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Student-Based Community Service Learning to Assess Water Issues in Rural Parts of Virudhunagar District of India

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***Abstract*—Advancements in science and innovation have been carried out in the state of art engineering design standards for the improvement of humankind. Regardless, there is a basic need to take the benefits of science and engineering and offer reasonable responses for the headway of the overall rural population. The Bachelor of Technology (B. Tech.) in Biotechnology students of Kalasalingam Academy of Research and Education, India (KARE) refined the water-related issues faced by rural people of Virudhunagar district in Tamil Nadu. The students through their custom audits identified specific drinking water and wastewater-related issues faced by the rural people in one of the backward districts of Tamil Nadu. Afterward, the students had the option to foster the ideas to devise decisive solutions to the water-based issues of the rural people. The endeavors taken by the students through their half-year community-based projects have made advances in the instructive program to alleviate the water problems faced by the rural community. Besides, the solutions mandated by the students have been tested in this study. The solutions devised and tested by the students are of minimal expense and effectively moderate. Consequently, we prescribe that educational institutions incorporate socially applicable result-based ventures for addressing the environmental problems of rural communities while enhancing transformational learning through conventional teaching methods to service-learning methods.**

***Keywords*— Community service project, drinking water, wastewater treatment, transformational learning**

***JEET Category*—Practice**

I. INTRODUCTION

The improvements in the Science, Development, and Innovation have ignited a vital part in propelling ideas to design and innovate community projects in our institution and elsewhere. Socially important result-based projects to support the rural folk have been implemented by schools, colleges, and universities in India and across (Arunajanani et al., 2021). Rural neighborhoods assume an imperative part in carrying out socially significant result-based community service projects (Anitha et al., 2018). The staff of schools, colleges, and universities have been a significant part of mentoring the students to partake in community service projects (Adi et al., 2017) with an arrangement-based thinking philosophy (Aruan et al., 2021). Such community-based projects have been executed in the instructive program of educational institutions. Engineering programs nowadays are so designed that students are invoked to focus on the different necessities of rural individuals (Buch et al., 2020), for example, drinking water and wastewater treatment (Kulkarni, 2016) Various activities have been executed at many places by educational institutions through neighborhood projects to resolve the issues faced by rural people (Bajet et al., 2012; Trisurat, 2006).

One of the consistent issues faced by any rural community is access to clean drinking water. While the demand for freshwater increases, there is a growing concern about the raising levels of polluted waters. Virudhunagar is considered one of the backward districts of Tamil Nadu, it also water deficit and requires the earliest actions from the Government and local bodies to ensure the facilitation of drinking water and treatment wastewater for the betterment of rural hood (Trisurat, 2006; Arcilla & Ocampo, 2011; Blanchard et al., 2019). Here, we have used the principles of science and advancement to offer sensible responses to the issues faced by the rural people of Virudhunagar District in the neighborhood of Kalasalingam Academy of Research and Education, India (KARE). The present pedagogy practiced in several developing and underdeveloped countries is primarily that of classroom or laboratory-based learning, leaving no room for the students to tinker with real-world or real-life issues and problems. The major setback in conventional teaching pedagogies is that the students are bereft of developing personally meaningful skilled projects and are exposed only to general subject knowledge. In the sections that follow, information is provided on the collection tool used by the students in identifying the problem, the applicability of service projects to discuss and design appropriate prototypes, and finally field testing of the prototypes. This ensures that the students earn enhanced learning by practicing community service projects while achieving attributes laid by the National Board of Accreditation, India (NBA) and the Accreditation Board of Engineering and Technology, USA (ABET) to meet the quality of engineering education. This paper answers the question of achieving transformational education through community service projects and intends to help institutions to replicate the process to devise new scenarios more appropriate to local

societal problems and look beyond conventional teaching strategies such as class discussion, lab, videos, and notes taking. The major objective herein is to demonstrate the effectiveness of the service-learning program and its ramifications for providing a reasonable solution to water issues faced in a rural region of Southern India.

