INNOVATIVE WATER KNOWLEDGE TRAINING PROGRAM FOR SUSTAINABLE DEVELOPMENT IN EGYPT

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ABSTRACT

Innovative Water Knowledge training program is the engine for the process of achieving national water development proficiency. This paper assesses the Water Knowledge training needs for professionals in Egypt. Based on the national needs assessment, the writer constructs an intensive program for water development professionals. The program is designed to provide an overview of international best practice on sustainable development issues associated with national water development projects. The program introduces aims and objectives of sustainable development such as modifying and improving designs, ensuring efficient resource use, enhancing social aspects, avoiding damage to the environment and protecting human health and safety. The program addresses the environmental effects such as biophysical and resources use, social, cultural, health, safety, economic and fiscal, landscape and visual, indigenous peoples rights and traditional areas. The program concentrates on some core values such as integrity, utility, credible information for decision-making, sustainability and in environmental safeguards. In designing the program, the guiding principles are to be focused, adaptive, participative, transparent, accurate, practical, credible and efficient. The Paper concludes that the Water Knowledge training program has a good capacity building impact. After training, water professionals can propose and campaign practical solutions to water and sustainable development problems.

Keywords: Water - Knowledge - Program - Outcome - Assessment

I. INTRODUCTION

The focus of this innovative water knowledge training program for sustainable development is to guarantee that the participants have an adequate knowledge about water environment disciplines. The planned participants are graduates of engineering, agriculture technology, and applied science. If they possess professional water knowledge for all water environment disciplines, they will be capable of doing their best in both of Water conservation and Water savings different fields.

The ability to solve problems and creative potential are highlighted as essential characteristics for both novice undergraduate engineers and qualified engineering professionals in UK benchmark statements [1, 2]. Additionally, much research exists on the characteristic differences between expert and novice problem solvers, and how this can help our understanding of developing problem solving skills in the classroom [3, 4]. There are reportedly a number of characteristics that differentiate an expert from a novice problem solver. These include the use of memory, attitude, strategy and

visualisation [5]. Perhaps central to this difference is how experts and novices initially think about problems. "It is desirable, as a challenge, to acquire a technological and interdisciplinary curriculum, aiming at the union and the necessary integration to avoid activities from being executed without a systemic direction and the courses from being taught without any connection to each other in a repeatedly and independent way". [6]. Outcome assessment has been a major topic of discussion in almost all fields of higher education. The methodologies of assessment have been debated for many years and become more pressing in recent years, [7, 8, 9]. Using the fundamentals of engineering (FE) exam results to assess participant outcomes has been discussed in the engineering education society for many years [10, 11].

This paper presents both innovative water knowledge training program for sustainable development and how the Outcome may be assessed using program assessment package with micro and macro analysis, which was developed in hopes of providing acceptable levels of assessment to verify training program performance.

II. WATER KNOWLEDGE TRAINING PROGRAM DESIGN

Water Knowledge Training Program for Sustainable Development is designed to bridge the gap between the academia and the professional practice. The Objective of the Program is to train water professional for the future. In order to survive in the future, the water professional should be qualified to deal with different and diverse subjects of water environment. They ought to achieve Sustainable Development in the fields of water environment, science, engineering, technology and management.

The target audience of the Program is the water professional in the fields of Water Resources, Non-Conventional Water Resources Technology, Water conservation, and Water savings, Hydrology, Water Science, Water Pollution, Aquatic Science, Conservation Biology, Fisheries and Wildlife, Forestry, Ecology, Wastewater, Natural Resource Management.

The Program is designed to offer both two main both types of instructions lectures and laboratories (or field sessions). The Program offers both theoretical and applied training in technical, analytical, and presentation skills necessary in the Water Knowledge fields using a huge range of river, stream and lake data and case studies. The Program is divided into ten major courses summing up to thirty syllabus units. The Ten Major Courses are Water Related Basic Science, Water Related Issues and Crisis, Inland Waters Analysis, Water Engineering, Water Related Knowledge, Water Survey and Instruments, Water Schemes Management and Restoration, Water Statistics, Modeling and Information Technology Water Environment Assessment, and Sustainable Development of Water Environment.

