Connect2U Approach to Teaching Introduction to Water Resources Management as a General Education Course

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The purpose of undergraduate general education courses (GeDC) is to develop a wide range of skills in a student beyond the student's chosen field. However, a GeDC class generally comprises students with different levels of interest, preparation, prior knowledge, work style and ethics. Hence, teaching a GeDC urges a different pedagogy from what is required in teaching a course in a student's major discipline. This paper presents an approach, "Connect to you" (*Connect2U*) to teach a GeDC for the natural science requirement based on a twelve semester period of teaching experience with the course, *Introduction to Water Resources Management.*

Introduction to Water Resources Management has been taught for fifteen years as a GeDC in the traditional textbook based teaching and evaluation. The fundamentals of hydrology were taught with an introductory level book. The students were evaluated with the textbook assignments, three closed book examinations and class participation. In this approach, six drawbacks were identified: 1. Although students learned the concepts of hydrology, they lacked the stimulating learning of their practical applications; 2. They did not get enough information about the emerging water issues pertinent to them; 3. Students had limited opportunities to learn about the social, economic, administrative and legal issues related to water resources management (WRM); 4. Many students were inclined to think of the course as an imposed GeDC rather than taking the opportunity to connect it to their major field of study for creating unique expertise; 5. They lacked simple laboratory experiences to visualize the concepts and field trips to provide knowledge about how water works and how related careers develop; and, 6. The assessment methods did not facilitate the students to develop enough inquiry, research and communication skills.

Connect2U was developed on a collaborative instructing-learning concept to minimize these drawbacks and implemented in gradual steps for six years. The success of the approach was assessed based on student performance indicators.

In *Connect2U*, topics on water resources applications, and the social, economic, administrative and legal issues related to WRM were included within the curriculum. Since no single appropriate textbook was found, additional teaching materials were developed by the instructor and his colleagues. Simple laboratory demonstrations and field trips were added. Current water issues and emerging water problems were learned in the class 'icebreaker minutes' and through documentary review assignments. Important assignments and teaching materials were posted on Blackboard. Students were guided to research and gather water related information relevant to their neighborhoods. They were encouraged to work on a term paper topic that could either connect water resources to their majors or be based on a water issue.

Student enrollment in the course increased after the implementation of the Connect2U approach. The grading system and the data gathering assignments made the students work more than their predecessors for achieving the passing grade, while making them understand the water related issues pertaining to them. The students found that the term papers can be connected to their own field of study or to a contemporary issue so that they could be actively engaged. However, given the low number of students in the WRM department, the instructor was unable to make a

comparison between the Non-WRM majors and WRM Majors. In a nutshell, it was evident from the evaluation that the *Connect2U* approach stimulated student interest and raised awareness concerning water resources.

Introduction

The purpose of undergraduate general education courses (GeDC) is to develop a wide range of social, communication and intellectual skills in a student beyond the student's chosen field that will be helpful in the student's lifelong journey. Each institution, guided by the requirements of its respective state's education regulatory board, has accommodated its own set of GeDCs distributed in various disciplines so that the students can choose [1]. Hence, a GeDC class generally comprises students with different levels of interest, preparation, prior knowledge, work style and ethics. This urges a different teaching pedagogy for a GeDC from that which is required for teaching a course in a student's major discipline [2].

Course: Introduction to Water Resources Management

Introduction to Water Resources Management, a three credit hour course, has been taught to fulfill the general education-natural science requirement for non-Water Resources Management (Non-WRM) majors and the core course requirement for freshmen Water Resources Management Department (WRM) majors. Three major programs, Water Resources Management, Geology and Geography require WRM 2200 as a core course. Each semester, this course is taught in three sessions with twenty students per session by two or three instructors. The university catalog description of the course is given as follows [3]:

WRM 2200. Introduction to Water Resources Management (I, II, III; 3) — Introductory course in water resources management designed to give students an interdisciplinary view of the nature of water as a resource. Topics include: Hydrologic Cycle, soil ecology, hydrogeology, irrigation and crop water requirements, water pollution and economics of water policy.

