water in Othman's day that is enough for two days to avoid the monopolism of the Jewish man. As result, the Jewish man did not get costumers anymore	Is.M.B.11.01.01.45	Drinking water	1. The presentation is formed in away to present one side of Othman's good qualities as a Muslim model that always supported his community with whatever he could. 2. To support poor people with drinking water free of charge is the only obvious concept which is expected to be acquired by learners.	The concept is not utilized form the water management point of view even though many concepts related water can be highlighted and reflected on the field of water management as follows: 1. Islam and Muslims accept the principle of drinking water price (what is called water bill today). 2. Monopolism in drinking water supply should be stopped however by using fair solution. 3. Private sector can take the task of water supply but without any kind of monopolism	Othman Bin Affan. 45	

(Annex 3.J) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	so that he found it better to sell his portion to Othman with the same price of the first one. Finally, the well was daily accessible by all people for free						
Scientific Crocking	Some verses of the holy Qur'an explaining how winds inspire soil/dust particles raising them up, throwing them into clouds so that water steam comes around those particles forming many layers till it becomes a heavy water drop and carrying heavy clouds to fall down the rains everywhere to relies the dried lands.	Is.Im.11.01.40-41	Rainfall formation			Scientific Crocking.40,41	
Scientific Crocking	Some verses of the holy Qur'an explaining that there are underneath waves like the ones existed on the seas and oceans surfaces. Besides that, they mention that the seas and oceans beds (in deep ones) are totally dark and light cannot reach there due to the three layers (clouds, the surface waves and the underneath waves) breaking , reflecting and preventing the sun light to reach the deeply beds of seas and oceans	Is.Im.11.02.42-43	Sea characteristics			Scientific Crocking.42-43	
Resources Property	It is said that natural resources on the earth such as forests, beaches, rivers, minerals…etc cannot be owned personally by people. However, any investments or efforts can lead to authorize the investors to have the right and priority of using what he invested own	Is.F.11.02.01.53	Rivers and beaches property	The whole lesson presents the main principles of the economic system in Islam such as resources, resources property tools and conditions, property restriction, resources utilization, distribution and development, exchange and consumption…etc. However, water is not included except what is already mentioned about the rivers and beaches as resources that can not be owned	Many water principles such as water rights, use and priorities, price, conservation are totally absent even though this section is a very good place to present them	The Economical System in Islam. 53	
12th Grade							
nothing							

Annex 3.K: Water Concepts in Mathematics Subject in grades 01-12

(Annex 3.K) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
1st , 2nd, and 3rd Grade							
nothing							
4th Grade							
Multiplication Exercises	A house consumes 256 L/day of water, how many liters do the house consumes in one year knowing that year contains 365 day?	Ma.04.01.01.84	Water consumption	Liter as unit is not touchable especially for such age		84	3
Approximation	A family consumes 293 L/day, approximate how many liters does the family consumes in one week?	Ma.04.01.02.88	Water consumption			88	3
Division	A water tank has size of 1440 Liters utilized by a family of 6 members in five days. How many liters per day the family use and the person consumes separately?	Ma.04.01.03.114	Water consumption			114	4
5th Grade							
Arabic Rivers	Put the following rivers lengths in exponential order: Jordan, Nile, Tigris and Euphrates	Ma.05.01.01.05	Rivers	1. Typing mistake (الطول بالكم تعدل الى الطول بال كم) . 2.It would be better to write the respective Arab countries that share those rivers in a third column	A tailing comment can follow as " Note that Yemen does not have any rivers"	Hundred of Thousands. 05	Millions. 0`
Water Consumption	An exercise asks student to write in letters the number of Yemen water consumption in 1990 which is 229,000,000 m3	Ma.05.01.02.15	Water consumption	This figure might refer to the drinking water consumption in urban cities supplied by the public network.	1. The introduced figure is 22 years old and needs to be updated. 2. Either to mention that the figure is for the drinking water consumption or to replace it by the total annual use of all sectors.	Millions.15	Millions. 01
The Hydrosphere	It is given that the water surfaces area is 362,ooo,ooo km2 and the land area is 148,000,000 km2. Which area is larger? Calculate the difference?	Ma.05.01.03.20	Hydrosphere		1. it would be better to illustrate the exercises by a pile figure. A following exercise can follow giving the values of the total and salty water amounts and ask students to calculate the fresh water. For more acquiring, the difference between the quantities can be visualized relatively by any shape such as two big and small cylinders on which to write the salty and fresh water visualization	Deduction in Millions.20	Millions. 01
International Oceans	The areas of the Pacific, the Atlantic and the Indian oceans are given. Student are asked to calculate the total area	Ma.05.01.04.35	Oceans		Mere	The Addition in Millions .35	Millions Addition and Reduction. 02
Agriculture Encouragement	The useable agricultural lands and the already cultivated areas in Yemen in 1996 are given as 1.660,985 ha and 1,063,540 ha respectively. Calculate the useable agricultural area that still not utilized?	Ma.05.01.05.40	Agriculture Expansion	Eencouragement for agriculture expansion.	1. The presented figures are old and need to be updated. 2.Encouraging agriculture expansion means increasing the water imbalance especially under the current low efficiency of use in irrigation-35%	The Addition in Millions .40	Millions Addition and Reduction. 02
Water Consumption	A village used to consume 156,000 Liter of water per month. After awareness for rational water consumption, it consumes	Ma.05.01.06.50	Water Save	1. The rural areas in Yemen have very limited access to water and the individual water consumption rate	1. Useless presentation. 2. It would be more fruitful to change the context to present the water abuse and potential water save either by a farmer	Addition and Reduction	Millions Addition and