The thirty Syllabus Units are Aquatic Science and Hydrobiology, Aquatic Chemistry, Water Physics, Water Schemes and Society, Multiple Perspectives of Water Concerns and Crisis, Inland waters Systems, Inland waters Aspects, Inland waters Application, Hydrology and Hydraulic Analysis, Water Works Design and Engineering, Watershed Assessment, Degradation and Rehabilitation of Watercourse, Water Knowledge

Principles, Water Related Problems, Water related management and Culture Knowledge, General Water Related Surveys, Standing Water Surveys, Running Water Surveys, Water Schemes Management, Water Schemes Restoration, Non-Conventional Water Resources Technology, Experimental Design and Water Scheme Modeling, Water Related Information Technology, Environmental Impact Assessment Principles and Techniques, Environmental Impact Assessment Proficiency, EIA of Water Resources Projects, Sustainable Development Principles, Sustainable Development Instruments, Sustainable Development Management, Climate Change and Water Environment.

III. WATER KNOWLEDGE PROGRAM DESCRIPTION

1. WATER RELATED BASIC SCIENCE

1.1 Aquatic Science and Hydrobiology

Water Properties, hydrological cycle, and Aquatic Science (Aquatic Respiration, Fish Stocking Decisions and Sustaining Life in the water environment). Application of physics, chemistry, geology, and geography to ecological problems. Physical and chemical factors, Horizontal (advection), Vertical (light, temp, density; O₂; stratification; mixing).

1.2 Aquatic Chemistry

Aquatic Chemistry (pH Effect, Photosynthesis and Respiration), Major ions, and Chemistry of Oxygen Solubility. Biogeochemistry, Nitrogen cycle, Phosphorus cycling, Iron and sulfur cycles.

1.3 Water Physics

Water Physics (Thermal Stratification, Heat Budgets and Temperature Variation of water bodies, Conductivity and water bodies Turbidity).

2. WATER RELATED ISSUES AND CRISIS

2.1 Water Schemes and Society

Beneficial uses of water, Groundwater, Human impacts, land use practices, Landwater interactions, Climatic influences. Sediments and sediment-water interactions (nutrients/metals release vs DO, Fe, S). Geomorphology, and Basins (including reservoirs issues). Paleolimnology, Temporal variations (physical, chemical, biological). Eutrophication, and Organisms (algae, higher plants, invertebrates, and fish issues). Biological distributions of organisms, Food webs concepts, Food web dynamics (Organism and metabolism), Plants, animals, bacteria/fungi (within habitat context), Productivity (respiration, microbial loop).

Case studies (Lakes Nasser "Freshwater", and lakes of Maraud, Edco, Manzala, and Brolos, "Brackish water").

2.2 Multiple Perspectives of Water Concerns and Crisis

Historical, Spatial (groundwater; rivers), Physical (scarcity; variability), Social (equity issues), Economic (pricing) and Political. Water Scarcity (Absolute Scarcity, Erratic Rainfall, Soil Disturbance and Population Growth). Water availability and withdrawal, Water supply and demand, Water quality, water-related disease and Human Health, Geopolitics and international law, (surface; ground; shared; rain; sewage).

Integrated Water Resource Management, (Link sector needs with water policy, resource allocation and management, Central policy-making and local management, Problems in pricing, fragmentation of decision making; health concerns), efficient water use through technical instruments and economic incentives, Resource pricing, water banking and modernization of conveyance and distribution systems.

Irrigation efficiency (through both pricing and technology), Reuse wastewater, Health risks, Reduce groundwater extraction, partnerships among NGOs, government and the private sector, Decentralized and participatory approaches, Private sector participation, Enhance supply (Desalination, Imports (tanker, pipeline), Virtual water), Partnerships – regional and international, technical and financial cooperation on water issues. *Case Study: Water and Cooperation in the Nile Basin.*

3. INLAND WATERS ANALYSIS

3.1 Inland waters Systems

The Inland waters study includes Freshwater and saline water, Natural and man-made water bodies, Running and standing waters. Standing water study includes reservoirs, lakes, ponds Marshes, swamps, and bogs and moors microhabitats. Running water study includes rivers, streams, and estuaries also groundwater, springs.