In this course, until Spring 2009 semester, the fundamentals of hydrology were taught with an introductory level book and the instructor's supplementary notes. The students were evaluated based on textbook assignments, three closed book examinations and class participation. Each examination comprised a section of multiple choice questions and a section of essay questions. And, in few sessions, term papers on water resources related topics were also used in the evaluation. These topics were assigned by the instructor.

However, assessing the existed course contents for the applicability, the assessment methods and the grading scheme, and the results of the mid term student survey, six drawbacks were identified in the Fall 2008:

1. Although students learned the concepts of hydrology, they lacked the stimulating learning of their practical applications;

2. They did not get enough information about the emerging water issues pertinent to them;

3. Students had limited opportunities to learn about the social, economic, administrative and legal issues related to water resources management;

4. Many non-WRM majors were inclined to think of the course as an imposed GeDC rather than to take the opportunity to connect the subject to their major field of study for creating unique expertise;

5. They lacked simple laboratory experiences to visualize the concepts and field trips to provide knowledge about how water works and how related careers develop; and,

6. The assessment methods did not facilitate the students to develop enough inquiry, research and communication skills.

Few previous studies have explored the issues in teaching courses such as GeDCs, and in methodologies and assessments to improve the success rate of learning. Ali and Smith analyzed the pros and cons of teaching an introductory programming language in a GeDC [4]. Wilck, *et al.* presented a case for Engineering Economics to be taught as a GeDC to expand quantitative and financial literacy [5]. Bechtel, *et al.* described a strategy to assess the success of GeDCs from the disciplines of humanities, and social and behavioral sciences[6]. While these studies have their own merits relevant to the central issues they address, they are not directly applicable in teaching *Introduction to Water Resources Management*. This paper presents a novel approach, "Connect to you" (*Connect2U*) to overcome or minimize these drawbacks in teaching the course, *Introduction to Water Resources Management*.

Teaching Methodology

Connect2U was developed on the collaborative instructor teaching-student learning concept instead of the instructor teaching -to- student learning concept to minimize these drawbacks. The "instructor teaching-to-student learning" approach is vertical, where an instructor provides the information, and guides the students in every aspect of the course. The instructor suggests the term paper topics and the homework and exam questions are restricted to the textbook. However, in the "collaborative instructor teaching-student learning" pedagogical approach, students are expected to connect the subject (water resources and relevant topics) with their surroundings, neighborhood and majoring disciplines. While the textbook is still used as the foundation for the course, practical uses and applications of water resources and their legal, economical and social issues are added to the course materials. Homework assignments from the textbook are reduced to accommodate the assignments that are required for the students to explore their local water resources, uses and their impacts. A term paper is introduced in a way that will help an individual student to find a water resource related topic that can be connected to the student's major field or to the student's daily life. These term paper guidelines are provided to the students in the beginning of the course. The term paper assignment includes a written report and a classroom presentation to fulfill the GeDC objective of developing communication skills. In the *Connect2U* approach, an instructor acts as a guide to the course and the students can contribute significant portion of the course fitting for the student's interests and major field of study. Figure 1 shows the schematic of *Connect2U*.