(Annex 3.K) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	98,500 L/month. What is the difference between the two consumptions?			(35l/cap. day) is even below the minimum level required for health conditions. So, there is no need to encourage for any savings here. 2. To present the total consumption in Liters is not touchable for students in Yemen. 3. It is asked for the difference. To change the form asking about the water saving is much useful	how changed from traditional to modern irrigation systems or to a family in x city that get award on how to save water by cleaning, showering,...etc. Much more can be gained to reflect the costs before and after and to ask for monetary saving calculation. 3. To use the cubic meter unite or the standard small water tanker might be much sensible and understandable by students	Exercises. 50	Reduction. 02
Water consumption	Calculate the water consumption of 86,900 families, in case the water consumption is 385 L/family? If each family reduced its water consumption by 100 L, how many Liters of water can be saved?	Ma.05.01.07.65	Water Save	1. It is somewhat a better presentation than the previous one.	However, it is still not that useful presentation for the followings: 1. If the aim is to motivate students on water save, how can they imagine and or get it without mentioning whether the presented consumption is for a day, week or month maybe! 2. The matter is not to inform about water save but to show how to do it. In other words more precise is strongly needed to state that they have that reduction done by repairing leakages, installing modern taps, a adopting more rational practices by cleaning for example...etc. 3. Again Liters is not that sensible unit at least for such age. 4. It is noticed that the exercises reflecting water save are focusing on water save on the domestic sector that consumes less than 8% in Yemen. Nevertheless, the irrigation sector that consumes more than 90% with very low water use efficiency and low economical returns is not even referred to. Therefore, it is strongly recommended that shifting the focus on water save by irrigation sector will be much practical and fruitful	Approximation. 65	Multiplication and division. 03
Water consumption	The daily water consumption of 395 families is 108,425 Liters, approximate the daily water consumption for each family?	Ma.05.01.08.80	Water Consumption	1. Reparative. 2. It would be better to change the given data on the individual level so that they can so some comparison. Otherwise, the exercise is useless	Almost the same comments given on the last two "somehow" similar exercise. In addition to the stated remarks	Approximation. 80	Multiplication and division. 03
6th Grade							
	The water area on the earth is around 362,000,000 km2 while the land area is around 148,000,000 km2. What is the total area of the earth surface? How much is the difference between the water and the land areas?	Ma.06.01.01.14	Hydrosphere	for more benefits, it would be better to ask for conclusion, to add another Q to show that most of this quantity is not useable/accessible	Repetitive	Addition and Reduction. 14	1
	The Arab Nation is not able to protect its countries, to have them full independents, and to govern itself unless it attains a self-suffecent food production	Ma.06.02.01.141	Food Security	it is presented as an exercise for student to calculate the frequency of some arabic lettes as an application of statistice	Adverse impact	Data collection and organization. 141	Statistice. 8