3.2 Inland waters Aspects

Inland waters studies, including their hydrological, biological Major Groups of Organisms, Habitats and Communities, the functional relationships and productivity of Inland water communities, Physical and Chemical Processes, Energy Fluxes, the dynamics of their physical, chemical and biotic environments, geological aspects.

3.3 Inland waters Application

River protection and regeneration, Lake and reservoir management, Aquaculture, Fish and wildlife enhancement, Wetland conservation, Water pollution control, artificial wetland construction.

4. WATER ENGINEERING

4.1 Hydrology and Hydraulic Analysis

Hydrograph, Meteorology, Surface water hydrology, Flow and occurrence of water on the surface of the earth, Hydrogeology, Irrigation, Power generation, and Cooling water. Hydraulic Analysis, Steady Flow, Water Surface Profiles, flood insurance studies, effects of channel modifications, Unsteady Flow Simulation, Sediment Transport/Movable Boundary, scour and deposition, Suspended and Bed load.

Channel Flow, Uniform Flow, Channel transitions, Critical, Subcritical and Supercritical Flow, Hydraulic Jump, Gradually Varied Flow, Classification of flows, Surface profiles.

4.2 Water Works Design and Engineering

Channel Design, River Engineering, Canals, Stable unlined channel design, Bed forms, Channel forms, River Training, Closed Conduit Flow, Control structures (sluice gates, weirs...), multi-waterway bridges, culvert options, and Stable channel design, and maintain navigation depths, flood plain management.

Dams, Balancing Supply and Demand, Hydropower, store runoff, protect against sea storm surges, Reservoir, Irrigation, Recreation, Levees, Discharge and dilution, Outfalls, Flood control and protection, Flood Design Techniques, Flood plain construction.

Municipal water supply, Water intakes, Drinking water, Water Treatment Design, Wastewater Treatment, Maintaining and upgrading the infrastructure, contaminated site remediation, Waste minimization.

4.3 Watershed Assessment

Identification of watershed issues, Hydrology and water use, Channel habitat type classification, Sediment sources, Riparian/wetlands, Landscape characterization, Channel modification, Watershed characterization of temperature, Watershed condition evaluation, Historical conditions and Watershed Assessment.

4.4 Degradation and Rehabilitation of Watercourse

Water abstraction, Hydroelectricity, Problem for upstream fish migration, sedimentation, changed communities behind dam, ecologically necessary minimum flow, renders schemes uneconomic, river pollution (point sources and diffuse sources), structural changes to the river bed, integrated river basin management, Sand and gravel extraction.

5. WATER RELATED KNOWLEDGE

5.1 Water Knowledge Principles

Water Resources, Water-Filled Depressions, Frameworks for Understanding Water Environment and Systems, Freshwater Life Zones, Aquatic Ecosystems, Biosphere Reserve, Coral Reefs, Coastal Zone, Community Ecology, Biotic and Abiotic environment, Wetlands, Terrestrial Biomes, and Biodiversity, Water Sustainable Future

5.2 Water Related Problems

Water Problems, Causes, and Sustainability, Impacts of Human Activities on Freshwater Systems, Agriculture, Production and Distribution of Food, Pests and Pest

Control, Eutrophication, Estuaries, Coastal Wetlands, Mangrove Forests, and Salmon. Water quality problems (nitrate, algae, changed fisheries, taste and odour problems). Hydropower, Population Ecology: Urbanization, Water Health, Toxicology, and Pollution, Sewage Treatment, Land Ecosystems, and Salinization.

The Atmosphere: Climate, Climate Change, and Ozone Depletion, Air Pollution and acid rain, Global Warming, Ecosystems and Restoration.

5.3 Water related management and Culture Knowledge

Water Awareness & Education, Water Worldviews and Ethical Perspective, Water Justice, Water Policy, Law, and Planning, Water Use and Management, Water Economics, Sustainable Clean and Healthy Drinking Water, and Urbanization and Sustainable Cities.