II. LITERATURE REVIEW

Community project-based learning is appreciated by accreditation bodies worldwide (Bewoor et al., 2019). On various occasions of prototype models and items designed by the students have given rise to socially significant result-based ventures that have helped rural folk (Buch et al., 2020). The critical parts of such community-based projects, for example, are socially pertinent result-based activities that have incorporated the positive dependence among the stakeholders (students, nearby community associations, and rural folk) (Ahrumugam et al., 2015). The practicality of such community service activities has been attempted by various associations (Goodman & Young, 2015; Sy, 2011). Subsequently, service-learning activities give adequate opportunities to students to accomplish venture-based community service learning and give reasonable answers for the veritable issues faced by rural people. Various socially supportive prototypes have been made by the students of KARE and conveyed to the neighborhood.

The 2018 curriculum revision at KARE for B.Tech graduates was designed in a way to develop scenarios aimed at addressing nearby communities by offering solutions to real-time problems. Arunajanani et al., (2021) have shown the effective implementation of community service projects (CSPs) to provide prototype models of Robotic arms, for amputees, sanitary napkins for rural women, natural biofertilizers, and zero energy low-cost refrigerators for local farmers. This demonstrates the potential of young minds to be actively involved in designing solutions to local needs while developing the necessary skills laid out by accreditation bodies. One of the crucial steps is to sustain the motivation and enthusiasm of the students to be optimistic about failures and learn from mistakes. The variables such as student interest in the project, need for the service, and student apprehension of the local issues was monitored throughout the study. These variables would possibly benefit experiential learning and apparently provide practical aspects of innovations, in this case, it was water-related issues, by student engagement. Of these, the greater emphasis was on continued student interest in the project and student approach to the local needs. Such community-based engagement is now prevalent in developed countries and case studies on solid waste management in a locality in Haiti were developed as a waste-to-energy service and have been demonstrated by Anju Dahiya (2020). It could be concluded that community-based learning enhances the engineering attributes of students while coming up with solutions to local real-time problems. Such innovative pedagogies would not only prove to be actively engaging to the students while parallelly developing the first practical aspects of many pertinent social issues. The authors have employed socio-technical theories (lenses) including the younger aspiring researchers to interact with real-world problems and develop competence addressing beyond the academic realm and mustering leadership, communication, and organization skills.

III. METHODOLOGY

A one-year duration socially pertinent result-based community service project course was undertaken by the students of the Bachelor of Technology (B. Tech.) Biotechnology of KARE. The project was planned as a socially pertinent result-based task performed with the direction of a project guide. The specific role of students, faculty mentors, and the community outcomes in the service-learning chain are shown in Fig.1. In 2018, a couple of students joined the project along with 2016 batch students already working on addressing sanitation and water issues of a locality near the institute. These students wanted to apprehend the community development with limited resources and started exploring drinking water/wastewater issues and its recycling in the Virudhunagar environment. They did hands-on work locally in Virudhunagar and came up with findings of fluoride contamination in and around Virudhunagar groundwater due to natural soil and geographic location. The students then devised sustainable media to dissipate fluoride and organic compounds from groundwater to address the need for safe domestic water for residents. The faculty mentor transfers the required academic knowledge, and service experience and motivates the students, especially during failures. The students discuss, explore, evaluate, collaborate, organize, determine, and establish solutions by meeting the beneficiaries from the rural neighborhood.

During the field visit, the students reviewed by posing applicable inquiries identified with social prosperity, monetary and issues related status of the people of the rural folk. By then, the students recognized the need and issues pertinent to the local community. Subsequently, the students merged the academic expertise for the recognized need and issues of the rural folk dependent on three parts: instructive arrangement, neighborhood, and income. The students collaborated with neighborhood leaders to explain while fostering the items to resolve the water issues faced by rural folk to make headway for future course corrections. Thereafter, the students presented a report dependent on the study, need examination audit, and proposed models. The students implemented the proposed prototype through effective tutoring provided by the project guide.

A. Main Pedagogical approach

Community projects are experience-based learning methods that amalgamate learning and service while emphasizing student development with social responsibility and providing first-hand technical solutions to pressing local issues through public engagement.

