

The Benefits of Involving Undergraduate Students in Outreach Programmes: a Case Study in Singapore

Linda Sellou¹, Mei Hui Liu², Kim Yong Lim³, Jianhong Kuang⁴, Yuebo Yu⁵, Qian Hui Hua⁶, Amelia Loh⁷

National University of Singapore, Department of Chemistry (Singapore)

¹chmsll@nus.edu.sg, ²chmlmh@nus.edu.sg, ³scilky@nus.edu.sg

⁴scikj@nus.edu.sg, ⁵alice.yu@outlook.com, ⁶qiazhua@gmail.com, ⁷amelialoh@nus.edu.sg

Abstract

Education in Singapore has received international recognition. Schools are well supported in terms of facilities and technology. However due to the focus on examinations, most of the classroom time is dedicated to its preparation and teachers have little time to explore related topics out of the curriculum. As a consequence students (both proficient and weak) may often lose their fascination and interest in topics like science. This usually leads to a loss in motivation to pursue further studies in the subject. To improve this situation, the Faculty of Science at the National University of Singapore (NUS) and its Department of Chemistry conducts outreach programmes to engage young students in science subjects such as chemistry. One of the themes of this programme was the "Science of Cooking & Molecular Gastronomy", adapted to local flavours and delicacies. An important feature of the programme was the involvement of undergraduates. Undergraduate students act as educators, demonstrators, facilitators and role models in this environment and inspire young school students. We also found that undergraduate themselves improved their own perceptions of chemistry and increased their motivation for independent learning. This talk will share the experiences and lessons learnt in the development and execution of the programme. We will highlight that with proper training and guidance, the participation of undergraduates in the outreach programme has a positive impact on their personal development, academic learning and career prospects.

1. Introduction

Generally, Singaporean students study science until Junior College and score well academically [1]. Nevertheless, local students hesitate in pursuing further studies in science and those who do often have the wrong expectations due to perceptions and attitudes towards science. Teachers find challenging to balance between teaching content and developing science appreciation in daily life. Bringing schools and universities closer is necessary for a smooth transition and preparation to higher education. Long-term outreach projects are keys to obtaining durable results [2,3] at all levels improve the quality of science education.

2. Motivation

NUS conducts outreach activities as an educational body primarily to promote science to a large audience by sharing knowledge and up-to-date research. There are many other advantages for universities to conduct outreach. It provides young students direct exposure to university life and give them opportunities to interact with academics and undergraduates. Students can also clarify doubts and obtain more information about further studies and careers. During these events, we observed undergraduates are great ambassadors for the University and engage with younger students. In this paper, we present a case study of an outreach programme in an Asia context and how it benefited undergraduates.

3. The Science of cooking

Singapore is renowned for its diversity in food and culture, we naturally adopted cooking and nutrition as central themes. Molecular Gastronomy [4] experiments were included for novelty and promote scientific and interdisciplinary approach. Students could then appreciate how culinary art and science work together [5]. Furthermore this theme allows students to continue experimentations at home and preserve their interest.

4. Undergraduates and postgraduates

Any international outreach programmes involve postgraduate helpers [6]. They are more mature, have better expertise and have a less intensive coursework schedule than undergraduates. However, NUS

is a research-intensive university where postgraduates focus primarily on their research. In addition, we have observed the young participants interacted more readily with undergraduates compared with more senior faculty. Undergraduates can also appear as role models. Further, involving undergraduates in outreach has a valuable effect on the undergraduates themselves. Most volunteers in the programme are year-2 or above and had enough time to acclimatise to tertiary education. As observed, students share many similarities with their seniors and this helps in building a rapport. This is paramount, especially with young children who need extra support. The events were scheduled outside of the semester to facilitate time management for the undergraduates and to maximize the benefit for both the undergraduates (hereafter referred to as facilitators) and the attendees.

5. Programme organization

We had diverse events comprising, family events, science camps and children home activities. For family events, the facilitators had to engage children and parents. Children focus on entertainment whereas parents were concerned with educational value. Facilitators were then viewed as direct representatives of the institution. For the science camp, the audience was mainly interested in learning science at a greater depth and facilitators had to master the concepts to fulfill expectations. For the children home activities, the scope was bigger and not just limited to science. Here the facilitators had a wide-ranging impact on the children's life by inspiring, motivating and revealing their potential.

6. Contributions of the Undergraduates

The team conducting the programme was composed of two lecturers, staff from the NUS Demo Lab (<http://www.science.nus.edu.sg/outreach/sdl-main>) and undergraduate volunteers from the Faculty of Science. The undergraduates could develop their personal, academic and professional skills by contributing to three components of the programme:

(1) development of experiments, (2) design of teaching resources and (3) leading interactive sessions. These undergraduates volunteering were from various disciplines (Biology, Chemistry and Physics) that added the 'integrated' dimension to the project. The ensuing discussions provided them with opportunities to apply and reinforce their knowledge and understanding of scientific concepts. They would come together to brainstorm on the topics. Once finalized, the volunteers were then sub-divided into various task teams including the experimental team, media team, and communication team. The conception and development of the experiments were handled by the experimental team. The practicals chosen had to be educational and easily executed by young students under supervision in a limited time. Each week, two undergraduates would take the lead and engage the rest of the team. The group regularly exchanged ideas online before finalizing the design and motivation for a practical. Subsequently, the media team would work on the instructions and create a friendly platform for sharing the resources. Analogies and visualizations are known to facilitate understanding [7], hence some drawings were designed to simplify the physical and chemical concepts involved in cooking (fig. 1). The final instructions were distributed in laminated sheets amongst the helpers.

In addition, prior to the actual workshop, the participants were also sent preliminary questions such as "Draw something that you think best represents chemistry" or "Describe chemistry in one sentence." The answers were used to gauge the audience and adapt the activities, the support materials and the training of the facilitators.