6. WATER SURVEY AND INSTRUMENTS

6.1General Water Related Surveys

Water related analyses (survey, sampling & laboratory analysis), Good Laboratory Practices. Water sampling techniques, Conventional water samplers, automated water sampling, Contaminants, and Microbes. Sampling – collecting samples of **water** (for major ions, nutrients, chlorophyll-a, phytoplankton, total suspended solids, turbidity, color, organic carbon, biochemical oxygen demand, Iron and other metals, organic contaminants, bacteria), **sediments** (for bulk properties, nutrients, contaminants (heavy metals, organics), organisms, and paleolimnological studies), and **aquatic organisms** (Phytoplankton, Zooplankton, Aquatic vegetation, and Fish and fish habitat assessment). Field Profiles, physical and chemical parameters, Light profiles, Transparency, Secchi, turbidity, Chlorophyll probes, and Sensors (Temperature, Dissolved oxygen, pH, Specific conductivity). Probe types - calibration, storage, and cleaning.

6.2 Standing Water Surveys

Geographic location of the water body, geographic orientation, Quantification and measurement of Standing Water basin shape, Bathymetric map, Areal characteristics, volumetric characteristics, Hypsographic curve and Hydraulic residence time. *In-situ* instruments (data logger calibration and maintenance), Physical and chemical field profiling, Light (Secchi; radiometers), Temperature, DO, pH, EC (including calibration and maintenance). Manual water sampling, (conventional, contaminants, microbes), and automated water sampling (zooplankton, sediments, aquatic vegetation, and fish habitat assessment). Laboratory Water quality analyses, (Alkalinity, hardness, TDS, salinity, EC, color, TSS, turbidity, Nutrients, Water chemistry kits, Microbiology, Specific ion probes, Ions Chlorophyll-a, and Phytoplankton assessment.

6.3 Running Water Surveys

Water quantity, discharge and quality assessment, Field instrumentation (WQ meters, flow metering, and data loggers), and Water sampling, Organism collection, Biotic parameters, physical, chemical, and biotic characteristics, Fish and fish habitat assessment.

7. WATER SCHEMES MANAGEMENT AND RESTORATION

7.1 Water Schemes Management

Water resources use planning, Organizational resources, Involving stakeholders, coastal zone, watershed management, and Shoreland development, Water extraction/quantity, Water diversion, Water reuse, Wetland draining, Water laws, Drinking Water law, Regulating point and nonpoint sources, Hazardous and solid Waste law, Toxic Substances Control, Resource Conservation law, Insecticide, Fungicide, and Rodenticide law. Community education and involvement, Presenting technical information to non-technical audience, Working with the media, Media and educational resources. Risk management, Health-based risks, and Ecological risks, Risk assessment process.

7.2 Water Schemes Restoration

Water Schemes restoration techniques, land use planning, Physical and chemical methods (e.g., nutrient inactivation, dredging, aeration/circulation, channelization, gradient, flow, dam removal), Biological methods (e.g., riparian management, biomanipulation). Educating Decision-Makers (factors that influence behavior positions of decision makers, Risk communication, Effective presentation skills, Oral and poster techniques).

7.3 Non-Conventional Water Resources Technology

Freshwater Enhancing Technologies, Cloud Seeding, Fog harvesting, Artificial recharge of aquifers, Rainwater harvesting in situ, Flow diversion structures, Rainwater harvesting from rooftop, Runoff collection using structures, Water conveyance by water tankers, and Runoff collection from roads.

Water Quality Improvement Technologies, Desalination, Clarification using plants, Filtration systems, and Disinfection by boiling and chlorination.

Wastewater treatment technologies, Mechanical treatment systems, Aquatic Systems "wetlands", Global Systems "infiltration", Drainage water reuse, and Wastewater reuse.

Water Conservation, Evaporation Reduction Methods, Tank irrigation systems, Small-scale clay pot, Automatic surge flow, and Dual water distribution.

8. WATER STATISTICS, MODELING AND INFORMATION TECHNOLOGY

8.1 Experimental Design and Water Scheme Modeling

Principles of experimental designs, survey instruments and design, Water Problem and Objective Formulation, Establishing goals. Precision and accuracy (e.g., variance, spikes, data tracking and control charts, calibrations; Best Professional Judgment); Quality Assurance and Quality Control. Data Analysis, Principles of Statistics, Measures of variation, Interpolation, extrapolation, Hypothesis testing, and exploratory data analysis. Applications of Regression to Water Quality Analysis, linear regression, Detecting and analyzing trends, Curve fitting, Assumptions and limitations of regression analysis. Data Visualization, Water Scheme Modeling, assumptions and Limitations of models, Types of models (e.g., conceptual, empirical, mechanistic),

Applications of models, Pollutant loads, Lake water quality, Streams, Stormwater, and urban runoff.

