Experiences of a New Teacher*

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This article is an attempt to put together my experiences gathered over the last six years of teaching biology. Since joining as a research faculty, I have learnt that teaching is a tough but extremely rewarding (both scientifically and emotionally) activity when done the right way. As research institutions across India are increasingly focused on imparting quality education, I consider it imperative that every researcher aims to be a good teacher. I have been striving to be one, but at this point, I am far from it. In this article, I share my opinions based on my personal experiences. These experiences have helped me improve my teaching, as well as, connect better with the students—in the class, as well as, in the laboratory.

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1. Laboratory Teaching Versus Classroom Teaching

I consider teaching to be a vital aspect of research, and I believe that every researcher should aspire to be a good teacher. This might sound simple, but the act of explaining new information to students, who are not well versed with it can be challenging. I realized this after taking up my assignment as an independent researcher. In principle, teaching in a laboratory to graduate students at the bench should not be different from teaching a classroom full of students. In practice, this is not the case. The former involves talking to your students about the subject one has expertise. This is where we excel since, as researchers, we are well versed in our research domain. We have thought about the subject in different ways, and hence explaining it to a newbie is a relatively easy job.

Classroom teaching, on the other hand, is often not about our research domain. It also involves dealing with a large number of

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active minds working on the same problem at a given point of time. I like to think that clarity of expression on the part of the teacher promotes clarity of concept in student minds, empowering them to think about the concepts and leading to more questions for the teacher to handle, which in turn could be challenging. As researchers, we are often egoistic about what we know. Hence a good classroom question could sometimes leave us stumped. When I began my classroom teaching, I was a bit reluctant to say, "I do not know the answer at this point. However, I will read more about it and get back to you." It took me a while to gather the courage to make the above statement in my class in response to the questions that stumped me. Every time I do it now, it forces me to go back and read about it after the class and address it the first thing in my next class. This has taken away a lot of anxiety out of my teaching.

Having had no formal classroom teaching experience, I was asked to teach a subject that had failed to fascinate me as a student. I was directed to teach synthesis and breakdown of biomolecules (referred to as 'metabolism') to a class of about 30 students, who were a mixture of PhD (mostly Master's in biology) and integrated PhD (mostly Bachelor's in biology) students.

As I began to teach a part of this 3-credit course, it dawned on me that many students found 'biochemical pathways' boring. My classes were listless, and I was finding teaching 'difficult'. Some thinking helped me realize that I cannot re-invent the pathways to make them interesting, but could certainly change the context of the class to focus on the regulation of pathways and their connections to other cellular processes. For example, key gluconeogenic enzyme, fructose, 1-6 bisphophatase (FBP-1) was recently reported to perform a moonlighting[1] (a non-canonical) role in the cell nucleus (independent of its catalytic activity) antagonizing renal cell carcinoma progression [1]. This report turned out to be an excellent tool for me to discuss in the class because such a discussion invariably involved first learning about the canonical role of FBP-1 in gluconeogenesis. I have discussed this article every year since 2015 in my course. My perception over the years is that

[1] Refers to the phenomenon by which a protein can perform more than one function.

I have observed a clear difference in the enthusiasm of students in terms of participation in the classroom discussions before and after the discussion of this article. Students still learn biochemical pathways in my class but the eventual aim is to understand a recent regulatory aspect of the pathway or a novel role of an 'old' enzyme. I have added newer articles to keep the course content updated with recent literature. In 2017, I incorporated another article as a part of teaching glycolysis. This article reported the association of glycolytic enzymes into glycolytic bodies (G bodies), and the importance of this association during hypoxia response and tumorigenesis [2]. The article focuses on the exciting new G-bodies and its significance. However, while trying to understand the article, students invariably become well versed with the process of glycolysis. Perhaps a similar approach can be applied to other topics to make both the teaching and learning process more interesting. It can be argued that the above approach could dilute the significance of the specific metabolic pathway that I am supposed to teach them. However, I perceive that students appreciate metabolism more when they are able to realize that the pathways and cycles are invariably connected to other cellular processes.