(Annex 3.K) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	Some of the African rivers with their lengths are presented in an evaluation exercise. The students are required to put them in table ordered from the shortest to the longest.	Ma.06.02.02.141	Rivers			Data collection and organization. 141	Statistic. 8
	In a chart, the water consumption for producing 1 liter, 1 car, 1 ton of paper and I liter of oil are 250,000 L, 450,000 L, 125,000 L and 125,000 L respectively. The students are requested to identify, how much water does it need to produce one car and 3t of papers? And to compare which consumes more producing one tire or three ton of paper?	Ma.06.02.03.153	virtual water	This is a very good example of how can we apply the water concepts in Mathematic. Nevertheless, the presented concept is not that useful in the case of Yemen. Because, Yemen does not produce cars, tires, papers…etc. It would be much more useful if the exercise contents reflect the water consumptions of some agricultural crops that are widely planted in Yemen	To have the most of benefit, such question could be followed by another one that presents the average prices of the presented crops to instill the concepts of which are less consuming crops and meanwhile are cash crops. Or to present the water consumptions in the different sectors	Data presentation in charts. 153	Statistic. 8
	In a pile chart, the family monthly expenditure of 20,000 YR (90 USD) is presented and distributed on rent, gas, food, and water electricity. It is shown that water and electricity make 15% of the total expenditure. The student are requested to calculate how much does the family pay for the W&E.	Ma.06.02.04.158	Water bill	The total expenditure is underestimated	1. It is better to ask student to compare the result of the exercise with what they actually pay for the water and electricity? 2. It would be better if the water expender to be presented separately	Data presentation in charts. 158	Statistic. 8
	In a figure, the rainy days in Sana'a, Hadhramoot, and Ibb are presented by number of umbrellas. It is mentioned that an umbrella figure represents 20 days. The students are requested to calculate how many rainfall days in Sana'a? how much is the deference between the rainy days of Ibb and Hadhramoot?	Ma.06.02.05.166	Rainfall		the exercise should be reformed to indicate the precipitation depth/quantity rather than the number of the rainy days. Furthermore, it could be compared with the averages of some water poor/rich countries	Average calculation. 166	Statistic. 8
7th Grade							
Arithmetic average Evaluation	The rainfall average of three consecutive days is 3.5mm. So, if the Pr of the first day= 3.7, Pr of the second day= 3.6, calculate the Pr3?	Ma.07.01.268	Rainfall rate calculation	It would be better to localized it with some real figures of the annual Yemeni rainfall and reflect it by comparison to rainfall average of any water rich country so that students realize how scarce the water in Yemen is	Mere presentation	Arithmetic average. 268	7
Back outside cover	A photo of an abundant water view in a wadi is presented supported by above message as " water is the secret of life, so save it	Ma.07.02.back cover	Water is life		Repetitive and mere presentation	back outside cover	
8th Grade							
back cover	A photo of a huge abundant waterfall is presented and supported by a verse from	Ma.08.01.back outside	water is life	It is wondering how can such abundant water view help to	1. Repetitive, 2. Miss-match between the message and the selected photo	back outside	