8.2 Water Related Information Technology

Data Types, Sources and Retrieval (Meta data, Structuring spreadsheets and relational databases, Essential information, Spatial versus non-spatial data sets), Spreadsheets and Non-spatial Databases Software, **Geographic Information Systems (GIS) and Remote Sensing**, Maps as data (points, lines, polygons, objects), Data input (GPS, scanning) and data delivery, Polygon versus raster-based, Spatial data sets and analysis functions, Software survey, GIS/Spatial Analysis (Vector analyses, Raster analyses and Patch statistics), **Remote Sensing**, Satellite and aircraft imaging, sensors, automated *in situ* data loggers, samplers and modems, Sonar, hydroacoustics, Radar.

9. WATER ENVIRONMENT ASSESSMENT

9.1 Environmental Impact Assessment Principles and Techniques

EIA Principles, Public Involvement, Environmental Screening and Scoping, Baseline Monitoring, Reporting in the EIA process, Environmental Monitoring, Auditing and Review, EIA Scientific Tools, The role of EIA in decision-making and Case Studies.

9.2 Environmental Impact Assessment Proficiency

Environmental Awareness, Environmental Management Systems, Integrated Resource and Environmental Management, EIA Procedures and Decision Making, EIA Scientific Tools and Techniques, Cumulative Effects Assessment, Strategic Environmental Assessment.

9.3 EIA of Water Resources Projects

Project General information, Hydrology, Surface water, Groundwater, Dams, Reservoirs, Flooding and Wetlands, Water Quality, Air Quality, Organic and Inorganic pollution, Soil Properties, Salinity Effects, Erosion, Sedimentation and siltation. Ecology, Biological and ecological changes, Meteorological data, Irrigation system, Drainage and flood control systems and other works or construction, Cultivation and Crops, Socio–economic impacts, Ecological Imbalances, Human Health, Domestic water supplies and sanitation and Case Studies and Applied Project.

10 SUSTAINABLE DEVELOPMENT OF WATER ENVIRONMENT

10.1 Sustainable Development Principles

Sustainable Development Ideology, Agenda 21, Physical, Demographic, and Ecological Characteristics of a River Basin, Sustainable Development Mechanism, Environmental Economics, Dams and Sustainable Development, Millennium Development Goals, Millennium Ecosystem Assessment and Case Studies.

10.2 Sustainable Development Instruments

Application of Scientific EIA Tools and Techniques, Environmental Effects Monitoring, Ecological Risk Assessment, Applied Environmental Modeling,

Integrated Resource and Environmental Management, Natural Resources in the River Basin, Practical Integrated Resource and Environmental Management IREM Tools and Barriers to IREM, Policy Instruments for Environmental Protection and Case Studies and Applied Project.

10.3 Sustainable Development Management

Environmental Policy, Legal, and Responsibility, Sustainable Development Training, Awareness, Communication, Documentation & Operation Control, Sustainable Development Corrective, Preventive Action, Monitoring, Measurement, Records & Audit, Sustainable Development Management Review, Case Studies and Applied Project.

10.4 Climate Change and Water Environment

Climate change Indicators, Climate Change Hotspots, Hydrological responses, Regional Impacts, International Climate Change Agreements, Cooperative Mechanisms of the Kyoto Protocol, Greenhouse gas (GHG) emissions, sources and trading, Climate Change Impacts and Assessment, Climate Change Transactions, Adaptation, Mitigation Analysis and Scenarios, National Climate Change Action Plans and National Report on Climate Change.

IV. WATER KNOWLEDGE TRAINING PROGRAM ASSESSMENT

The Researcher has developed a program assessment package using micro and macro analysis to assess the Program performance toward the achievement of superiority criteria. The paper demonstrates how to develop and implement micro and macro analysis through pre-and postcourse assessment, to a higher-ranking course. Data collected from the implementation has been analyzed and results indicate that pre- and postcourse assessments provide valuable information about cadet knowledge. Moreover, the results can be used to continue improving effectiveness of training.

