Enhancing Physics Learning through good demonstrations

Teacher presented with the Award

Mr LEE Chuet-kwan
(Years of teaching : 35 years)

School

St. Mary's Canossian College

Subject taught

Physics (S3-6)

Teaching Philosophy

"Combining traditional and innovative teaching methods with the use of appropriate physics demonstrations; consolidating the basic foundation but leaving room to develop students' creativity and innovation."

Interview with the Teacher

"I've always wanted to be a scientist when I was a student," says Mr LEE, "When I was in the university, however, I realised I was more inclined to training and inspiring future scientists. That is why I am dedicated to passing on to my students not only knowledge, but also the passion and enthusiasm for science."

"Will the force be larger, smaller, or the same, or it cannot be determined? "

The majority of the class raises their hands to show their answers gingerly, peeking at one another for reassurance. With a seemingly mischievous smile, Mr LEE announces the correct answer. The whole class bursts into discussion, trying to figure out an explanation. When Mr LEE explains the theory behind afterwards, every student suddenly sees the light and is genuinely awed.

Interaction as a crucial element

Similar situations happen several times in every single Physics lesson. "I love to ask students such kinds of questions where every option seems to be possible. This provokes thinking. They will have to integrate what they observe in daily life with the newly learnt knowledge before they make the decision," says Mr LEE. Chances are, the majority of the class will choose the incorrect option, falling into Mr LEE's "trap". This is exactly the perfect timing that he is looking for.

▲Questions focusing on key concepts were asked to promote student thinking

Students pay more attention and their memory lasts longer if the explanation comes after they have all answered wrongly. This also allows the teacher to understand which parts the students are more confused about and how their misconceptions can be clarified.

"I try to add some interactive elements in the lessons to make learning more interesting. At the same time, though, I do not abandon the traditional way of teaching by giving students assignments and quizzes regularly so as to consolidate their foundations."

▲"Beauty and the Weight" experiment

A wonderland laboratory

Assignments, quizzes and challenging Q&A sessions are all useful teaching tools, but Mr LEE's "secret weapon", and the most anticipated part by the students, is certainly the laboratory demonstrations.

The Physics Laboratory at St. Mary's Canossian College is quite different from those in other schools. Of course there is the usual equipment for physics learning, but there are also objects that people would not expect to normally find in a secondary school laboratory — toy cars, exercise bikes, even different kinds of cooking ware! There is physics in almost everything in the world. Mr LEE likes to modify things that can easily be found in daily lives into teaching aids to teach students the physics principles behind.

Every little thing in the laboratory, with Mr LEE's design, can be transformed into interesting devices that aid student learning. An example is a lead ball hanging from the ceiling near the blackboard. In his "Beauty and the Weight" experiment, the lead ball is raised and then released with a student standing

▲Students are observing with interest.

nearby. Other students cannot help but feel worried for their fellow classmate — but of course, as we can all expect, the ball will not even touch the student. It is through this thrilling experiment that Mr LEE implants the idea of "conservation of energy" into his students' minds.

Turn around to the other side of the laboratory and you find a corner named "St. Mary's Kitchen". Indeed, this is a laboratory, not a place for cookery lesson. However, Mr LEE's intention is to arouse girls' interest in physics by illustrating some physics principles through kitchen ware. Vacuum cookers and vacuum flasks are used to explain heat transfer. The microwave oven is turned on to "toast" a fluorescent light bulb so that a gas discharge can be produced. There is still much more to be discovered.

Designing his own teaching aids

"Most of this kitchen ware belongs to my wife," Mr LEE explains, "I like to modify common objects in daily life into useful teaching aids myself. This is not only cost-effective, but can also be tailor-made in a way that I think is the best to aid student understanding." Going around the laboratory, one can see many interesting teaching aids developed from common household appliances. For example, the multi-purpose wireless visualiser which consists of a small camera can project demonstrations on an old TV; a pair of loudspeakers is modified to show effects of electromagnetic induction, etc.

◀The "witch's magical pot" - previously a prop from a school drama, it now has become a teaching aid.

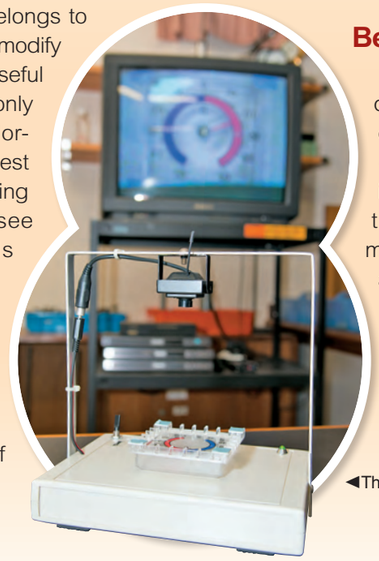
Beyond the Physics classroom

Mr LEE likes to encourage students to participate in competitions so as to gain experience and apply what they have learnt. He always lends his apparatus to the students and gives guidance to them throughout the whole process, hoping that they can achieve the best, not only in terms of the results but also in terms of their knowledge.

Additionally, Mr LEE is actively involved in the school's famous annual dramas, preparing the electrical installations and designing physics-related props. These props often amaze the audience and add much colour to the drama performance. Each year, these props become new members of the apparatus in the Physics Laboratory. For example, there is a pot that continuously produces mist from water. This pot was originally a pot for preparing magical medicine by a witch in a drama! Now this pot, together with the mist produced, is used to demonstrate the reflection of light. These props amuse the audience, while also stimulate students' creativity, showing them that science can be applied in different occasions.

