Role of service learning in water quality studies

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Abstract

Background: Chemistry students often complain that they are unmotivated because they see no applications of chemical principles in "real life." It was thus decided to put into use the knowledge gained during the course on water quality and analysis. Learning the principles of quantitative chemical analysis requires innovative, hands-on laboratory experiences that would challenge students to think independently about a problem.

Aims: The water project selected by the Department of Chemistry was meant to serve two purposes. One of the objectives of the programme is to increase student interest and critical thinking skills while reinforcing the concepts learnt in the classroom. The second objective is to remind the students of the benefits derived from the society. With a view to enrich the moral and civic values inherent in serving others, this project was integrated into community service to form a package called "Service Learning" and this package formed a part of the curriculum.

Sample: A community pond near the College was chosen for its restoration and the local residents were made partners of this project.

Method: The students first interacted with the community and got their views and concurrence regarding the restoration of pond ecosystem. Then the pond water was analysed for the physical and chemical parameters and on the basis of the result, restoration process was carried out. In order to evaluate the effectiveness of the service-learning component, students were surveyed at the end of the semester about their service-learning experiences.

Result: The students with the help of local community and the municipal authorities were able to completely restore the quality of the pond water. The students responded very favorably to the service learning programme involving the water project. The programme, in the opinion of the students was both challenging and time consuming. The service-learning project achieved the educational objectives of requiring the students to think critically and work as a team. Almost all students agreed they had learned more about course concepts as a result of their service-learning experience, and the majority felt their service-learning activity provided a needed service to the community.

Conclusion: It was observed that effectively linking service-learning to course content not only offered students a powerful opportunity to maximize academic learning, but also promoted their personal growth and instilled a commitment to lifelong, civic engagement.

Keywords: Restoration of Pond, Water analysis, Civic responsibility

服務學習在水質研究中的角色

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摘要

*背景：*化學系學生常常抱怨說他們缺乏學習動機，因為他們不知道如何在「現實生活」中應用化學理論。這篇文章就是要運用化學科裡所學到的知識對水質作出研究及分析。學習化學量化分析的原則是需要創意思維和實質的實驗室經驗，而這都是考驗學生獨立思考問題的能力。

*目的：*化學系所挑選的水工程計劃主要有兩個目標。其中一個目標是要提高學生的興趣及批判性思考，同時加強學生在課堂裡所學到的概念。第二個目標是要提醒學生從社會中所得到利益的意識。為了加強從服務別人而固有的道德及公民價值，這計劃揉合了社區服務，形成一套「服務學習」，並成為課程的一部分。

*調查對象：*挑選了一個位於大學附近的社區池塘作復修，當地居民亦成為這計劃的合作伙伴。

*調查方法：*學生首先與社區接觸，得到他們對池塘的生態系統作出復修的同意。然後，對池塘的池水作出物理和化學參數的分析，根據這些結果進行修復工程。為了要評估服務學習成分的有效性，在學期結束時，對學生的服務學習經驗進行了調查。

*調查結果：*得到社區及市政府的協助，學生能完全恢復池塘的水質。學生對水工程計劃加入服務學習反應非常好。這計劃，在學生的角度來說是既富挑戰性亦很費時。服務學習計劃能達到要求學生批判地思考及團隊合作的教育目標。幾乎所有學生都認為由於服務學習的經驗，他們更了解課堂的概念，而大多數人都認為服務學習活動為社區提供了所需的服務。

*總結：*有效地連繫課程內容與服務學習，不但能有效地加強學生在學術上學習，更能促進個人成長及灌輸終身學習，公民參與的承諾。

關鍵詞：池塘復修，水分析，公民責任

Background

Community and social service during an academic programme were always carried out as a part of extra curricular or co curricular component. Students as well as the staff in charge of such programmes often chose topics and fields which are not connected to the classroom activity. As the community service was delinked from the academics, there developed a tendency, where academicians and students believed that there could be no connection between subjects learnt and the service provided to the community. However, service learning approach has been found to provide adequate motivation to the service components as it involved application of principles learnt in the classroom to the problems faced by the society. This is the principal reason for its success in many science settings. Many practitioners (Kesner &Eyring**,** 1999; Nix**,** 2000; O'Hara, Sanborn & Howard, 1999; Alison, 2004) have found success in increased student learning, using service learning as their active approach. Chemistry is well suited for the promotion of service learning, as there are a number of scientific issues that affect the society.