Design of Pre- and Postcourse Assessment

When designing the pre- and postcourse assessment for Water Knowledge Training Program, several aspects of assessment were considered including the measurement of adequacy of the basic information covered by the course, the format should be simple so that it would not require great effort from participants, and the results should evaluate the basic knowledge gain of the participants.

Based on these criteria, and because the true-or-false format makes it easy for participants to conduct the assessment, the researcher developed 20 true-or-false questions to evaluate the outcome of the course (Appendix I). The 20 questions cover the major topics of the course. In order to make sure that the assessment measures the basic knowledge gain of the participants, it discourages participants from guessing the answers by introducing the following assessment rules: each correct answer receives +1 point; no answer receives 0 points; and each incorrect answer receives -1 point. The possible score for each participant ranges between (+20 to -20) points.

To implement the pre- and postcourse assessment for the Water Knowledge Training Program, the researcher has investigated what participants are expected to have mastered after taking this course. Program graduates are expected to have mastered the following:

- Discover, learn and apply Water Knowledge concepts through direct, guided experiences.
- Meet the standard criteria of experimental design, data collection, and management, interpretation of results, and reporting results, as a milestone in improving Water Knowledge skills.
- Modeling the practices of water professional through building a framework of scientific thinking and involving more problem-solving

Implementation and Data Analysis

The pre- and postcourse assessment was implemented in the Water Knowledge Training Program during the Spring 2007. Ten participants took the precourse assessment at the beginning of the Program. During the Program there was one participant who withdrew from the Program. The remaining 9 participants took the postcourse assessment at the end of the Program. The results of the 9 valid sets of data are presented in Table 1. Data Summary of Pre-course Assessment is shown in Table 1-A, where as Table 1-B is assigned to present Post-course Assessment.

The correct, no attempt and incorrect, rows for pre- and postcourse assessment recorded the numbers of participants who answered the questions right, skipped the questions, or wrong respectively. Knowing that each correct answer received +1 mark, no answer received 0 mark, and each incorrect answer received -1 mark, then the total Program score is equal to the number of correct answers minus the number of incorrect answers.

Table 1. (A) Pre-course Assessment Data Summary

| Itamaa | | Question number | | | | | | | | | | | | | Cyron | | | | | | |
|-------------|---|-----------------|---|---|----|----|---|---|---|----|----|----|----|----|-------|----|----|----|----|----|-----|
| Items | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Sum |
| Correct | 6 | 3 | 4 | 2 | 1 | 0 | 1 | 2 | 3 | 2 | 1 | 0 | 1 | 2 | 1 | 4 | 2 | 4 | 3 | 2 | 44 |
| No attempt | 1 | 5 | 5 | 5 | 6 | 8 | 7 | 6 | 5 | 7 | 6 | 8 | 6 | 7 | 6 | 5 | 7 | 5 | 5 | 6 | 116 |
| Incorrect | 2 | 1 | 0 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 20 |
| Class score | 4 | 2 | 4 | 0 | -1 | -1 | 0 | 1 | 2 | 2 | -1 | -1 | -1 | 2 | -1 | 4 | 2 | 4 | 2 | 1 | 24 |

Table 1. (B) Post-course Assessment Data Summary

| Tuble 1. (b) I obt course rissessment but a summary | | | | | | | | | | | | | | | | | | | | | |
|---|---|-----------------|---|---|---|---|---|---|---|----|----|----|----|----|-------|----|----|----|----|----|-----|
| Itamaa | | Question number | | | | | | | | | | | | | Carre | | | | | | |
| Items | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Sum |
| Correct | 9 | 7 | 8 | 8 | 8 | 9 | 7 | 8 | 6 | 8 | 7 | 9 | 7 | 8 | 8 | 9 | 6 | 8 | 6 | 8 | 154 |
| No attempt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| Incorrect | 0 | 2 | 1 | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 3 | 1 | 2 | 1 | 23 |
| Class score | 9 | 5 | 7 | 7 | 7 | 9 | 5 | 7 | 4 | 7 | 5 | 9 | 5 | 8 | 7 | 9 | 3 | 7 | 4 | 7 | 131 |

Figure 1 (A) and (B) show the pre- and postcourse assessment results, respectively. Percentage of sum of correct increased from 24 to 86% and percentage of sum of incorrect was up from 11 to 13%. Although both the sum of correct and the sum of incorrect were up, the increase in sum of correct was much larger than the increase in sum of incorrect. Percentage of sum of no attempt was down from 65 to 2%.