(Annex 3.K) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	the Holy Qur'an as "Say, ye thought become your water disappeared, who can come up with fresh water for you? "	cover		encourage students for water saving		cover	
back cover	A photo of a huge abundant waterfall is presented and supported by a verse from the Holy Qur'an as "Say, ye thought become your water disappeared, who can come up with fresh water for you? "	Ma.08.02.back outside cover	water is life	It is wondering how can such abundant water view help to encourage students for water saving	1. Repetitive, 2. Miss-match between the message and the selected photo	back outside cover	
9th Grade							
back cover	A drawing illustrating water, trees, birds, human, fish….is presented and supported by a verse from the Holy Qur'an as "We made from water every living thing"	Ma.09.01.back outside cover	water is life		Repetitive presentation	back outside cover	
arithmetic median evaluation	As an exercise of statistic, the water consumptions of twenty families for two months are given in a table with families' frequencies that have the same amount of the consumed water. The students are requested to calculate 1. The upward and downward accumulated repetition. 2. The consumption average using both of a) the accumulated upward and downward repetition method, b) the graphic method	Ma.09.02.01.139	Water consumption	Students are not asked to compare or reflect what they are supposed to found out.	1. Mere presentation. Hence, it would be better to provide the water consumptions for the same sample after adopting/installing rational shower methods and or device or may be after repairing some leakage points at houses and then let them compare the reduction in the water consumption. Or to ask them to compare the average they yield form the activity with the average water consumptions of the houses belong to the classmates. 2. It is presented at the last pages of the second semester book. Hence, most of the students might not do this exercise since the majority of public schools cannot manage to finish the books	Arithmetic median evaluation. 139	7
back cover	A drawing illustrating water, trees, birds, human, fish….is presented and supported by a verse from the Holy Qur'an as "We made from water every living thing"	Ma.09.02.02.back outside cover	water is life		Repetitive presentation	back outside cover	
10th Grade							
Logic statement	When was Marib dam re-built?	Ma.10.01.01.09	Marib Dam	It is presented as a mathematical example of determining whether this statement can be considered as an example of logic statements or not	Focus on dam. Many other water concepts can be presented here in the form of logic statements	Logic issues.09	1
Logic issues	Land is saturated with water. The crop grows. So, link both statements to make a logic issue in three different mathematical forms	Ma.10.01.02.18	Water for Irrigation	Mere and much simplexes presentation	Using examples of water solutions would be more fruitful	Logic Issue. 18	1
Logic issues	Every living thing needs water	Ma.10.01.03.25	Water importance	student are asked to give the contrast for the mentioned statement	In this age, concept should meet students' ability. What is the use to give such mere and simple example	Logic Issue. 25	1
11th Grade, Science stream							
Successive calculation	Water tank has storage capacity of 1350 gallon. In the first day, 20 gallon has leaked. Then every day, water leaking	Ma.Sc.11.01.01.82	Water leakage	The used unit of gallon is not common in Yemen. So, using liter or m3 might be much more	It is presented in a passive way. It would be better to say, assume that the water tank or a leaking tap at your home loses …liter and so on. Furthermore, for much usefulness it	Successive formula. 82	3

(Annex 3.K) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	increased by 5 gallon. Calculate how many days does it take for the tank to be empty of water? The example is solved			practical	would be better to give a price for the unit of water and ask students to calculate how much money they lose due to the leaking tank/tap and to compare it with the reparation cost		
Successive formula	An empty water tank has received 243 gallon in the first day. Then within the next days, the inflow was 1 and 1/3 time the inflow of the previous day. If you knew that the water was full at the end of the sixth day, calculate the tank volume?	Ma.Sc.11.01.02.99	Quantity calculation	An exercise for the engineering series formula	What is the fruit gained after solving the exercise?! Hence, giving examples of water consumptions in irrigation, GW over-pumping, GW level drop might be more useful. For instance, the following purposed exercise might be more fruitful. A farmer drilled a well and started to pump its GW for grapes irrigation. In the first year, the GW level in the well has dropped 6m. Then every year the GW level drop increases by 1/3 of the first year drop. If you know that the well has run out of the water in 15 years, calculate the total water depth in the well? If you finish, re-calculate how many years can the farmer utilize the water of the same well in case he changes his crop to a higher return crop such as almond knowing that the first GW level drop in this case is 2 m and it increases by 1/4 yearly? Third scenario, the farmer adopted the drip irrigation system so that GW level drop at the first year was 0.2 m and increases by 1/10. In this case calculate how many years will it takes the well to be depleted	Successive formula. 99	
Successive Formula	Q.19. Water flows from a house tap in a basin with 50 L/hr, then in one hour the flow increases by 5L/hr. Calculate how many hours does it take to have 725 L?	Ma.Sc.EX.11.01.24	Flow Measurement	Mere presentation	1. students are not required to comment on result they get. 2. It would be more useful to make the exercise to calculate the losses from a house tape, or from conveyance irrigation pipe…etc and then to ask them to reflect it in monitory value for a month/year and compare it to the estimated cost of repairing the pipe or replacing the house tap. Another example can be to give them the monthly GW extraction rates of two similar GW wells that irrigate the same crops for equal areas and to tell them that the first farmer uses the flood irrigation so that his well production decreases monthly by .....m3/month while the other farmer is using the drip irrigation and his well production decreases with much less rate comparing to the first farmer. Then to ask them to calculate the monthly wells production after 5,8, 12 years and which well is supposed to run out of water firstly	24	
Successive formula	An empty water tank has received 243 gallon in the first day. Then within the next days, the inflow was 1 and 1/3 time the inflow of the previous day. If you knew that the water was full at the end of the sixth day, calculate the tank volume?	Ma.Sc.EX.11.02.27	Quantity calculation			27	
11^{th} Grade, Humanitarian stream, 12^{th} Grade, Science and Humanitarian streams							
nothing							

