

Introduction an innovative method to enhance a senior level course in water sustainability

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Abstract

An innovative project of water sustainability related was assigned to the senior students of State College of the Sate University of New York. The assignment was related to the present concern of water sustainability. According to a recent review by International Circle of Blue, GlobeScan surveys, fresh water sustainability, management and conservation is the world's top environmental problem greater than air pollution and even climate change. Along with United States General Accounting Office (GPA) states 36 states in US will face the water shortage under normal conditions by 2013. In proportion to this fact that water is a limited source and it is essential to all human life, students were asked to choose a topic associated to water sustainability. Total numbers of 26 students were divided to five groups. Progress report from each group was due in two weeks followed by the completion of report and presentation within a month. Selected titles by students and accepted by faculty were as follows: Toilet Water Efficiency, Water Efficient Household Fixtures, Water Efficiency Irrigation, Waste Water Treatment from Beginning to Environmentally Friendly and Grey Water Systems. A peer review evaluation score sheet was distributed among students. Students were asked to rank each group from outstanding through inadequate. Each student was requested to evaluate all groups beside their own group. The categories used in evaluation were: Specification and Sustainability , Concept and Selected Details, Design process and Good Dynamics, Organization and Clarity of Presentation, Participation within the Group, Evaluation and Suggestion for Future Improvements and Overall rate of project. Both students and faculty agreed on choosing the most successful group and the top category among the groups. This concludes that based on students and faculty evaluation this project could advance the course and improve the student's knowledge toward the effect of water sustainability.

Introduction:

The word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). Dictionaries present more than ten meanings for *sustain*, the primary ones being to "maintain", "support", or "endure".^{2,7} However, since the 1980s the most worldwide accepted definition of *sustainability* is "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability and sustainable development.^{9,11}

At the 2005 World Summit it was illustrious that this requires the bringing together of environmental, social and economic demands. The "three pillars" of sustainability,¹⁰ this view has been expressed as an illustration (figure 1) using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive and can be mutually supporting.⁴

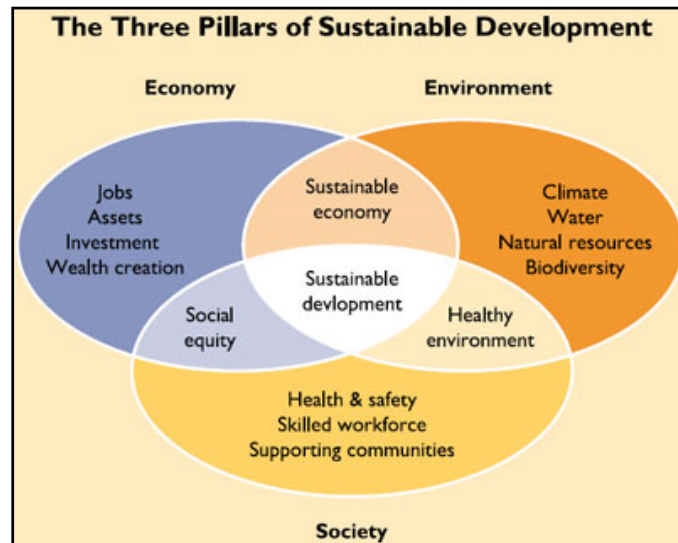


Figure 1 : The Three Pillars of Sustainable Development⁵

As it appears in the figure 1 one of the columns is environment. Water resources belong to this category. Water resources are the source of water that is available to human. Water is a limited source that is essential for all human life and ecology. Water is been used in agricultural, residential, industrial, recreational and environmental activities.