Figure 2 (A), (B) and (C) present more detail comparison between the results of pre and postcourse assessment. These provide more detailed information regarding participant learning. For example, for questions Number 6, 12 none of the participants knew the correct answer at the beginning of the Program, but at the end of the Program, 9 out of 9 participants gave the correct answer (Figure 2 (A)). Knowing that a pre assessment result is not available to the instructor, this indicates that he taught the subject very well during the Program.

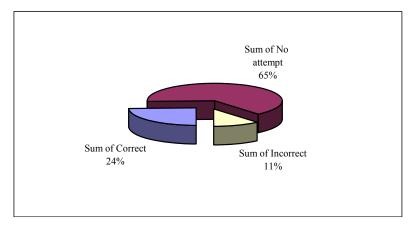


Figure 1. (A) Precourse assessment results (percentage base)

Some participants made no attempt to answer Questions 9, 14, and 19 at the postcourse assessment (Figure 2 (B)). This indicated that some participants did not know the subject covered in these questions and/or might have difficulty learning the material covered in these topics. In the future, the instructor should pay closer attention to these subjects.

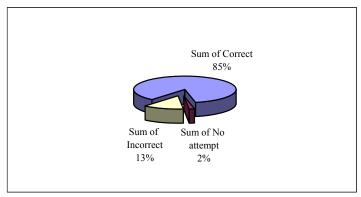


Figure 1. (B) Postcourse assessment results

For some questions, such as Numbers 2, 3, 7,9, 10, 17,18 and 19, the number of incorrect answers increased in postassessment than Preassessment (Figure 2 (C)). This was a warning sign to the instructor that he might not have covered the material very

well during the Program. In the future classes, the instructor should pay closer attention to the latter topics to ensure the participants understand what is being presented. Thus, the comparison results actually provide valuable information to the instructor in terms of where he can improve his teaching in the future.

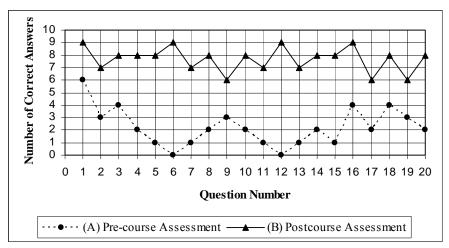


Figure 2 (A) Correct Answers (Preassessment versus postassessment)

Comparing the results of pre- with postcourse assessment (Figure 3) both sum of correct and sum of incorrect were up from 44 to 154 and from 20 to 23, respectively. Sum of no attempt was down from 116 to 3. The sharp decrease of no attempt indicated that participants felt more confident to answer the questions at the end of Program. Most of them answered the questions correctly. Few of them answered the questions incorrectly. As a result, the sum of correct increased almost 250%, while the sum of incorrect increased only about 15%. The class score was 24 for the precourse assessment or 3 out of 20 points on average for each participant. This score improved to 131 at the end of the Program or 15 out of 20 points on average for each participant. The large increase of the sum of correct and class score, and sharp decrease of the sum of no attempt all demonstrate the effectiveness of participant learning and appropriate level of the basic knowledge of participants' disciplines after completing the Program.

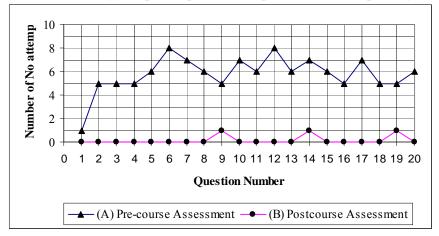


Figure 2 (B) No Attempt (Preassessment versus postassessment)

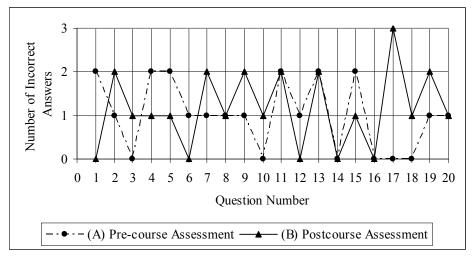


Figure 2 (C) Incorrect Answers (Preassessment versus postassessment)