In addition, it is found that with standard laboratory exercises, many students are not challenged to think independently. The students are usually required to completer a very specific list of tasks, which does not require them to think about what they are doing. A multi-week project would allow students to think independently about a problem. Water is one of the most abundant substances on earth's surface. However, most of this water is salty and so it unfit for human consumption. The fresh water which is available for human use is only 0.003% of the total availability of water. This is not evenly distributed and the fresh water availability varies from place to place. If the available water per person per year is more than 1700 m^3, then the area is regarded as one where there is abundant water. The area where less than 1700 m^3 of water is available per person per year is called water scarcity area. In India, though the water available is 2200 m^3 per person per year, the situation in Tamil Nadu, where Madras Christian College is situated, is totally different. Only 800 m^3 of water per person per year is available in these areas and so management of water resources poses a big challenge to the society.

A need for sustainable management of available water supply thus gains importance. Generally, the onus of managing water resources is left to the government. Implementation of service learning programme under these conditions will result in a paradigm shift in the attitude of the society. Instead of an individual surrendering to the state, there is community participation. The society realizes the need to join hands with the government in solving the problem faced by them. The people begin to realize that water shortage is not about the mere failure of rain or enormous increase in the population level. It is about the failure of the society to live and share its water endowment.

The society is made to be partner in the integrated water management system. This involves various elements such as water augmentation through rain water harvesting, water conservation through judicial usage and preservation of existing water reservoirs like lakes and ponds. The interactions among the elements within the system are related to quality and quantity of available water. Water quality

is a term used to express the sustainability of water. The statistics provide by the government agencies reveal that there has been a steady and marked fall in the water table from 7 meters in 1995 to 20 meters in 2004 in the study area. Ponds and lakes help to main the water table by recharge process. The vanishing of lakes and ponds has resulted in a drastic reduction in the quantity of available water. Further, the water quality of such resources has deteriorated as a result of runoff of from surroundings.

The service learning programme aims at the preservation of such water resources. Water chemistry, which involves the characterization of water using physical and chemical parameters and the analysis and treatment of water for domestic consumption and domestic waste production, are taught as an academic programme in the third year of study of chemistry. The academic programme also involves practical classes where the systematic procedures of the analysis of a water sample are taught. Instead of carrying out such exercises as a routine academic process, it was decided to apply these principles to real life situations. Provision of clean drinking water is inherently important to everyone and thus it has become a part of social issue. Thus water project, which would involve taking samples from a natural water reservoir and analyzing their quality, would keep the students interested in their contribution to the society (Juhl, Yearsley, & Silva, 1997; Richter, 2001; Schaumtoffel & Joubert 2001).

Project Timeline

The service learning project was carried out for a year consisting of two semesters. Each semester had a contact time of 13 weeks and throughout the 26 weeks, the work was carried out outside the regular class hours. Most of the days the students worked from 2.00 p.m. to 5.00 p.m. but the duration were not rigid and on several occasions they spent time beyond 7.00 p.m. Substantial class time was also devoted to discussion of the projects. In these discussions the students shared their experiences, challenges they faced and exchanged ideas. The residents of the local community were invited to discuss the progress of the project and their views regarding the restoration process were incorporated in the project. The students made clear to the community, that the success of their effort and sustainability of the project required their continued support. Thus the local community was invited to the release of final draft and in the ensuing celebration process where some of the locals who helped the process were also honoured. The assignment schedule is outlined in Table 1.