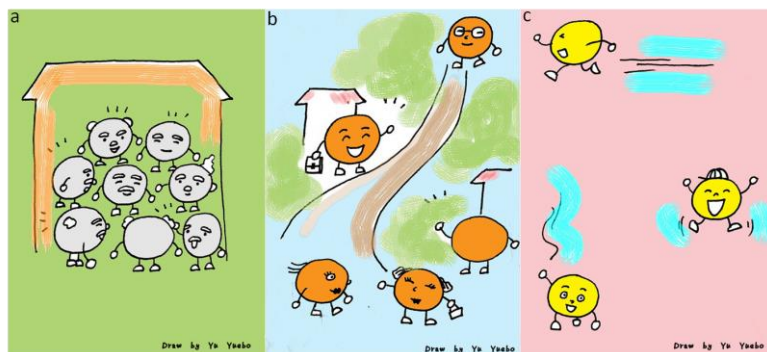


Fig. 1. Phase change (by Yu Yuebo): a) The Solid House, b) The Liquid Village, c) The Gas Kids.

Finally the communication team was in charge of bringing the newly designed material to life by implementing it. There were several events scattered throughout the semester and the

undergraduates chose which to facilitate. The undergraduates were trained in each activity and the pedagogical approach to adopt based on the participants' response to the preliminary questions. A typical outreach event was composed of two parts, an introductory talk by the staff and a hands-on activity session. For the hands-on activities the class were split into small groups and each facilitator was in charge of one. This was a crucial stage where the undergraduate and students could engage and interact closely. During this activity the facilitators re-emphasized the theory, re-explained the techniques and demonstrated the general good practices of experiment and observation used throughout the fields of science. Facilitators also encouraged the students to make observations and provide their own explanations to questions. For example, what physical transformations occur upon whipping chocolate and water emulsion, mixing dry ice and fruit juice. To conclude the workshop, participants had to highlight the key concepts learnt by drawings.

7. The Activities and the Topics Covered

Most of the concepts used were directly related to the participants' school syllabus such as the nature of basic chemicals and states of matter. More specifically: (1) The importance of water in life and its properties, (2) Proteins, Fats and Carbohydrates and (3) States of matter and phase transitions. Phase change in cooking was demonstrated with the preparation of chocolate mousse from only chocolate and water. Through this experiment, the properties and structure of fat, proteins, sugar and water and the chemical component of cocoa were discussed. Other activities included the use of dry ice, carbonated drinks and the preparation of sorbet. Hydrocolloids were introduced using the agar-agar pandan dessert and the making of alginate spheres. The material (ingredients and utensils) used were intentionally very simple and familiar to the students. Nutrition values of the different ingredients used were also explained. For example, the physiological effects of sodium alginate and tapioca starch balls in bubble teas, that are popular among students, were compared.

8. Impact on the undergraduates

8.1 Academic benefits

After all the events, the volunteers gave their reflections, comments and suggestions about their experiences and what they learnt. Some appreciated the concepts they were learning through their coursework were more widely applicable than initially thought.

Some who joined the experimental group because they had strong interest in cooking and nutrition did not expect the method of scientific inquiry they usually apply in the laboratory could also be used in the kitchen to improve recipes. Often, the culinary experiments helped them to better understand what they had previously learnt. Also having to master the theory and find different ways of describing and explaining concepts to the workshop attendees had benefited them greatly.

8.2 Professional benefits

Some undergraduates produced videos of the experiments and a website and created explanatory cartoons. The resources were used during the workshops and shared with teachers. The materials produced form a valuable portfolio for the undergraduates for their future career. They had the chance to acquire new communication skills that is useful in any field. Many undergraduates receive scholarships by the Ministry of Education of Singapore to become teachers. These activities provide opportunities to practice, discover and gradually refine their own style of teaching. Others find the possibility of a new vocation and contemplate the idea of becoming a teacher. Regardless of their post-graduation prospects, science communication is an essential part of their training as scientists. Other important leadership, teamwork and project management skills were also garnered as the volunteers were in charge of the conception and execution of projects and had to manage groups of 4 to 6 students during workshops.

8.3 Personal benefits

Lastly, some undergraduates appeared to gain much more on a personal level. The workshops were organised for mainstream schools but also families and children homes that were not familiar with science. The exposure for all parties was very meaningful and inspiring. We observed the students facing academic challenges or lacking self-confidence benefited tremendously and became empowered. The integrated science approach used in the programme also allowed the undergraduates to connect and appreciate diverse concepts in a more conducive setting with no examinations.

9. Challenges

Some undergraduates joined the programme due to passion and strong motivation to learn, teach and communicate. Some joined to add experience to their portfolio and were not always motivated. Motivation and enthusiasm, more than academic abilities, were found to be the impetus behind the programme's success. This is especially true when no academic credit was awarded. This diversity required constant guidance and supervision at all stages of the programme. Not everyone has a natural talent for communication and it has to be groomed in some. With such a broad spectrum, first timers might encounter difficulties with young children. For this it is important to encourage strong team support and cohesiveness. We observed the interactive sessions were the most appreciated and rewarding part of the programme due to the rich social and personal dimensions.

10. Conclusions

The outreach programme described here used an integrated approach that involved university staff and undergraduate students. For the undergraduates, such activities can influence them positively by complementing their academic studies. The interaction with younger students is a great platform to share what they know and to solidify their knowledge. Additionally, on a more personal basis, we believe the students gain confidence and more self-awareness through teaching, which is primordial for their personal development and future endeavours. The full impact on individual undergraduates is different depending on the student's profile; but overall clearly beneficial and worth the effort in involving them in outreach activities.

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