Implementation

Connect2U was introduced to a WRM 2200 session in Spring 2009, and the gradual changes have been made since then until Spring 2014. Although WRM 2200 has been taught in three or four sessions per semester by different instructors, *Connect2U* was implemented only by this author in his sessions. Hence, the study is based on these sessions. The learning outcomes and the assessment instruments of WRM 2200 are provided in Table 1.
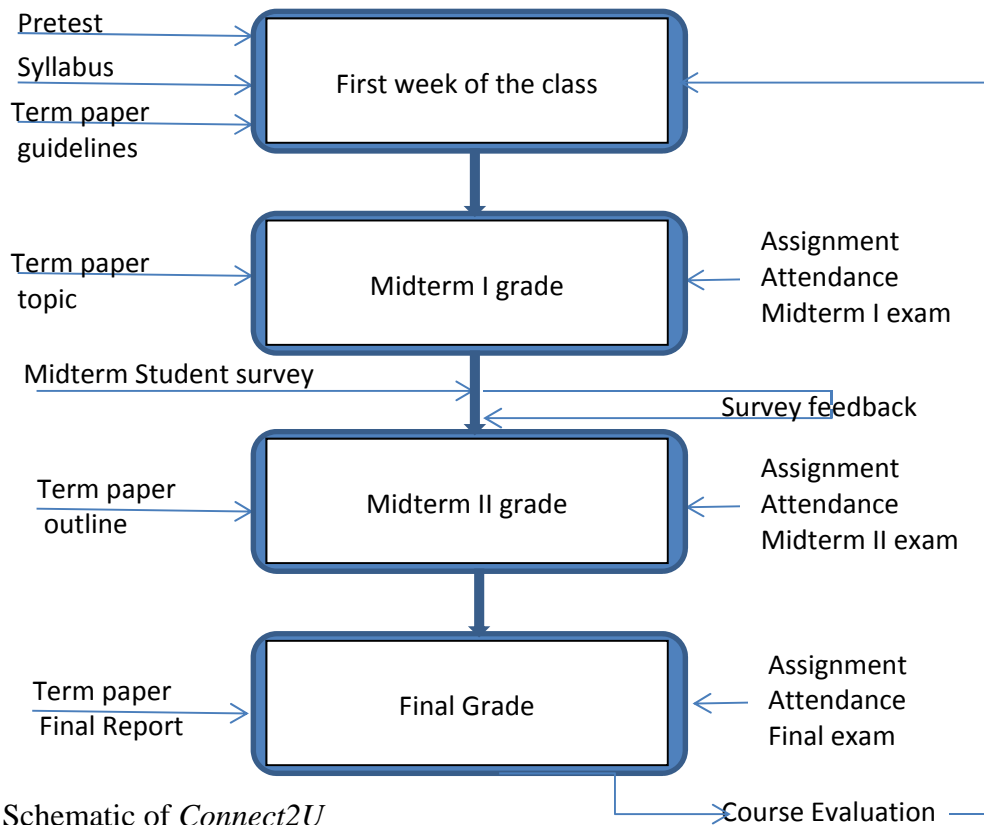

Figure 1: Schematic of *Connect2U*

Table 1: Learning outcomes and assessment instruments for *Introduction to water resources management*

Learning Outcomes	*Assessment Instrument*
Understand the basic processes of the hydrological cycle and how they are correlated	Pre/Post tests, Exams, Homework, Assignments
Understand the hydrological measurements and their estimations	Exams, Assignments
Do quantitative & qualitative analyses in Water Resources Management	Homework, Term paper
Increase abilities to understand the emerging water issues	Assignments, Homework, Term paper
Increase skills for gathering scientific data & report writing	Assignments, Term paper

In *Connect2U*, topics on water resources applications, and the social, economic, administrative and legal issues related to WRM were included into the curriculum. The new topics included multiple uses of water resources, water supply, wastewater treatment, water law, water regulation, water conflicts and economics of water resources. These topics were taught at the introductory level with the support of field trips and case studies. Given the time allocated to these new topics, few class hours on upper level theoretical components were omitted. As an example, the exercise of constructing Thiessen polygons for estimating areal precipitation from point precipitation measurements usually takes four to five classes. This exercise was reduced to the estimation only so that the hours could be used for the new topics.

Simple laboratory demonstrations and field trips were added to the course to expand the knowledge and the experiences of the students. The laboratory demonstrations included the basic hydrologic system, sieve analysis and moisture content measurements. A field trip to the water treatment facility was added as a class activity. Current water issues and emerging water documentary review assignments were also included. These 'icebreaker' topics were mostly brought up by the instructor in the class. They were helpful for the students to connect the course to the real issues, to understand them and to choose their term paper topics. Table 2 provides some of those issues that were discussed during the icebreaker minutes and chosen by a student as the student's term paper topic.