B. Useful Methodological Lens: Service-based Research

As mentioned, the major goal of this service-based research learning is to implement community projects at a local level in the teaching context.

In the case studies here, we use a service-based learning methodological frame to set up the projects. On a micro level, the projects feature very varied data (e.g.,

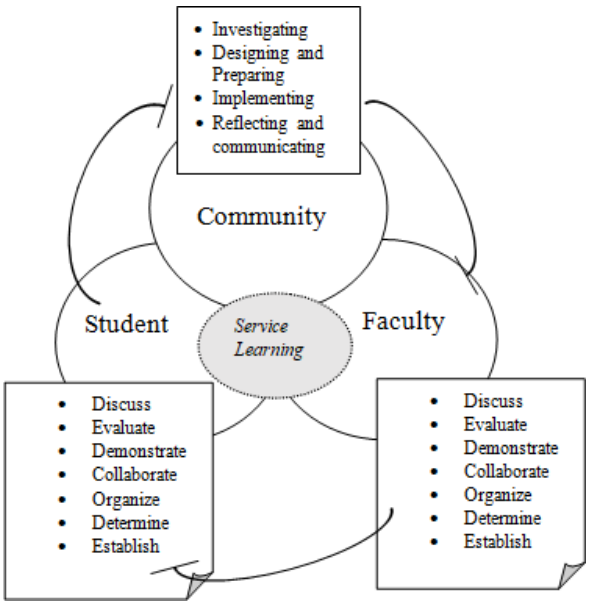

Fig.1: Approaches and tribal benefits to the students, faculty, and instructor through service learning

surveys, water analysis, interviews, texts, etc.) and methods (e.g., content analysis, statistical analysis, field experiments, etc.). The students decide rationally on the different approaches and come up with a solution based on the inputs and data shared by the community pupil, thereby reinstating their technical knowledge.

The course of the community project crosses the following nine stages (i) survey analysis (ii) identifying problem statement (iii) discussion with community beneficiaries (iv) receiving academic expertise (v) developing prototypes (vi) design and fabrication (vii) testing and evaluation (viii) implementation (ix) result analysis. The satisfaction levels of the students during the service learning were surveyed at the end of the implemented projects. The following questions were raised with the students and scaled from 0 – 5 (with 0 marked as not satisfied to 5 as completely satisfied).

1. Whether the students felt motivated throughout the project work?
2. Whether students developed empathy towards the rural people at hand?
3. Did the proposed solution convince the students about their innovation?
4. Whether the students were able to meet the expectations of the rural people?
5. Do the students feel that they were able to acquire the required skill set forth by accreditation bodies (for example The ability to identify, formulate, and solve broadly defined problems)

IV. RESULT AND DISCUSSION

A. Assessment of Drinking water fluoridation

A community service-based project implemented by the students mentored by the faculty of the Department of Biotechnology, KARE dealt with the drinking water fluoride contamination in the villages of Virudhunagar District (Fig.1). Today's learners are highly interactive and socially active. The teacher's role is to facilitate such interactions and discussions and turn them into box thoughts and ideas. The increased anthropogenic activities and changing lifestyles of the population have raised the levels of various contaminants and pollutants, particularly Fluoride, Arsenic, and Nitrate in both surface and groundwaters. Late examinations, be that as it may, show the disturbing danger of groundwater pollution and the pressing need to track down a minimal-expense treatment measure for contaminants present in the drinking water sources of the rural population. The opportunity to combine own learning with delivering service was described as an important theme of community learning. The motivation of students was enhanced by being a service to someone with parallel engagement in the methodological parts of the course.

