Molecular Gastronomy in Science Education and Science Communication at the National University of Singapore

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In this chapter, we will describe our efforts to use molecular gastronomy as a vehicle for communicating and teaching science in Singapore. We will share how to set up molecular gastronomy workshops and also the impact of these efforts on the people involved. It turns out that the benefits go beyond just sharing and teaching science.

The Project: Reaching Out with Molecular Gastronomy in Singapore

One of the characteristics of Singaporean society is its obsession with food. There are many food centres (locally referred to as 'Hawker Centres') scattered all over the country. These centres offer a variety (e.g., Chinese, Indian, Malay, Thai) of affordable food through small stalls. It is not uncommon for the denizens of Singapore to stand in long queues just to treat themselves to local favourites (e.g., chicken rice) at these hawker centres. In this sense, food also plays an essential role in gathering and bonding people.

Science Education and Science Communication

The National University of Singapore (NUS) strongly encourages efforts to improve the learning, understanding and appreciation of science both within and outside the campus. Promoting the science of local food and engaging the public through Molecular Gastronomy (This, 2009) was, therefore, an obvious choice. Molecular Gastronomy allows us to use a topic, food, that is close to everyone’s heart to demonstrate how art and science can work together (Symcox, 2013). The fact that food is relevant, accessible and adaptable to all audiences makes it an ideal vehicle for outreach. We carried out workshops centred around the science of cooking.

An Example of a Typical Workshop

To give an idea of what a typical workshop entails, we will briefly describe an event organised in 2015 to rediscover local favourites called “More Rojak, Less Rocket”. This was part of the 50th birthday celebration (SG50) of Singapore. We invited children and their parents to investigate and reinvent local favourites (Figure 102.1).

Some local delicacies we included were ice kacang (shaved ice topped up with red beans, grass jelly, agar agar, sweet corn, evaporated milk and syrups), cendol (pandan-infused dessert made of mung bean flour, palm sugar syrup and coconut milk) and bubble tea (hot or cold tea with milk and tapioca pearls). In these...
desserts, colours, consistencies and flavours paint a delicious and intricate visual and gustatory picture for the consumer. We also discussed science! We talked about polymers, hydrocolloids, and the possibilities and results of substituting starch hydrocolloids with non-starch hydrocolloids. The ingredients and utensils used were very simple and mostly inexpensive, so that the participants could pursue their experimentations back at home. A few parents asked us for some ingredients to take back home!

People and Planning

People

A key feature of the molecular gastronomy workshops was that students undertook most of the organising and planning of these efforts under the guidance of members of the academic staff. These students were volunteers from different parts of the Faculty of Science of NUS: undergraduates from various science disciplines (chemistry, life sciences, mathematics and physics), from the Special Programme in Science (SPS), and graduate students from the NUS-Australian National University (ANU) Science Communication programme (Figure 102.2). Another important partner was the Young Educators in Science (YES) programme, which organises many other outreach events throughout the year with undergraduate volunteers. This diversity of individuals added significant interdisciplinary strength to the planning and execution of our molecular gastronomy workshops. We will refer to all these individuals (students and faculty academic staff) involved in the planning as ‘facilitators’ and those attending the workshops as ‘attendees’.

Roles, Tasks and Teaching Material

The student facilitators contributed in three general ways:

1. Designing molecular gastronomy activities and experiments
2. Creating teaching material

The student facilitators met regularly to explore and brainstorm on what type of cooking experiments they could undertake and share with their audience. They would record their reflections in a journal. Some focused on the design of hands-on practicals, others on the creation of teaching material.

Some teaching materials included the design of videos or web pages. In Figure 102.3, Yu Yuebo, a graduate student from Science Communication, used analogies and visualisations to explain the concept of states of matter involved in cooking. Another student, Lim Vee Heng (from the same programme), who is also a high school chemistry teacher, went further by doing his final science communication project on how the systematic approach of science can encourage and help people cook better. For example, he designed graphics and a recipe explaining pan-fried salmon with snow peas and sweet and sour pork. He highlighted the scientific concepts behind fish sticking to the pan and how to prevent it, and the role of baking soda in the frying batter.

He took great care to focus on traditional Asian cuisine in order to be more relatable to the local audiences.

Once the student facilitators came up with molecular gastronomy experiments and teaching topics, the faculty advised on appropriate pedagogical strategies to target the content to specific audiences (e.g., young school children vs. adults) in a better way. Most students were comfortable with the scientific aspects of the culinary experiments; however, they found it more challenging to explain the culinary aspects of each experiment.

Choice of Topics Related to Molecular Gastronomy

We tried to relate the topics we chose for our workshops to specific audiences. For school children, we connected with the public school syllabus. When possible, we extended beyond the curriculum: for instance, the properties, structure and interactions...
of ingredients (water, proteins, fats and saccharides), states of matter and phase transition during cooking.