Table 2: Issues that were discussed in the "Icebreaker minutes"

Issue	*Semester used as a paper topic*
Hurricanes	Fall 2010
Bottled water Vs. Tap Water	Spring 2011
Global Warming and Hydrology	Spring 2011
Droughts	Fall 2011
Drinking Water Contaminants	Spring 2012
Polar Ice Caps	Fall 2012
Africa's Water Crisis	Fall 2012
Pharmaceutical wastes in waterbodies	Spring 2013
Detroit's Water issues	Fall 2013
Hypoxia in United States	Spring 2014

Text book based short-answer homework, and research and review based assignments were used for the weekly or the biweekly assessment. Text based questions were used to assess knowledge in the fundamentals of hydrology. Students learned to gather water resources-related information through the research based assignments. Table 3 lists a few water resources data pertaining to every student's residential area that the student gathered for the assignments. Every semester, students were assigned to review two to three video documentaries and articles on emerging water issues in three hundred words. In addition, 300-word technical reviews were expected from the students for the field trip and the laboratory demonstrations.

The students were encouraged to work on a term paper topic that could either connect water resources to their majors or be on a water issue. Table 4 shows a few topics that the WRM 2200-01 session students researched in Spring 2014. The guidelines for the term paper were given to

the students in the first week of the class with the syllabus. Appendix-A provides a template of the term paper guidelines for WRM 2200. The students were expected to submit the term paper topic before the midterm exam I and the outline of the paper before the midterm exam II.

Table 3: Water resources data gathering assignments

Information	Sources to research
Watershed name and HUC number	EPA website
Drinking water source	Local water supply agency
Daily quantities of water & wastewater treated	Local water treatment & wastewater agencies
Precipitation-Duration-Frequency information	NOAA website
Evaporation data	NOAA website
Stream flow and water quality data	USGS website
Type of soil	NRCS website

Table 4: Term paper research topics of WRM 2200-01 class in Spring 2014

Polar Vortex	Dying starfish in California
Acid rain	Oil leaks in the Gulf of Mexico
Waterborne diseases	Growth hormones & waterbodies
Chemical spill in Elk River, WV	Environmental violations related to water
Drought in US	Hypoxia in US waters
Water pollutant sources	Hurricane in Haiti
Desalination	Lack of communication after Hurricane Katrina
Childhood cancer around Lake Erie	Pricing the water
North Korea: Water issues	Water policies
Urban water pollution	Tsunami

Important assignments and teaching materials were posted on Blackboard. However, it was found in the early semesters that posting the PowerPoint slides ahead of time decreased the attention among the students in the classroom lectures. Hence, a week or two delay was introduced in uploading the lecture notes on Blackboard.

There were three tests: two mid term tests and a comprehensive final examination. One of the midterm exams was given as an open book examination. Each exam had two sections: the multiple choice had fifteen questions and the essay had five to seven questions depending on the difficulty of the questions. In the early semesters, multiple choice questions were given 60 out of 100 points. After a few semesters of teaching, 45 points were allocated to them. This helped to provide points for the questions related to assignments and points for the open-ended questions that were added into the essay question section.

The grading schemes used in two semesters, one in the early part and the other in the latter part of implementing *Connect2U*, are shown in Table 5. When class attendance was correlated to the course passing rate, the instructor decided to allocate the points relevant to class participation through the information gathering assignment. Hence, the participation and attendance points were reduced from 10 to 5 in the grading scheme. With the instructor's experience in teaching

this class, it was found that increasing points to data collection assignments and comprehensive final exams helped in increasing students' interest in the subject. On the contrary, providing 15 points for the term paper report and five points for the students' presentation were found to be excessive given the size of the report and the presentation length. Hence, the total points for the term paper and its presentation were reduced to 15.

Since no single appropriate textbook was found to cover all the intended topics, supplementary teaching materials were developed by the instructor and colleagues.