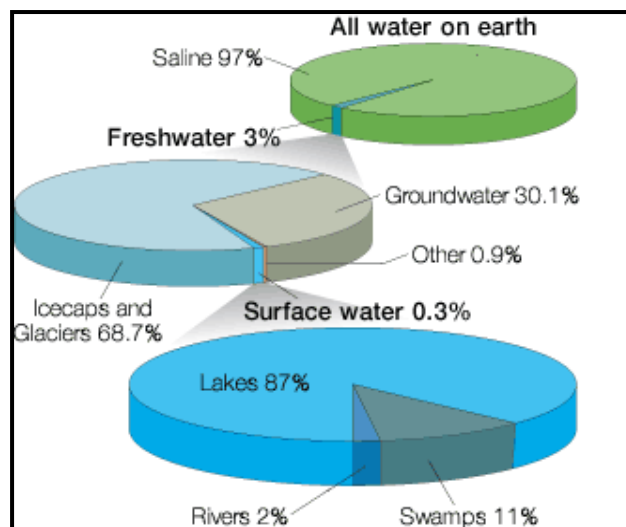


Figure 2: Water Distribution on Earth⁶

Water covers 70.9% of the Earth's surface¹. 97% of water on the Earth is salt water, and only 3% as fresh water (figure 2) of which slightly over two thirds is frozen in glaciers and polar ice caps⁸. Figure 3 shows how much of water's earth is available for human use. Fresh water is a renewable resource, yet the world's supply of clean, fresh water is gradually decreasing.

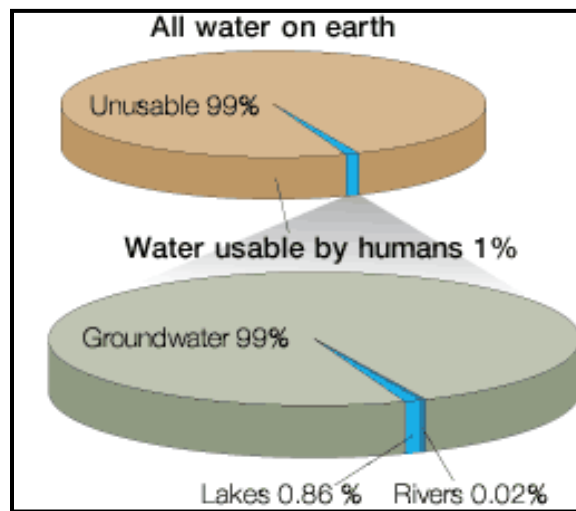


Figure 3: All Water on Earth⁶

Water demand goes above supply in many parts of the world and as the world population continues to increase, so too does the water demand. Over one billion people don't have access to clean drinking water. Water resources around the world are threatened by climate change, waste and pollution. There are about five million people mainly children everyday die from avoidable water related diseases. Unfortunately, despite a growing recognition that more must be done to help those without clean water or adequate sanitation, it has been estimated that over 34 million people might perish in the next 20 years from water-related disease, even if the United Nations "Millennium Development Goals (MDGs)," which aim to cut the proportion of those without safe access by half, are met⁸. MDGs are eight international development goals that all 192 United Nations member states and at least 23 international organizations have agreed to achieve by the year 2015. One of these goals contains ensuring environmental sustainability. Water sustainability is in that category which stated by 2010 a significant reduction in the rate of loss of total water resources used. In addition it states that the proportion of people without sustainable access to safe drinking water and basic sanitation must be half by 2015. Awareness of the global importance of preserving water for ecosystem services is number one world environmental problem. The goal of his paper is to illustrate an innovative method to improve a senior water related course in water sustainability.

Method:

Outline and procedure:

This study was conducted to the senior construction management technology students at spring semester 2010. The students were senior with a total number of 26. They were divided into five groups. Each group has to select a topic related to water sustainability. The project outline description is in appendix A1. The topics were discussed with the faculty for approval. Here are the topics that were chosen; group 1: Toilet Water Efficiency; group 2: Water Efficient Household Fixtures; group 3: Water Efficiency Irrigation; group 4: Waste Water Treatment from Beginning to Environmentally Friendly and group 5: Grey Water Systems.