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2. Scientific Videos can be a Wonderful Teaching Aid

Despite its usefulness being debated, the use of PowerPoint presentations in classroom teaching is commonplace [3, 4]. I find PowerPoint presentations an effective way of communicating my thought process to the students. However, PowerPoint is not an end-all-be-all for teaching. I learned this as I was preparing for a new teaching assignment.

A colleague of mine came up with the idea of offering a new course on 'molecular basis of ageing' and (luckily for me) wanted me to be a part of it. I decided that instead of being part of a course on 'ageing', I could add and teach another related component on 'how some animals regenerate', an addition that would make the course more interesting. Thankfully, my colleague agreed and we started offering a course on 'molecular basis of ageing

and regeneration'. My research interests in the lab did not overlap with studying 'regeneration' in any manner, but I was fascinated by it. I started preparing for the first batch of students and soon realized that there was little in standard biology textbooks about regeneration. The majority of 50-odd students crediting the course turned out to be undergraduate students (2nd or 3rd year biology majors) as opposed to graduate students who are either regular or integrated PhD students with Masters or Bachelors degree, respectively in some branch of biology. This was unexpected as it was an advanced course and we had anticipated that the majority of students opting for it would be graduate students. Therefore, I prepared to explain to undergraduate students an advanced course that was minimally covered in textbooks. I had decided to focus my course on hydra, planaria, salamander, and zebrafish as these model systems have contributed a lot to our current understanding of regeneration. While searching the literature about regeneration, looking for a way to introduce regeneration and the above model organisms in my first class, I came across some videos about these animals (hydra, planaria, and salamander). One such video [5] is a short interview of Dr Alejandro Sanchez-Alvarado, who has almost single-handedly established planaria as a 'poster animal' for studying regeneration. He explains along with short movies of planaria, how this animal has been instrumental in shaping our understanding of regeneration and stem cell biology. There are similar videos about salamander [6] and hydra [7]. I decided to intersperse my first 2–3 classes with these videos. The impact of the initial classes was evident. It generated curiosity among the students for the remaining classes. Over the years, the first few classes of this course have served as a curtain-raiser that piques student's interest in the phenomenon of regeneration. The heightened curiosity makes them more receptive to understanding the complicated mechanistic details that follow in the subsequent classes. The point I am making here is simple. There are numerous teaching aids like videos and podcasts that are freely available to most of us. The challenge often is to find the aid that best fits our subject and style of teaching.

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An alternate version of this approach would be to prepare a video lecture (or online lecture) for a given topic and let it do all the teaching every year in the classroom. This is practiced by some colleges and universities. The idea that such a form of teaching will one day replace live face-to-face teaching in the classroom is realistic. However, studies do indicate that students can suffer decrement in grades while undertaking online courses as compared to live face-to-face courses [8, 9]. At this point, I personally support live face-to-face teaching by teachers who are open to using videos merely as a teaching aid. I opine based on my perception that the quality of teacher-student interaction (an integral part of learning experience) attained in live face-to-face teaching is tough to replicate in online teaching. Having said that, given the current pandemic I prepared myself for my first ever online teaching experience in the August semester.

3. Students as Teachers in the Classroom

The learning process has been suggested [10] to comprise three steps: 1) actively seeking information, 2) arranging it logically and coherently, and 3) explaining it to others. I realized early on when I started teaching that in my classes, I did not put enough emphasis on letting the students go through the above process regularly except during exams. It was not surprising that I benefitted the most from the teaching routine and not as much my students!

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I currently teach three different courses in an academic year. While teaching, I try to relate the textbook content with recent advances in the literature. In the past six years, a pattern has emerged in my approach to teaching. After every 3–4 classes of conventional classroom teaching about the basics, I discuss relevant recent research advances. Initially, I used to discuss the research article by going through some important figures to highlight the importance and relevance of the research. Over a period of time, this exercise has evolved to be completely driven by the students during which I become a facilitator for the exchange of ideas. To make it inclu-