Table 5: Grading scheme for *Introduction to the Water Resources Management*

Assessment methods	*Activity type*	*Percentage contribution*	
		(2009 Fall)	*(2014 Spring)*
Assignment, Homework	Individual	20	25
Midterm Exam – I	Individual	15	15
Midterm Exam - II	Individual	15	15
Final Exam	Individual	20	25
Term Paper	Individual	20	15
Participation and Attendance*	Individual	10	5
Total		*100*	*100*

Outcome

Connect2U was implemented in gradual steps for six years since 2009 Spring by the author of this paper. The success of the approach was assessed with the grades, the combined indicator of the student performance indicators, exam performance, term paper and water related information collection. Figure 2 and Figure 3 show student grades for Non-WRM majors and WRM Department majors respectively only for the sessions taught by the author. The data on the sessions taught by the other instructors are not provided here nor taken for the assessment presented in this paper.
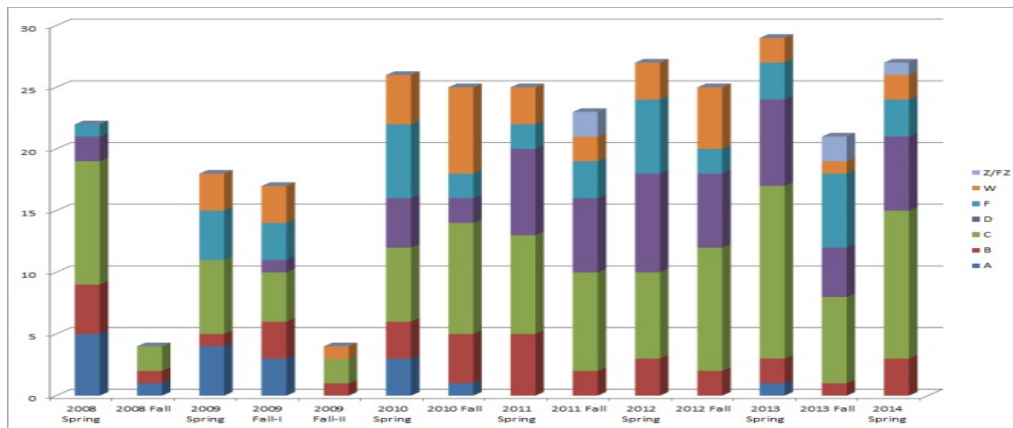

Figure 2: Grade distribution for Non-WRM majors from Spring 2008 to Spring 2014 (where W stands for withdrawal and Z/FZ stand for students who registered but never or only one time attended class)
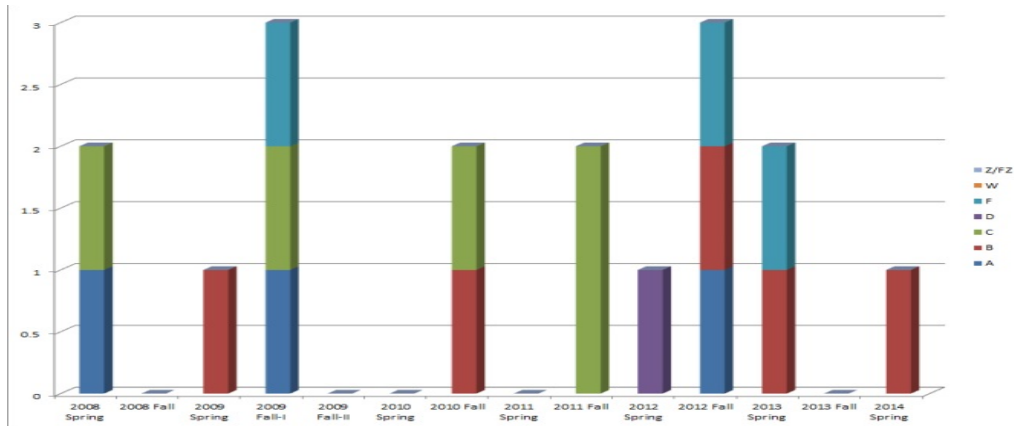
Figure 3: Grade distribution for WRM majors from Spring 2008 to Spring 2014