Annex 3.L: Water Concepts in English Subject in grades 06-12

(Annex. 3.L) Context	Description	Concept ID	Concept	Remarks	Gaps/weakness	Topic	Unit
	Two pictures present the rational way of using the water for teeth cleaning and car washing	En.Co.07.01.29,40	domestic use	Unless it is English, the presented concepts are very simple for such age	Stand-alone concept	29 & 40	
Daily activities	In the workbook, a mascot called Sam is presented while he is doing various activities during the day. Three pictures show Sam's showering, teeth cleaning and face washing. Nonetheless, they are illustrated in away that it seems he has abundance of water.	En.H.W.07.02, 65	domestic use	It does not encourage the water save	Mis-conceptualization	What is Sam doing? 65	
8th Grade							
Nothing							
9th Grade							
nothing							
10th Grade							
nothing							
11th Grade							
Forestation advantages	It is mentioned that trees prevents soil erosion. Besides that, they slow down flood waters giving more time for water to soak into the soil	En.11.01.36	groundwater infiltration		Mere	Towards green land. 36	5
Forestation	It is presented that desertification happened due to trees and plants disappear. Trees and plants need water which we can get by drilling wells. However, if we drill wells too close together, the water will disappear because they will use up the water quicker than one well does. When a well runs dry, the farmer moves on leaving a desert behind him.	En.11.02.36	GW depletion	Good information		Towards a greener land. 36	5
The World	It is presented the total area of the earth is 510 million km2 out of which 361 million km2 covered by water. Then the longest river in each continent with its length is presented	En.11.03.62	rivers		mere	The world. 62	Science reading. 5
Polar region	It is mentioned that area with precipitation rate less than 25 cm/year is classified as deserts	En.11.04.67	Arid zones		Mere	The polar regions. 67	Science reading. 10
Energy Production	It is presented that rivers, streams, tide of the seas and waves all provide endless sources of lean an safe energy. However, to generate electricity from rivers, dams should be built which means flooding huge areas of lands that could be utilized for food production. Waves also have some disadvantages when they used for electricity production. It is concluded, that even water is everywhere and free, it cannot substitute the oil, gas or coal	En.11.05.69	Energy Production	well presentation	the conclusion destroys the concept a way	Energy Sources for the future. 69	Science reading. 12
	the greenhouse effects such as seas expansion, polar melting, floods, draught, more rain in some areas vs. scarcity in the others, tropical rainforests disappear…etc are mentioned	En.11.06.71	Climate change		Mere	Man- the destroyer. 71	Science reading. 14
12th Grade							
Natural disasters	"Drought is a water shortage after a long period with no rains". On the other hand, "when there is deep water over normally dry land, this is called flood. When this happens very quickly, such as in a wadi in the mountains, it is called flash flood"	En.12.01.13	Drought and Floods		Meer	Natural Disasters. 13	3
How to do simple research	A presentation of how to do an experiment proving that the pressure at the bottom of water bodies is much higher than at the surface	En.12.02.30	Water pressure	well presentation		Investigating the world around us. 30	4
States of Matter	The kinetic theory, water states and cycle are presented	En.12.03.66	water states and cycle	water cycle is briefly and incompletely presented		States of Matter. 66	Science reading. 02