Innovative process:

Group's progress report was expected two weeks after the acceptance of the topic. The final project was due two weeks followed by presentation after a week. Students suppose to show the percentage and detail the labor division of their work. the reason for this was to make all members of a group work together. A creative peer review method was used to assess each group. All students were evaluating each group beside their own group. Instructor has used the same evaluation sheet as the students. The review sheet had certain criteria. It was divided to 4 ranking, 1 stands for outstanding, 2: good, 3: barely adequate and 4: missing or inadequate. The listed categories in the evaluation sheet were targeting all aspect of the project. It is been divided to six individual set and one overall rate of the project. Specification plus sustainability, concept with selected details and design process along with good dynamics were associated by design section. On the subject of the presentation ranking the organization and clarity of presentation, participation within the group were targeted. One of the categories was allied to evaluation and suggestion for future improvement which is vital subject with the purpose of force students to think outside the box. The last rank was the overall ranking of assignment. Instructor asked students to record their names on the evaluation sheet that they will fill out the forms with more responsibility. A copy of assessment score sheet is available in appendix A2.

Groups subjects:

Each group chose a different topic that was related to water sustainability. The first group topic was Guide to Toilet Water Efficiency, they have discussed about the science behind how the toilet functions as well as information on how future units may function. In addition it shows how the toilets industry developed toward water efficiency. Toilets built before 1980 may used anywhere between 5.5 to 12 gallons per flush (gpf). In the late 1980 and early 90's the toilets with 3.5 gpf become standard. In 1992 Environmental Protection Agency (EPA) set a new standard stating that no toilets can use more than 1.6 gpf. This new standard can save the average American household 9740 to 17300 gallons of water per year. The second group subject was Water Efficient Household Fixtures. This group report was focused on household appliances such as: washing machine, dishwasher, toilets and showerheads. "The year is 2010 and "go green" is the new phrase in our commitment to save the planet from human's negative impacts.

Water efficiency in the home environment is very important". They have discussed about energy star dishwasher that are using less water than a standard one, using a dual flush toilet can reduce the consumption of water by 30% and a low flush flow showerhead reduces the amount of water used during a shower which therefore reduces the amount of energy used to heat the water. Water Efficiency was the subject of the third group. Water efficient landscaping, innovative wastewater technologies, water use reduction and process water use reduction were the topics that were covered including their benefits and implementation. Group 4 theme was about Waste Water Treatment from Beginning to Environmentally Friendly, which starts at waste water history from 500 CE to 1500 CE, continued by fall of the Roman Empire in the western world began to turn urban into rural society which refers to as the "Sanitation Dark Ages." When Middle Ages came to end a new time period came along. This time period was referred to as the Renaissance which more concern was given to health, water issues and sewage treatment. The cesspool was one major development at that time. The innovation wastewater technologies continued in current era. The last of the paper was related to Department Environmental Protection Wastewater Pollution Control Plant. It was broken to five parts: flow from wet wells to the primary settling tanks (PST's), from the PST's to the Aeration Tanks (AT's), from the AT's to the final settling tanks (FST's), from the FST's to the Chlorine Contact Tanks (CCT's) and the last process is from the CCT's to Hendrix Creek and go right into Jamaica Bay. The last group paper was about Grey Water System. Grey water refers to any wastewater generated including wash water from sinks, showers and washing machines. Grey water system are designed to capture, treat and reuse this water for other purposes usually irrigation.

Statistical Method:

The t-test was done between two independent populations that have different mean value. The first population was the students evaluation mean of each group. The second population was the instructor. The research hypothesis was that the instructor might have different assessment over the groups based on her experience compare to students. The statistical t-test allows us to determine a p-value that indicates how likely we could have gotten our results by chance. By convention, if there is a less than 5% chance of getting the observed differences by chance, we reject the null hypothesis and say we found a statistically significant difference between the two groups. For a paired t-test on data sets $\{x_1, x_2, x_n\}$ and $\{y_1, y_2, y_n\}$:

$$t = \frac{\bar{D}}{S_{\bar{D}}}$$

Where $\bar{D} = \bar{X} - \bar{Y}$

and

$$S_{\bar{D}} = \sqrt{\frac{\sum D_i^2 - \frac{(\sum D_i)^2}{n}}{n(n-1)}}$$

Where

$$D_i = x_i - y_i$$

Results:

As we mentioned in the methodology the study of each group was done separately. The first group was the mean of all of the students evaluation rating opposed to the evaluation rating from the instructor. Figure 4 shows the results for group 1. As it shows in the graph the solid line is the mean of students evaluation and the dotted line belong to the instructor evaluation.