Findings of this study are summarized below.

a. There was no clear difference in performance between the grades of Non-WRM majors and WRM department majors. However, given that the WRM students enrolled in the class in any semester vary from none to three compared to the high number of Non-WRM majors, it is statistically not viable to come to a definite conclusion about the performance difference between these groups. In the near future, the situation is expected to remain the same as the WRM department is comparatively smaller than other departments.

b. From Figure 2, it can be seen that there was a definite increase in student enrollment in the post Fall 2009, after starting to implement *Connect2U* except for Fall 2013. While the class size was defined as 25, in some semesters, given the needs of the graduating seniors, a few more students were allowed to register. As has been stated earlier, there were usually three sessions of WRM 2200 per semester, each with different instructors. Considering the demand for the class, in Fall 2013, an additional session was added by the WRM department in the beginning the semester that the author volunteered to teach. A time slot that enabled the students who could not register for the other sessions was allocated for the class. Since this fourth session was a late addition to serve the students who wanted to take the course, this fourth session ended with a lower student enrollment of 22 for Fall 2013 than in Spring 2013 or in Spring 2014.

c. While the enrollment for the course had gone up with the introduction of *Connect2U*, it can also be noted that the percentage of Grade A fell and the percentages of withdrawal increased. However, two-thirds of the class got passing grades on average. It should be noted that while a Grade D was considered as a passing grade for a Non-WRM major, it was not accepted as a passing grade for WRM majors. The reason for the fall in As and the increase in withdrawals may be related to the change in the grading policy. The direct contribution in points for the attendance component was reduced, and the difference was directly connected to the data gathering assignments. In addition, in the pre *Connect2U* assessment, the use of textbook-based short answer homework assignments was mostly found as a 'look in the book' exercise that did not elevate the students' interest in the

subject, nor disseminate knowledge to the students beyond giving good scores in the homework assignments. Similarly, as lower percent in the final exams helped the students who were not prepared for the subject pass with their attendance and the homework assignment, it also helped the students get As with little effort. By revising the grading policy with enough data gathering assignments and higher exam share in the *Connect2U* approach, students were expected to work more to achieve a good grade. Those who could not cope with such an environment withdrew from the course.

d. Comparison of the term papers of the pre-*Connect2U* semesters and post-*Connect2U* showed an increase in the diversity of the term paper topics and an improvement in the paper writing. The diversity in the topics was either due to the discussion in the "icebreaker minutes" or due to the students' interest in choosing water topics related to their own disciplines. Table 6 provides a few term topics that the students picked related to their majors in the post-*Connect2U* period . The final classroom presentations by the students to their peers helped the class become informed on a variety of water issues that the instructor could not cover in the regular teaching hours.

Table 6: Student term paper topics relevant to their disciplines

Term paper topic	*Students' discipline*
Water scarcity & conflict in the Middle East	Political Science
Water conservation in the hotel industry	Hospitality Management
Hydraulic engineering	Manufacturing Engineering
Geology and hydrology: A beautiful unity	Geology
Water and recreation management	Recreation
Promoting water conservation among Central State University students	Marketing
Water and social work	Social Work
Droughts in US	Water Resources Management
Edwards Aquifer	Geography

In the pre-*Connect2U* semesters, since the points for the term papers were only assigned in the final grades, the students naturally worked during the last month on the term paper rather than all through the semester. With the introduction of *Connect2U*, the students were expected to get approval for the their topics before the Mid Term Exam I and requested to provide abstracts for term papers before the Mid Term Exam II. In each case, points were given for term paper development in the exam grades. The students were encouraged to submit the draft of the term paper two weeks before the deadline so that the instructor could provide corrections. In addition, they were encouraged to get help from the University College Writing Specialists. This approach helped students improve their technical report writing.

