Diversity in Science Grant 2023

Introducing Female Students from Rural Indian Schools to the World of Advanced Scientific Research

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Background

The primary objective of this project was to present an opportunity to female school students from rural Karnataka, a southern Indian state, to participate in advanced-level scientific research. The funding awarded by the Biochemical Society through their Diversity in Science grant (2023) allowed us to involve four students in the project. The research was conducted at the campus of Prayoga Institute of Education Research, a not-for-profit education and research organization (Home | Prayoga), whose motto is to bring about a transformation in society by enhancing the utility and quality of learning through research. The newly built research labs at Prayoga house a wide range of sophisticated instruments and the students could avail unrestricted access to this state-of-the-art research facility. These students were selected through brief interactions under the program 'Anveshana' (Anveshana | Prayoga), a flagship and one-of-a-kind programme offered by Prayoga. Anveshana is a research platform to understand the impact of hands-on research as a pedagogy on the development of scientific temperament and competencies among students. Under Anveshana, high school students passionate about science participate in research projects guided by research mentors at Prayoga. The title of this project was 'Nature to Nanotech: Saponin-capped Green Nanoparticles for Environmental and Biomedical Applications'.

Prayoga campus

Sophisticated instrumentation lab

Project implementation

The selected students participated in the research activities for almost eight weeks (April–May 2024). First, the research mentors taught the students the fundamental concepts behind the project idea through a few interactive sessions and familiarized them with the objectives and research design. After a mandatory safety training session, students started the research work in the lab under the constant supervision of the mentors. The interdisciplinary nature of the project exposed the students to different branches of science simultaneously – chemistry, biology, material science, and nanoscience; and in turn, introduced them to a diverse category of scientific concepts such as nanomaterials, green synthesis, thin-layer chromatography, photocatalysis, antioxidant activities, and antibacterial activities. Students were trained in basic lab equipment (analytical weighing balances, magnetic stirrer, pH meter, hot air oven, micropipettes, etc) as well as sophisticated lab instruments (UV-Visible spectroscopy, Fourier-transform infrared spectroscopy, centrifuge). In addition to this hands-on training, students also acquired the opportunity to learn about two other advanced techniques – atomic force microscopy (AFM) and X-ray diffraction (XRD). During the course of the research work, students were also trained in standard operating procedure for the instruments used, procurement, analysis, and interpretation of research data, followed by the basics of scientific writing. Students also visited Indian Institute of Science (IISc) Bangalore, one of the most prominent research institutes in India, where they interacted with some of the leading scientists and researchers.

Students in the lab

Upon completion of the research project, students compiled, analysed, and interpreted their data to support their inferences drawn from the project. Their research results were documented in the form of a thesis. Further, they presented their research work before an audience of eminent scientists and educationalists and defended their thesis. The novel findings of the research work led to a manuscript, soon to be submitted to an internationally acclaimed journal. The grant money offered by the Biochemical Society was utilized to purchase a 4-digit analytical balance, microwave oven, portable pH meter, micropipettes, quartz cuvette, lab consumables, and to cover the printing of thesis.

Outputs and impact

The project was designed in an interdisciplinary way to ensure that the students get exposure to research at the interface of chemistry, biology, and material science. Some of the topics integrated within the project were known to the students, while the other topics were new and unfamiliar. Students were able to grasp a wide variety of scientific concepts, topics, and techniques through 'project-based learning' (PBL). To test the effect of PBL on their learning, pre-test and post-test were administered before and after the project, respectively. All four students showed improved scores in the post-test, resulting in a superior average score in the post-test (7.25 ± 0.96) compared to the pre-test (5.25 ± 1.50). This clearly demonstrated an enhancement in their understanding of the concepts, due to the experiential nature of PBL. The research work was recorded in the form of a thesis and the novel findings led to a manuscript. The manuscript will soon be communicated to an international journal.

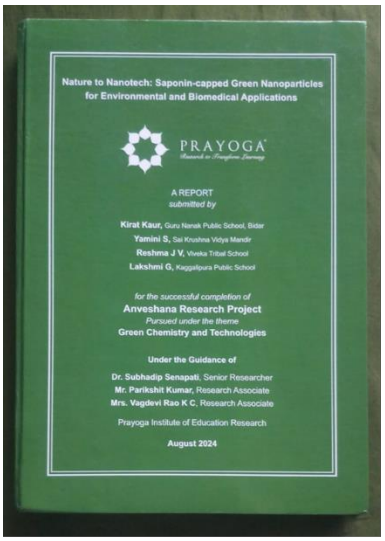
Students presenting their research work

Students with project completion certificates

We are hopeful that the actual impact of the project could go well beyond the scores and the research publications. Lab facilities had mostly been inaccessible to the students as they were from remote and rural areas. Rural female students are underrepresented and often underprivileged in the vast domain of science and STEM (Science, technology, engineering, and mathematics) in general, and this gap often gets reflected in the jobs and workforce. In India, women comprise only 27% of the total workforce in STEM, and unfortunately, this number is significantly lower for rural women. Some of the participating students were first-generation learners and empowering them with advanced-level education and research facilities has the potential to leave huge impact on them, their families, and their societies in general. The positive impression may encourage other rural students to pursue science, which in turn, can lead to an increasing influx of less fortunate students in the fields of science education and jobs.

Students demonstrated noticeable progress in their technical, methodical, problem-solving, and critical thinking skills. These higher-order thinking skills could enable them to apply their knowledge to real-world problems. In anonymous feedback upon completion of the project, they univocally stated that the project work made them keener to learn science and even pursue a career in science. Moreover,

presenting their research work in front of a panel and interacting with esteemed scientists made them more comfortable and confident, and helped them pick up a few essential life skills.



Research Thesis

Green synthesis of saponin-capped CuO nanoparticles and their efficacy in photocatalytic dye degradation

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Research Manuscript

Challenges

Despite the positive outcomes of the project, there were a few obstacles on the way. As cutting-edge scientific research is expensive by its very nature, we could not accommodate more students even if we would have liked to. We appreciate the funding provided by the Biochemical Society and are thankful for it. However, we could only engage four female students, a number quite minuscule in comparison to the millions of underserved rural female students. Encouraged by the current study, we aim to involve many more students in the coming year and have started applying for additional funding from government agencies and private entities. Another minor challenge was the language of communication as English was not even the primary or secondary language of some of the students, most modern scientific communications are English-based. However, we were able to overcome the language barrier by translating the texts and instructions from English to their native languages.

Conclusion

To summarize, four female students from rural areas of India participated in a two-month long research project, followed by data analysis, report writing, and eventually showcasing their research in front of renowned academicians, scientists, and industry delegates. These students participated in an interdisciplinary science project in labs equipped with modern facilities, which were otherwise inaccessible to them. Their investigation led to original findings that could potentially be published in international standard journals. Moreover, through this project-based learning exercise, students appeared to assimilate an improved knowledge in the topics of interest, as evidenced by the post-test data. The research experience helped the students pick up scientific and some life skills, and motivated

them to ponder over the thought of choosing science as a potential option for higher education and career. We acknowledge that we were able to reach out to only a handful of rural female students this year mostly due to budgetary constraints. Nevertheless, we are determined to provide more and more underrepresented students with access to innovative and superior research experience in the years to come.

Participating students

Students with mentors