التعليم المائي في اليمن
دراسة تقييمية لمفاهيم المياه في التعليم الأساسي والثانوي

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الملخص

هذه الدراسة تسلط الضوء على ما يتم تدريسه للأجيال في اليمن فيما يتعلق بمجال المياه وكيف يتم تدريسه. ففي حين تهدف بشكل رئيسي إلى تقييم مفاهيم المياه المعطاة في المرحلتين الأساسية والثانوية والوسائل التعليمية المساعدة فهي تسعى أيضا الى اقتراح امكانية وسبل تطويرها كي تؤدي في نهاية المطاف إلى إيجاد تعليم مائي شامل ومتكامل يساعد على تحفيز واشراك تلاميذ اليوم في تحسين الوضع المائي المتدهور حاليا وكذلك تهيئتهم ليكونوا شركاء ومدراء المياه الفاعلين مستقبلا.

لتحقيق ذلك تم تبني منهجية متعددة المحتوى تقوم على أساس استعراض وفحص محتويات الكتب المدرسية واستخراج المفاهيم المائية وتحليلها تقييمها وفق عدد من المعايير المائية والتعليمية. لهذا الغرض تم تطوير مصفوفة متعددة الأبعاد تسمح باجراء العديد من التحليلات رأسيا على مستوى كل مادة وأفقيا على مستوى المراحل الصفية (اساسي أدنى، اساسي اعلى، ثانوي) كما تم استخدام برنامج الاكسل لتنفيذ تلك التحليلات. بإختصار شديد تم تحليل وتقييم مفاهيم المياه المتواجدة في كل مادة دراسية

من حيث مدى تغطيتها وطريقة عرضها التي تحدد العمق التعليمي للمفهوم وكذلك تسلسلها وتطورها الرأسي في تلك المادة عبر الصفوف المختلفة. في الجانب الآخر تم تقييم المفاهيم افقيا على مستوى المراحل الدراسية لتحديد مدى تغطية مختلف المفاهيم المائية وتنوعها ودرجة العمق التطبيقي للمفهوم بالاضافه الى تحديد اماكن التناقض والنواقص والاخطاء في كل مرحلة بالاضافة الى تحديد وتقييم تلك المفاهيم المتعلقة بالوضع المائية وادارته في اليمن. كما تم رسم خريطة لكل مادة تحدد ما هي المفاهيم المطروحة واين تقع وطريقة عرضها وعمقها التعليمي والتطبيقي بالاضافة الى تسلسلها وتطورها الرأسي؟

نتائج الدراسة اوضحت ان معظم مفاهيم المياه تطرح أما كمفاهيم تكميلية في دروس لمواضيع اخرى او كتحشية وتنويهات لا تتعلق بالنطاق التي وضعت فيه. ناهيك عن السطحية الشديدة سواء من حيث تنوع وحداثة المعلومات المعطاة او سطحية التطبيق العملي لتلك المفاهيم. فيما يتعلق بتنوع المفاهيم وجد ان التركيز الاكبر هو حول مفاهيم اهمية المياه كنعمة من نعم الحياة ووجودها في الطبيعه وخصائصها الفنية الاخرى، بينما المبادئ والمفاهيم المتعلقة بالمشاكل المائية وتاثير الانسان فيها كانت مغطاه بشكل سطحي جاف ومتكرر فيما مفاهيم ادارة المياه وادواتها واستدامتها حصلت على التغطية الادنى. التسلسل الراسي كان متواجد في بعض المواد على الرغم من ضعف التطور في المفهوم المتدرج بينما كان مكررا ومتقطعا في غالبية المواد. اما من ناحية تجسيد عرض المفاهيم عبر الصور والمجسمات فكان اما ضعيفا او لا يعبر عن السياق واحيانا كثيرة كان غائبا تماما.

أخيرا وليس بآخر لوحظ أن هناك تجاهلا لأهمية دور الآخر لدى المسئولين في كلا من قطاعي المياه والتعليم وأكبر دليل هو ضعف ان لم يكن غياب التنسيق والعمل المشترك إلى هذه اللحظه.

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