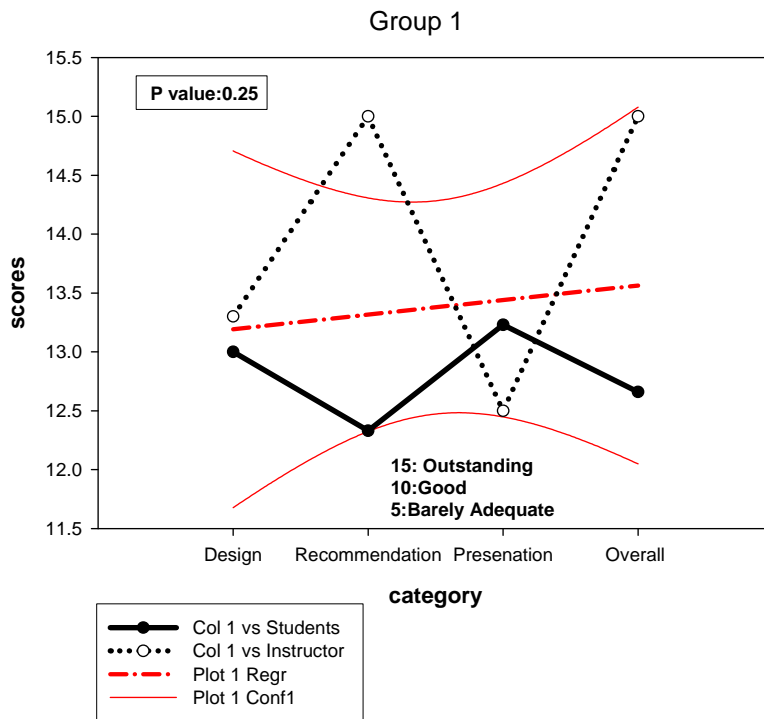


Figure 4: Group-1 Assessment

P-value is the probability that you incorrect in studying that two means are different. The choice of significance level set at 5%. The two samples are not significantly different when $P \geq 0.05$ for t-test. The p value for the first group is 0.25 which is greater than 0.05 that shows obviously there is no difference between the instructor and students evaluation. As is shows in figure 5 that belongs to group 2, the p-value is 0.2, which is greater than 0.05 therefore there is no difference between the instructor and students assessment in group 2 as well.