sive, the class is divided into 7–8 learning groups of 3–4 students each and assigned a certain portion of the paper. For example, group 1 explains the motivation and background of the article, group 2 explains *Figure* 1, group 3 explains *Figure* 2, and so on. The last group would focus on overall critique and possible future directions of the article. Each group presents their part in 10–12 minutes. The presenter for a given group is selected by drawing the names just before the presentation, and this ensures that all the students in the group put in an effort to prepare. This activity requires them to get together as a group to 1) gather the information, 2) assimilate and put it together in a coherent format, and 3) explain the idea to their peers during the class. Interestingly 1) and 2) happen outside the class. Such a group-learning activity pushes the students to go through the three key steps of learning process described above. Most of the students have embraced and appreciated this activity as they relish being in charge as a 'teacher' while trying to convey the concept. I have learned this based on their oral feedback in the class after the presentations. Sometimes this is also documented in the instructor's feedback provided by them at the end of the year.

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An obvious caveat of this approach is that a group might focus only on the part of the article they need to present defeating the purpose of such a group learning activity. I have learned to overcome this issue to some extent by assessing each group by questions and discussions they bring up while other groups are presenting. This encourages all the groups to read the entire article carefully. Not surprisingly, the groups in the audience are very much motivated to question and discuss with the presenting group since the 'teacher' is their own classmate, and hence the inhibition associated with questioning your teacher is reduced.

4. Making Students Aware of the History of Science

Although the importance of teaching students the history of science has been documented [11] it took me some time to realize the importance of this in my metabolism classes. While trying

to answer a student's question regarding how each reaction in the pathway of glycolysis was identified, I realized that I should incorporate the history of how metabolic pathways were discovered. It prompted me to include the information about how experiments performed by Eduard Buchner using yeast 'juice' and sucrose led to the seminal accidental observation that metabolism is as much chemistry as it was considered biology. Personal experience has taught me that instead of just explaining the concept to the students if I take them through the experiments that led to it, they are more receptive to the idea. I began this exercise by explaining classical research articles that led to the genesis of a given concept. For example, the history of the one gene-one enzyme hypothesis that involved Beadle deciding to use the fungus *Neurospora*. The hypothesis states that mutants that may be defective in growing on specific media owing to differences in their nutritional needs can be induced (Beadle and Tatum, 1941), leading to the emergence of biochemical genetics. While discussing this, I make sure to impress upon them that similar simple and inexpensive experimental screens using specific model systems can be designed even today to address complex biological problems. There is yet another benefit of making students aware of the history of science. It makes them realize the abundance of resources that are available to them to perform experiments as compared to what was available to the scientists who made the pathbreaking seminal discoveries. This may help them realise that impactful research need not always require cutting-edge technology and a copious amount of resources.

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Initially, the idea of discussing the history of science was to simply explain the experiments that led to the concept. Over the past couple of years, it has been modified to also include a component on 'how to read a research article'. Since the articles are old, the techniques are simpler and hence easier to comprehend for the students. In the beginning, I present one such article to the class explaining to them the importance of the question that was addressed in the article. I then go through each figure and explain to them the author's point of view and an alternative point-

of-view, which often would be a different interpretation of the presented experimental data. This would lead them to ask the question about what else the authors could have done to ensure that their interpretation is the correct one, resulting in the design of new experiments. The aim is to convey to the students 'why' and 'how' the chosen article made a difference to the field. Subsequently, the class presents another such article using the same group presentation-based approach described earlier. The difference here is that they are instructed to focus more on coming up with their own interpretation of the data while understanding the author's viewpoint. This encourages them to come up with alternative hypotheses and new experiments to test. I extend this teaching/training to the course examinations also where a quarter of questions test their ability to interpret the given data and come up with possible experimental strategies for articles discussed in the class during the course.

Overall, past six years of teaching has been a fantastic experience for me. I am not sure how much I have learned to teach. But, I am certain that teaching is a great way of learning when done the right way.

Overall, past six years of teaching has been a fantastic experience for me. I am not sure how much I have learned to teach. But, I am certain that teaching is a great way of learning when done the right way. I hope my perception of teaching presented in this article will be helpful to other teachers who are trying to figure out how to go about teaching when they begin. The idea of this article is also to get feedback from the readers (both students and teachers) that will help me improve both as a teacher and as a researcher.

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Suggested Reading

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