Of the many contaminants found in water, fluoride is known to be highly reactive and toxic to various living organisms. Having or not having fluoride in drinking water is still debatable, although data shows that a concentration range of 1 – 1.5 mg/L could improve dental and skeletal structures, while concentrations above 2 mg/L could bring about skeletal and dental fluorosis (Stenstrom & Wong, 2018) a diseased condition leading to bending of bones and yellow patches of teeth respectively. Fluoride contamination is not just a local problem but has been reported worldwide, especially in developing or underdeveloped countries (Hegde et al., 2020). The students conducted surveys on the issues faced by the rural community regarding the usage of fluoride-contaminated water (Fig.2) and found that a major chunk of the population was affected by dental fluorosis. From the survey, the students identified that the population was unable to afford costly water treatment units or filters available in the market. The rural population depended upon groundwater to meet their water demands. The students undertook a field visit to nearby three villages in Virudhunagar (Avaniyapuram, Oomatchikulam, and Krishnankoil) and collected drinking water samples as shown in Fig. 3. The students examined the concentration of fluoride at these spots and found 80% of the sites contaminated with fluoride above 1.5 mg/L as shown in Fig.4. The students visited 3 villages and collected more than 20 drinking water samples from different sites. From the survey and tests, the students thus identified and proposed the need to have a water filter system that could be used on-site (at home) and affordable. On-site and individual treatment systems could be developed from simple adsorbents which could be easily maintained by the users. The students studied various de-fluoridation strategies adopted worldwide and narrowed them down to a few adsorbents that were found to be effective for defluoridation (Huang et al., 2021).

Fig.2 Survey conducted by the students

Fig 3 Drinking water collected by the students for analysis

In our study, the students have chosen rural villages in the Virudhunagar district and gathered the Groundwater from different spots (Fig.2). The Fluoride analysis was done by the students in the Laboratory as per standard tests. To increase the learning outcomes for students; an important strategy is to work directly in the context such that the knowledge could be applied while learning.

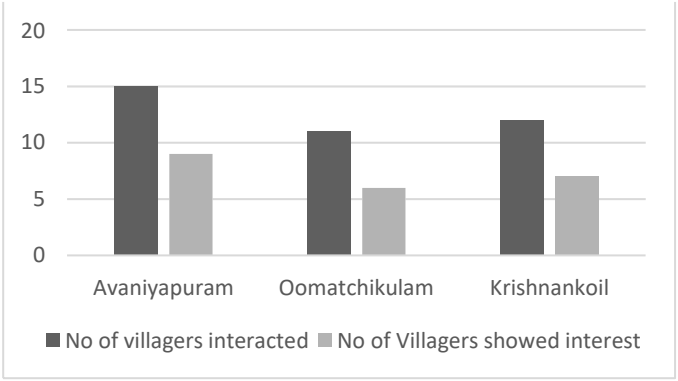

Fig.4: Willingness of villagers to interact with students and participate in the student survey

Put differently, the students could transfer the contexts of the learnings and helps to make them more applicable by engaging in real societal issues. The students, therefore, represented the complexity of the real problem while exhibiting knowledge construction rather than knowledge reproduction. The students were able to perceive the community as their learning environment breaking out of the conventional classroom learning based on notes, class lectures, and videos. The community boosted the thoughtful reflection in students as they happen to witness the problems and empathize with the rural population, this is least achieved in the classroom learning environment. This type of transformational learning encouraged the students to convert components learned from the class into meaningful contexts rather than abstract instructions.

B. Assessment of water quality affected by firecracker chemicals

The community service-based learning carried out by the students mentored by the faculty of the Department of Biotechnology, KARE dealt with the firecracker chemical contaminants in the water of the villages near Sivakasi, Virudhunagar District. Sivakasi is widely known for its firecrackers, matchsticks, and printing industries. Sivakasi has located approximately 25 km from the college campus. It was quite easy for the students to access the villages near this town to conduct a survey and examine water and wastewater samples. Fig.5 shows the survey conducted by the students in four different villages across the Virudhnagar district like mettamalai, thaiyelpatti, mutalipatti, and annupankulam. The students collected water samples from the near cracker industries located in the above-said villages. The students collected both water and wastewater samples located across this region (Fig.6). The wastewater was collected in sterilized 5 liters of plastic cans and stored at 4°C. pH and conductivity were analyzed by using a digital pH meter (Type: MK-VI, Systronic India), and a digital conductivity meter (MK-509, Systronic India) respectively. The students surveyed the dependence of villagers on the various water sources available to them. It was found that groundwater was the major water source for the rural

Fig. 5 Survey conducted by the student members

population not just to quench their thirst but for other domestic purposes as well as shown in Fig.7. The students tested the water samples for chemical oxygen demand as per the standard methods. The students were also able to develop their analytical skills by testing real water and wastewater samples.