Table: 1 Service Learning Course Schedule

Week	Assignment
1	Project proposal
3	Project plan & Interaction with community
6	Project plan – Pilot analysis
10	Ethical issues & awareness programme
15	Sampling and analysis
18	Bailing out of water
19	Analysis of water in households
21	Distribution of kits
23	Analysis Report &Reflection
26	Final draft & celebration

Site Description

A large pond, called “Tamarai Kulam” in native language, near the College was chosen as the field of study partly because of its proximity to the institution and partly because of accumulation domestic waste and unusable condition of water in the pond. The pond is one of the oldest water reservoirs of

Tambaram, the name of the town where the pond is situated. In fact, the name Tambaram is itself derived from Tamarai Kulam, which in olden days served as a source of fresh water for the local community. It also served as a recharge repository for the wells that used the water for agriculture. At present all cultivable lands have been converted into construction sites and thus the pond is surrounded by a cluster of houses. The pond also serves as a place to take "holy dip' during festival seasons in the nearby temple. For the past two decades or so, the pond was used as a place to discharge all domestic wastewater and all the solid wastes generated during festival times were dumped into the pond. The pond water has thus lost its original nature and became physicochemically and biologically unfit for human consumption. It was a case of neglected water resource and no steps were taken either by the local authorities or the community to restore the pond to its original glory. Thus the pond posed the required challenge for the students who wanted to study the quality of water and who wished to implement the remedial measures for the purification of the pond.

Method

The physico-chemical and bacteriological parameters were analysed as per the standard methods described in APHA and by using the analysis kits designed for this purpose. The physico-chemical parameters selected were pH, chloride, alkalinity, total hardness, calcium .magnesium, iron, sulphate, nitrate, carbonate, bicarbonate conductivity, Total dissolved solids (TDS), dissolved oxygen (DO) and chemical oxygen demand (COD).

The local government authorities were contacted and permission was sought to carry out the sampling process. As a part of learning the students were introduced to the method of sampling techniques from a water body (Harris, 2001).

The tests to be carried out were classified into two types .i. on site testes and ii. off site or laboratory tests. The sampling procedure itself posed great challenges to the students as they could sample as per the plan proposed by the statistical method of sampling. There were places in the pond which could not reached by them. They were forced engage manual labor for this purpose. When a man came forward to take sample from the inaccessible portions of the pond and from places where there was domestic grey water, for a small cost they were shocked to see the reality in the outside world. The manpower in terms of manual labor is not very expensive and poor people do not care about the health hazards associated with the labor. Their primary aim was to earn money, even if it means at the cost of one's health. The students were moved by the pathetic conditions of poor and the have- nots in their society.

At the conclusion of the sample analysis, a group discussion was held to pool the results and to compile them.

Results

The water samples were turbid, yellow liquids. The results of physico-chemical and bacteriological parameters are given in tables 2 and 3. The background sample quality indicated that the pond is truly contaminated by human activities and the characteristics of pond are not due to natural background of the given area.

No heavy metal contamination was observed and

this augured well with the absence of heavy metal industries around the pond area.

The dissolved oxygen (DO) levels very low (2.2mg/L) and this indicated that the concentrations of organic matter and nutrients should be high. This high concentration decaying organic matter was also responsible for the fish kill observed during the period of sampling. The high COD value accounts for the presence of high level of organic contaminants.

The chloride content, alkalinity, total hardness, calcium, iron, phosphate, nitrate, sulphate and pH were all well within the permissible limits. All these suggested that the deterioration of water quality was not due to natural leaching of minerals from soil and could only be due to organic waste generated from domestic waste. The presence of indicator microorganisms proves the contamination through discharge of human sewage.

Execution of Action

It was very clear to the students that the deterioration of water quality was mainly due to the discharge of domestic waste from the houses surrounding the pond. They understood that the discharge of the domestic waste has to be stopped first and the pond has to be cordoned off from the public misuse.

They approached the municipal authorities and the person in charge was kind enough to allot money to build a compound wall around the pond.

The local community was sensitized regarding the need to have a pond with good quality water and their cooperation in this regard was sought. All of them agreed to stop the discharge of waste into the pond and they were given suggestions to use the wastewater in a better way. They also understood the need to improve the water quality and to use the pond as water recharging repository for their wells.