e. Visits to hydrologic, hydraulic, limnology, geology and water chemistry laboratories between the two mid term exams provided students additional knowledge on the measurements of hydraulic properties, and water resources applications. During the lecture hours, the instructor also demonstrated tensiometer, neutron probe, sieve analysis,

hydropower model in a flume and basic hydrologic system model. In addition students were taken for a tour to the university water treatment plant. After the laboratory and water treatment plant visits, student learning was evaluated through their 300-word reports. These reports demonstrated that student understanding of water resources and water careers was improved with these visits.

f. The text book that was used for this course in the early semesters covered only the basic hydrological processes. However, the scope of this course covered topics even beyond the basic hydrologic processes including cost-benefit studies, water supply, wastewater treatment, water policy and water regulations. Hence, additional supplemental notes were prepared by the instructors. The teaching materials developed for this course by the instructors are currently available as an introductory level textbook (*Introduction to Water Resources*) so that this course can be adopted as a GeDC by any institution[7]. This methodology can easily be used in teaching any GeDC for the natural science requirement.

These outcomes showed that the six drawbacks identified in the pre-*Connect2U* period were reduced with the implementation of the *Connect2U* approach.

Conclusion and Future work

Connect2U approach was used to eliminate or minimize the drawbacks that were found to be learning barriers in the previous pedagogic approach. It was evident from the evaluation that the *Connect2U* approach stimulated students' interest in water resources, raised awareness about water resources, provided basic knowledge and guided how to gather water-related information pertaining to the students' neighborhoods. In this way, *Connect2U* assisted in fulfilling the objective of the course, *Introduction to Water Resources Management*, as a general education-natural science requirement course. However, this study was based only on the sessions that the author taught. To assess the full impact of *Connect2U*, a collaborative study with the data on the sessions taught by the other faculty should be done.

The instructor is currently working on an online version of this GeDC course that could help distance learning students. This course is expected for Summer 2015.

Acknowledgements

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Appendix-A

WRM 2200-<*Session*> <*Semester*>
Introduction to Water Resources Management
Term Paper Sample Topics & Contents (15 % of the final Grade)

Topics (Examples):

1. Water Policy and Economic Impact due to Water Issues
2. Chemical Quality of Natural Water and Its Impairment
3. Drinking Water Management in a Chosen Water District
4. Any topic that is relevant to WRM emerging issues or to the student's major discipline:
Student is encouraged to propose, but MUST GET permission from the instructor before
embarking on it.

Timeline

1. Choose one topic and notify the instructor before the first mid term examination
2. Second Mid term grade includes points for a 300 word outline of the paper
3. LAST DATE for the Report Submission: *<report submission date>*

(No late submission; any report that will be provided after *<submission date>* class will get no points UNLESS there is a valid reason with a document that supports it)
4. Plagiarism will not be tolerated, (see the academic dishonesty policy for the consequences)
5. Contact the instructor during office hours for any help s/he can provide

REPORT WRITING (12 Points)

1. Around 3000 words (This count does not include references, Figures and Tables)
2. All texts, except for the Abstract in Single Spacing Times Roman-12 Fonts with a page margin 1" X 1"
3. A cover page with
   a. the title of the paper,
   b. student's name,
   c. Course name, Course number and Course session, Semester
4. Tentative contents and the structure of the report
   a. One paragraph Abstract (maximum 100 words in Single Spacing Times Roman-10 fonts)
   b. Introduction
   c. Issues
   d. Data
   e. Analysis
   f. Discussion
   g. Conclusion
   h. Reference
5. All data given should be referenced in a standard style
   For standard reference styles, see
   http://subjectguides.library.american.edu/citation
6. References should be linked by numbers or name(s) of the authors in the text

PRESENTAION (3 Points)

1. Presentation is on *<presentation date>*, but submit the electronic copy on or before *<presentation submission date>*.
2. 3-min Power Point Presentation on your project (3 Points)
   Five-Six slides including title slide
   Tentative contents and the structure of the report
   a. Title
   b. Issue
   c. Introduction
   d. Data
   e. Analysis
   f. Conclusion
   g. References