Fig. 6 wastewater collection by the students for analysis near Sivakasi, Tamil Nadu

The community survey and water testing provoked the students to study various practice methods to render contaminated water useful for domestic purposes. The students undertook a literature study and concluded on the use of nano cellulose as a suitable alternative to building at-home usable filters. Unlike chemical-based adsorbents, nano cellulose could be derived from natural biomass (Carpenter et al., 2015), thereby leading to no secondary pollution and effective removal of contaminants from water.

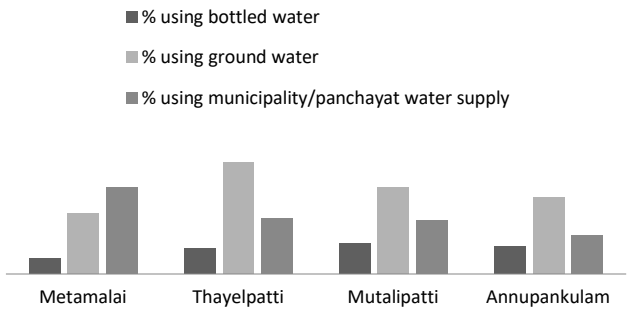

Fig. 7: Survey conducted by the students during interaction with the villagers

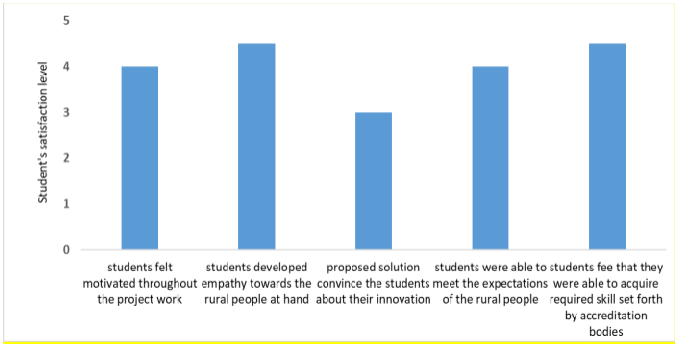

Fig. 8 Service learning – satisfaction survey results from the student members

The preparation of nano cellulose does not entail costly chemical reagents and is cheaper and more affordable compared to synthetic adsorbents (Leo et al., 2020). This enthused the students to practice techniques in developing low-cost nano cellulose to develop filtration units affordable and maintained by the rural populations. It was found that as community service learning entailed complexities, the students took to technology as a mediator between the instructors, community environment, and peers. Since much of the learning happens on the field, the students depended upon mobile resources which made the problem-solving steadfast. Even the instructors were to then adapt to technology-driven methods to enrich and support students in their problem-solving approach.

V. CONCLUSION

Socially applicable result-based projects done by B. Tech. Biotechnology students of KARE accept a major part in the upliftment of the prosperity of individuals influenced by water. Various Designing and Innovation establishments have executed local area-based tasks as a way of resolving the issues looked at by rural people with the help of science and technology. The techniques used by the students helped for addressing the issues of drinking water and wastewater treatment. Several themes of learning emerged in the cases above. Research services have been systematically approached to address concrete issues in the local field. Merging education theory with socially relevant topics is beneficial from multiple perspectives. The service-learning initiates a circular sustainable process facilitating the generation of mutual learning and providing first-hand solutions to societal issues. The standard test of executing any socially pertinent result-based community service venture is in supporting the enthusiasm of students to work past the term of the project to achieve a conclusive target of prototypes that will help the different necessities of the rural folk like water supply and treatment of wastewater in this manner, it is recommended that the B. Tech. / B.E. students to make advances in their undergraduate educational plan to incorporate socially applicable result-based community service projects.

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