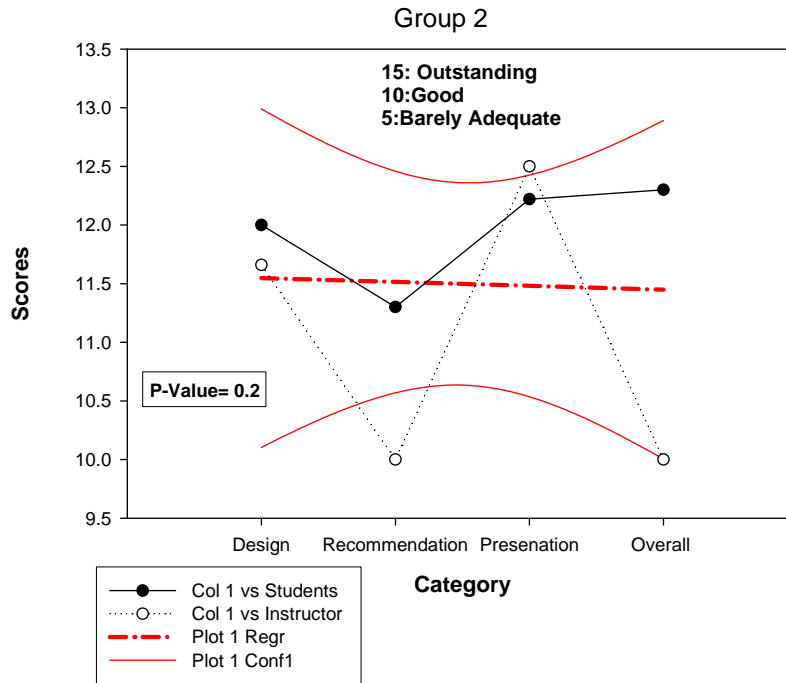


Figure 5: Group- 2 Assessment

Figures 6 shows the results for group 3 .The P value of 0.15 still is greater than 0.05 and like other two groups there is no difference between the evaluation of the instructor and students.

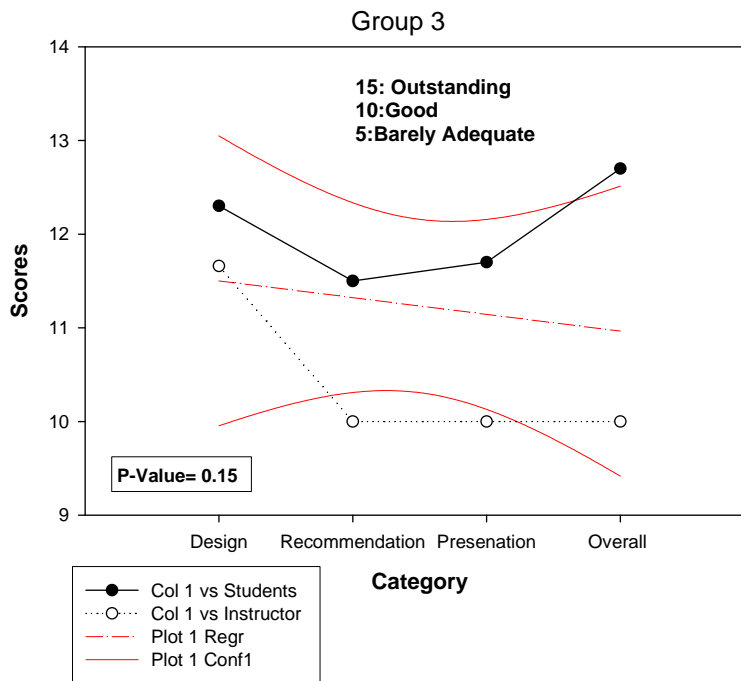


Figure 6: Group- 3 Assessment

Figure 7 and 8 show the results of group 4 and 5, the p-values are 0.08 and 0.26 respectively. Both are greater than 0.05 so there is no difference between the evaluation of students and instructor.