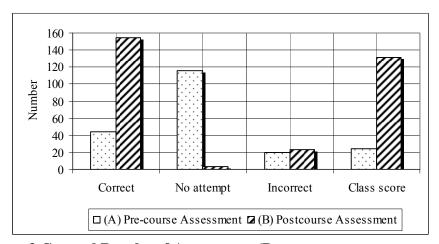


Figure 3 General Results of Assessment (Precourse versus postcourse)

V. CONCLUSIONS

The Outcome of this innovative water knowledge training program for sustainable development is guarantee that the participants have an adequate knowledge about water environment disciplines. The graduates possess professional water knowledge for all water environment disciplines, they will be capable of doing their best in both of Water conservation and Water savings different fields. The Outcome has be assessed using program assessment package with micro and macro analysis, which was developed in hopes of providing acceptable levels of assessment to verify training program performance. The results indicate that pre- and postcourse assessments with micro and macro analysis provide valuable information about cadet knowledge. Moreover, the results can be used to continue improving effectiveness of training. The paper suggested that Professional programs should be fully equal to other degree programs and enabling easy transfer to advanced Professional career and/or research oriented programs. The Water Knowledge Training Program encourages increase in innovation water proficiency level, effectiveness of the higher professional training. and creation of new expert professionalism. The results also validate that the Program has achieved the requirements of standard quality criteria. Furthermore, the results can be used to continue improving, since the results show which topics participants may have complexity learning and where the instructor should pay closer attention in the session. Based on these facts, the resultant conclusion is that the pre- and postcourse assessment is an effective method to assess the Program efficiency and continue improving the instructor's teaching ability.

Appendix I. Pre- and Postcourse Assessment of Water Knowledge Training Program

Instructions for completing this assessment

• Write your name, date and participant ID in the spaces provided below.

| Name | | Doto | Participant ID |
|------|-------|------|-----------------|
| Last | First | Date | Farticipalit ID |
| | | | |

- Answer as many questions as you can in the time allowed.
- Guessing on individual questions can negatively impact the assessment of participant learning. Each correct answer received +1 point, no answer received 0 point, and each incorrect answer received -1 point.

| | 0 point, and each incorrect answer received –1 point. | | |
|----|---|---|---|
| | Questions | T | F |
| 1 | Water, sand and mud reduce the frictional forces that hold a car in place | | |
| 2 | Water clarity and lighting conditions conceal the condition of the roadway beneath you | | |
| 3 | The pressure exerted by moving water increases with the square of its velocity | | |
| 4 | The higher the temperature within an organism the more energy-releasing chemical processes (metabolism) happen. | | |
| 5 | Dissolved Oxygen DO is dependent on a number of factors including salinity, temperature, photosynthesis rates atmospheric pressure, and the amount of wind & wave turbulence. | | |
| 6 | Water is the universal solvent due to the fact that it is a polar substance. | | |
| 7 | Higher turbidity increases water temperatures because the particles absorb more heat reducing the amount of DO. | | |
| 8 | Warm water holds less DO than cold. | | |
| 9 | Higher turbidity reduces the amount of light penetrating the water, and reduces photosynthesis. | | |
| 10 | Environmental neurotoxin affects growth, reproductive success, and development in plants and animals | | |
| 11 | "Good" water quality criteria differ from species to species | | |
| 12 | Differences in conductivity are usually due to the concentration of charged ions in solution (and ionic composition, temp.) | | |
| 13 | Turbidity measures the cloudiness of the water | | |
| 14 | Groundwater has higher alkalinity than surface water | | |
| 15 | Hardness and alkalinity are related | | |
| 16 | drinking soft water over long periods can increase chance of heart attack | | |
| | Questions | T | F |
| 17 | Water's physical properties not only affect life processes of marine organisms, but of human beings in the water. | | |
| 18 | Water's heat capacity affects the world's climate and weather. | | |
| 19 | Sound travels through warm water faster than coolbut it travels faster in deep water due to pressure | | |
| 20 | Hydrostatic pressure doesn't affect marine organisms because it is the same inside the organism as outside. | | |

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