We also included sensory effects and nutrition. For example, we talked about ‘chocolate chantilly’ (This, 2006), ice cream and sorbet with dry ice. We also talked about the colour, taste and smell of teas. Another topic was the properties of hydrocolloids like agar-agar (a local favourite), which is used ubiquitously in Asian cuisine. The experiments with bubble tea (another local favourite) were probably the most popular topic, especially with young audiences.

Benefits and Impacts
Teaching Science to Workshop Attendees
We ran our molecular gastronomy workshops intending to share science with several different audiences. The participants were either school students, families (i.e., young children together with their parents) or only adults.

For school students, the impact of our workshops is similar to most informal science education activities. They get to connect science with authentic and relatable experiences (food in our case). This alignment between the science they learn at school and the workshop activities allows deeper engagement, leading to better learning and further questioning (Bennet et al., 2007; Vartiainen et al., 2013).

An interesting observation with some students was that they seem to have forgotten that you can go back to basics and experiment, discover, and learn with simple apparatus. Who knew you could learn so much from whisking chocolate and water? Anecdotally, from discussions with students, the use of simple tools sounds too trivial to them. This may be because the Singapore education system has long been adopting digital technologies in the classroom with great benefits (Tan, 2017). Many Singapore schools have access to the latest technologies (e.g., personal learning devices such as iPads) (Ang, 2020; Ministry of Education, n.d.). In such a setting, it was gratifying to the facilitators to see students not only connecting with science through cooking exploration but also engaging all their senses.

For example, while making the chocolate chantilly, they had to engage their sight to observe the gradual change in appearance of the chocolate emulsion being whisked. At the same time, they could taste the changes in the mousse. Similarly, when experimenting with bubble tea, their sense of smell was engaged when tea was brewed, and the alginate sphere topping engaged their senses of sight, taste and touch.

From the perspective of parents, these workshops allow them to discover or rediscover science together with their family. This opportunity to experiment and learn science using cooking can continue even when they are back home. For the organisers, what is essential here is to use the workshops for kindling the attendees’ interest in science through food. This can empower them to embark on a self-regulated, life-long journey of learning by exploring cooking.

Empowering Undergraduates
It might appear that those attending the workshops will gain the most from these workshops. However, it turns out that the student facilitators who plan, organise and run these events reap unintended and sometimes life-altering benefits. The motivations of the student facilitators to take part in this molecular gastronomy initiative vary from sheer curiosity to being avid cooks or to wanting to extend their educational portfolios. Regardless of their primary motivations, we noted that the student facilitators gained as much as, if not more than, the workshop attendees.

Basing our analysis on comments shared with the organisers, we can break down the gains into three different categories: academic, cultural and professional.

For one attendee, thinking of cooking allowed them to see science come alive, connecting some of what they have learned through their academic journey to real life. This is what one of them said:

How we can apply scientific concepts to food, to make it more interesting and exciting and delicious was something I came to appreciate as well. And what I also came to understand was how cooking and the execution of the scientific method were so similar. Precision, technique, and protocol are all required but innovation is not limited. The balance between freedom and method are reflected both in the scientific method and in cooking. Those have been the key personal impacts from this educational experience.
Another significant benefit was that the student facilitators began to see molecular gastronomy as having a local identity relevant to their own home culture. Here is what one of them said:

It doesn’t have to be limited to the exotic. And somehow, while using local culture, the scientific gastronomy project felt more applicable, personally. It felt more real, and felt more understandable, and much, much less foreign. And I was then able to see how I could use it with my own culture’s cooking and really think about the flavours and textures that went into it, and appreciate it.

This sentiment can be better understood by highlighting that molecular gastronomy as a discipline emerged and has developed much more in Western societies. Most literature (research or educational) is based on “Western” tastes and ingredients (Ivanovic et al., 2011; Roosth, 2013; Wang and Wang, 2016). So, although the chocolate chantilly is a very popular experiment, even in Asia, students could relate more, culturally, to experiments with bubble tea or pandan-infused dishes. One of our future objectives is to develop further educational materials with local flavours to make molecular gastronomy more relatable to a wider local community.

Another benefit to the student facilitators was related to interpersonal skills. The fact that molecular gastronomy is so interdisciplinary provided an opportunity for teaching and learning from each other. Students from different disciplines such as chemistry, life sciences, mathematics and physics had to work together to design experiments, create material, and develop communication and educational strategies around a topic on which they had no or little prior background. They had to work in a team and practise excellent communication skills to reach their objectives. They also had to become innovative and creative when engaging the different workshop attendees (e.g., children, adults).

Unfortunately, we have not yet had an opportunity to survey the workshop attendees about the impact of the workshops on their views of food and molecular gastronomy, science and culture.

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