The water in the pond was bailed out completely just prior to monsoon rains and clean water allowed to seep into the pond. As the discharge of wastewater was completely stopped and as the compound wall prevented the unauthorized entry of people into the pond, the water quality of the pond had greatly improved. The students are monitoring the quality of water from time to time and are reporting to the local authorities.

The local community was provided with low cost, simple chemical kits so that any common can assess the quality of water using the kits.

The students were so proud of what they done to the local community and also what they learnt by way of tackling problems arising from poor quality water. They appreciated the local wisdom of using the gum obtained from a country tree to remove excess iron in water. This led to the execution several small scale projects using the natural gum as a coagulant.

Survey Results

Some of the students were so impressed by the work that they wanted to share their experience with other academicians. Four of the students presented the results of the study in two national conferences and impressed upon the academic population the need to include such service learning programmes in the curriculum. Since the advice came from the students who were partners of the programme their view was well received by the students as well, as the staff.

The staff understood the impact of service learning as a pedagogical tool to impart basic principles of chemistry to students.

As a part of self evaluation of the programme, a questionnaire, on a five point scale, from strongly agree to strongly disagree was circulated and the students were made to respond to the questions (Table 4).

It was clear from the survey results that the students generally agreed that the water project was more interesting than typical chemistry laboratory assignments. Instead of wondering why a particular experiment was introduced in their curriculum, students now realize the relevance of the experiment. (question 5). The students unanimously agreed that they needed to use critical thinking skills in the project. The structure of the project allowed the students to work independently which most of them enjoyed. (question 6). As with any investigative chemistry problem, not all parts of the water project went as planned (question 8). This is a valuable lesson for the students. The students were allowed to understand the reality of the problems that may arise while executing a plan. The interaction with the local community may not take place as nicely as envisaged. Many people have their own idea of service and the approaches by students were sometimes viewed with suspicion. Some of the on site tests could not be conducted as planned due to practical difficulties in obtaining the sample.

While students did not feel that they discussed chemistry more with their classmates during water project, (question 7), the instructors found a substantial increase in instructor-student interaction. Many students did not hesitate to ask the instructor for clarification when they encountered problems. Even when they were solving the practical problems using their skills, they did not miss a chance to check with the instructor whether they are following the right path. The informal atmosphere allowed the students to interact with the instructors without any inhibition.

The students also agreed that the project was time consuming than other laboratory assignments. (question 2). This is true because the analysis involved traveling to place, doing some tests on site and returning to laboratory to continue other tests and complete the analysis. The number of parameters chosen was also relatively high because the students did not want take risk with the public health.
Majority of them were also surprised by some of the results that they obtained during the project. (question 9). This again confirms the basic theory that the quality of water or any chemical for that matter cannot be quantified by its appearance. There will always be differences between what we assume based on appearance and the actual chemical composition.

As they gained major insight into the rudiments of water chemistry through this project, an overwhelming majority of the students recommended continuing the water project as a part of the course in the future. (question 10).

The students were given elaborate instructions prior to the project and sample analysis was carried out to get them familiarize with the techniques and to give them confidence to carry out the tests with the test kit in front of a crowd. This has helped many students to face the public and this factor is acknowledged by majority of students. (question 4).

Feedback from Staff

The staff involved in practicing service learning programme for the past two years reported that such approaches took students beyond the simple cognitive levels of knowledge and comprehension. The service component reinforced the connections to fundamental chemical principles emphasizing the unification of knowledge. They agreed that the students had an empowering experience through connections between the general principles and the service they render to the community. The students learnt the subject using skills of synthesis and analysis rather than rote memory. Faculty can use this tool to identify and document students' lack of understanding and thus design more effective intervention strategies. This instrument is adaptable across institutional and discipline contexts, making it a valuable assessment method for anyone interested in scholarly and reflective teaching.