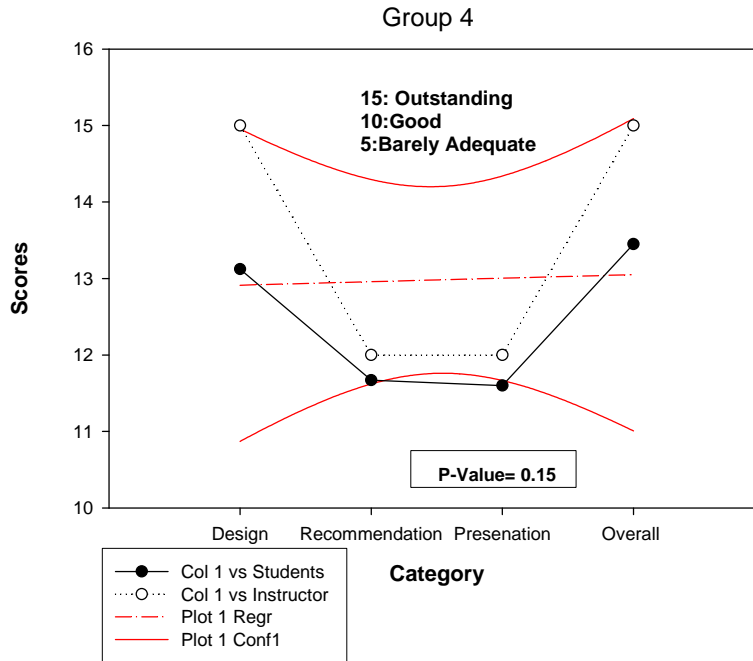


Figure 7: Group- 4 Assessment

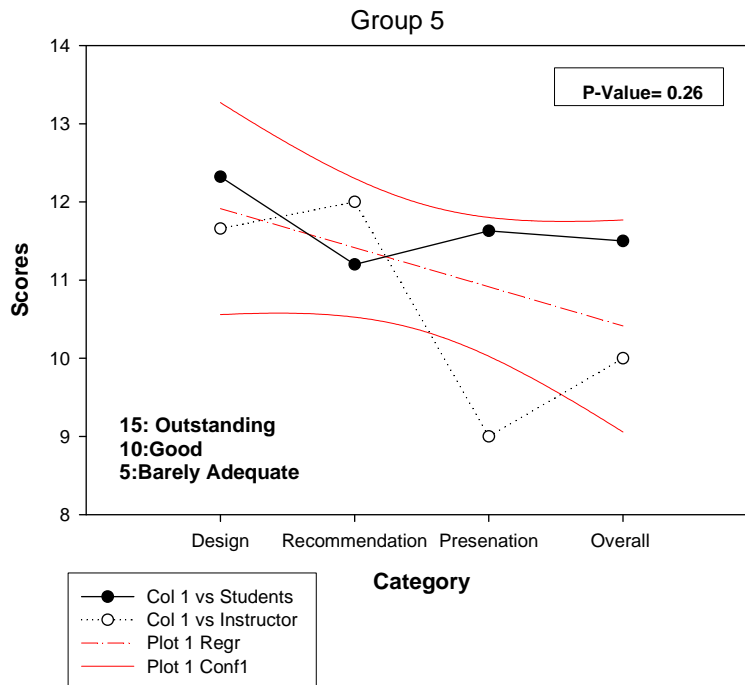


Figure 8: Group- 5 Assessment

Conclusion:

As it shows in result section the faculty and students reach to the same results when it comes to evaluation of each group. It means that students will think the same way if the opportunity is given to them. On the other hand the idea of having different topics for each group and asking students to evaluate each other work, led them to listen and judge about each other work. It gave them the prospect to absorb more information and enhance their knowledge related to water sustainability subject in the extensive approach. It moreover helped the instructor to improve the water related course.

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Appendix A-1

CON 303/Hydraulic Project

You have the choice of an open topic related to Water Resources Sustainability and Water Efficiency in Long Island (priority).

Report Format

The report (hardcopy) must contain the followings:

- 1- Cover page, including project title, group name, group member, course information, instructor's name and date
- 2- The pages must be single-sided with 1.5 spacing
- 3- All pages excluding the cover page should be numbered
- 4- The topics should be the followings (not limited)
 - a. Introduction
 - b. Literature review and background
 - c. Material and methods
 - d. Discussion
 - e. Suggestions
 - f. Division of labor
 - g. References

Due Date:

The progress report including the topic is due in two weeks on Wednesday March 24, 2010. The report and presentation is due Wednesday 4/28/2010. The presenting order will be posted prior to the due date.

Appendix A-2

Presentation Evaluation Score Sheet

Evaluator: _____

Date: _____

Please use a 1, 2, 3, or 4 indicate whether and how well each of the following issues was addressed in each presentation.

1= outstanding 2=Good 3= Barely adequate 4= Missing or Inadequate

Category	Group 1	Group 2	Group 3	Group 4	Group 5
Specification and Sustainability					
Concept and Selected Details					
Design process and Good Dynamics					
Organization and Clarity of Presentation					
Participation within the Group					
Evaluation and Suggestion for Future Improvements					
Overall rate of project					

Please comment briefly about each group presentation:

Group 1	
Group 2	
Group 3	
Group 4	
Group 5	

Thank you for agreeing to evaluate student's presentation. Your rating and comments will both contribute towards the assessment of students work, and also toward an evaluation of the course.