Community Response

One of the major difficulties in integrating the service learning into the curriculum is to find a good community partner. The community, which the students interacted with, was a heterogeneous group. There were well educated people at one end of the spectrum and at the other end were people from lowest strata of the society who were illiterates. There were business people and those who were daily wagers. Therefore no questionnaire was prepared to get the opinion of the project once it was completed. We felt that such step may alienate the lower strata of the society. However, the community people were encouraged to voice their opinion at every stage of the project and their help was sought in the implementation of the project. For example, when students found it difficult to sample water in the interior of the pond, the local community was asked to suggest a method to sample water from that spot. They identified a daily wager from among them who did the job of sampling for us and also received his wage from us. Some influential persons of the community did the job of liaisoning between the students and the municipal authorities. As all of them felt the need for a clean water reservoir, they commended the students for their service. These interactions helped students to identify and analyze different points of view to gain understanding of multiple perspectives of the present problem. A local vendor by name Mani, felt that the supply of water kits is irrelevant and that the students should continuously monitor the quality of the water on behalf of the community. A few others like Dr.Raman, wanted a water purification kit, which was beyond the scope of the course.

We firmly believed that the development of transactional and transformational relationships can result in benefits for both parties involved. Transactional relationships between faculty and community organizations or between students and residents are temporally discrete due to their project focus, whereas transformational relationships leave open the possibility that the process of relationship development will be sustained and ongoing beyond the completion of a project.

Conclusion

The students responded very favorably to the service learning programme involving the water project. The programme, in the opinion of the students was both challenging and time consuming. The service-learning project achieved the educational

objectives of requiring the students to think critically and work as a team. Based on the instructor availability and the current laboratory equipment, it would be difficult to attempt such a project with an enrollment larger than twenty students. Our chemistry staff are encouraged by the success of the project and hope to incorporate similar projects into the service learning programmes. Students learned more than they did with a traditional approach and gained insight into how environments chemists work.

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Comparison of characteristics of Pond water with IS 10500 of BIS (1991)

Table 2: Parameters falling within desirable limit

S.No	Parameter	Pond water	Background blank	Desirable limit of BIS
01.	pH	7.7±0.1	7.3	6.5 to 8.5
02.	Chloride	168 ± 5	163	250
03	Alkalinity	169 ± 9	152	200
04.	Total hardness	162 ± 8	160	300
05.	Calcium	65± 5	67	75
06.	Phosphate	0.13± 0.01	ND	0.1
07.	Sulphate	130 ± 6	57	200
08.	Iron	0.3 ± 0.01	0.15	0.03

Table 3 . Parameters falling outside desirable limit

S.No	Parameter	Pond water	Background blank	Desirable limit
01.	Magnesium	77 ± 2	48	30
02.	Electrical conductivity	882 ± 20	93	400
03.	TDS	1231 ± 35	65	500
04.	DO	2.2 ± 0.02	6	7
05.	COD	70.6 ± 4	ND	5
06.	TBC/mL	4800 ± 611	500	0

Table 4. Survey Results

S.No	Questions	Strongly agree %	Agree %	Neutral %	Disagree %	Strongly disagree %
1	I was challenged by the water project portion of the course	31.58	42.11	21.05	5.26	0
2	The water project was more time consuming than other laboratory assignments	15.79	52.63	5.26	26.32	0
3	I needed to use critical thinking skills to complete the project	0	26.32	47.37	21.05	5.26
4	Prior laboratory assignments in this course helped prepare me for the project	10.53	68.42	10.53	5.26	5.26
5	The water project was more interesting then typical laboratory assignment	31.58	52.63	5.26	0	10.53
6	I enjoyed working independently during the project	31.58	42.11	21.05	5.26	0
7	I discussed chemistry with other students during the project	0	26.32	31.58	31.58	10.53
8	All parts of the project went as planned	10.53	20.21	5.26	64.0	0
9.	I was surprised by some results I obtained during the project	42.11	42.11	5.26	5.26	5.26
10	I would recommend continuing the programme as part of the course work	52.63	31.58	5.26	0	10.53

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