Be the role-model to inspire

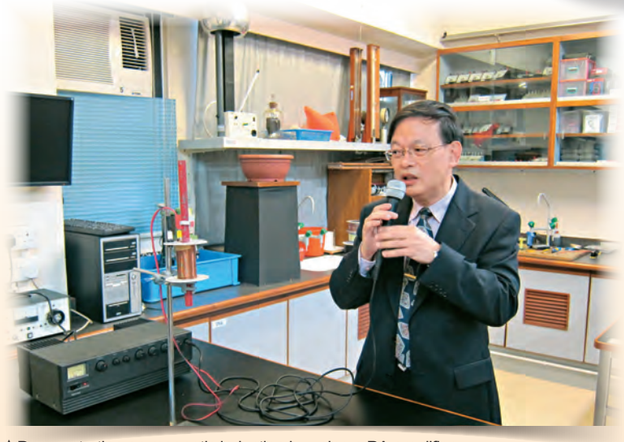
As Mr LEE's retirement draws near, he is very busy writing detailed instruction manuals for demonstration set-ups he has invented during his career. "I hope that my successor knows how to make good use of all these set-ups after my retirement so that students in the future can still benefit from them and be as interested in Physics as I am." says Mr LEE.



◀The set-up of the Wireless Visualiser

Teacher's Sharing

In recent years, the learning attitude of students has changed a lot. Experience tells us that it is important to convince students that Physics is interesting before any real learning can take place. In addition, there is also great learner diversity in a class. To look after the average students without neglecting the more able ones, I have adopted the following teaching strategies:



▲Demonstration on magnetic induction by using a PA amplifier

Tailor-made apparatus to improve Physics demonstration

Since the launching of the New Senior Secondary (NSS) curriculum, catering for the diverse abilities of students has become a great challenge to me. I also consider engaging students in interesting learning experiences in Physics an important part of my job. To me, the learning of Physics can be roughly divided into two stages:

- Acquisition of basic knowledge; and
- Application and further development of the basic knowledge.

For stage one, students can acquire basic knowledge quite effectively through lessons, experiments, problem-solving, Q&A and group discussions. For stage two, students can exercise their innovation and creativities almost unlimitedly through projects or science competitions. To leave more time for the students to create or make innovations, it is essential for them to do well effectively in stage one, that is, to understand as much as possible "how things work".

A well-made Physics demonstration is very good in explaining "how things work". Visual examples of abstract concepts aid immeasurably in their mastery. Physics demonstrations also provide an opportunity to illustrate the scientific method and to help students relate experimental observation to scientific theory. It is important that students in the back row, as well as the students in the front row, could see and hear what is going on at the same time so that whole class discussion could be carried out more efficiently. However, most of the existing apparatus and equipment in the laboratory are not suitable for whole class demonstrations. We need teaching aids that can appeal to a big class at once. Since nothing in the market serves the purpose, I challenged myself to making my own teaching aids.

In tailor-making demonstration kits of my own, efficiency is one of my great concerns. I have made necessary alteration in the laboratory so that all of the necessary facilities are close at hand so as to avoid undue confusion. Since the whole class is watching the demonstration at the same time, I can discuss the problem and the Physics principles to be examined in detail and sometimes I can even ask students to suggest the next step or the next piece of apparatus required. Thus the experiment arrangement takes form under student observation and, in part, under student suggestions.

Since the inspirational value of experiments depends so much upon the manner in which they are presented, I have also given much thought on the planning and presentation of the demonstrations as well as the timing at which to perform the demonstration. To show it too soon is to find a class unprepared to appreciate its importance; to delay it by prolonged explanation is to diminish its effectiveness. My students enjoyed the demonstrations and this contributed both to their understanding and their performance in experimental work.

►Mini-project on "Keeping an egg warm"

Participation in science investigations and competitions

To help students develop skills in science investigations, I have introduced a few mini-projects that could be accomplished within lesson time in S3. In S4 and S5, students are encouraged to participate in science investigations and different science competitions so as to put what they have learnt into practice. Since the launching of the NSS curriculum, universities and educational organisations have arranged many competitions. I have always been invited by students to be advisers of these competitions and many of them have won awards of various kinds. I am happy to see that students become more engaged and have learnt how to work in groups after they have participated in the competitions.

Promotion of self-directed learning

- Self-learning through the e-class - students are given a minimal number of written assignments after each lesson and they are expected to do, to check and to correct this minimal number of written work with the help of answers uploaded on the e-class before they hand in their work for inspection. This practice can ensure that every student has acquired the basic knowledge on the topic. For the more able students, they can further choose whatever they wish for further practice from the e-class especially before the examinations.
- Small quiz for each lesson - to ensure that students are doing their work themselves; small quizzes are arranged for nearly every lesson. The results of the quizzes are taken as part of the students' continuous assessment.
- The Question & Answer (Q&A) session - to ensure that students have learnt the topics well, I have prepared a lot of questions to challenge them, some of which requires higher-order thinking and deep understanding of the Physics principles. In every lesson, there is a Q&A session after the quiz. Students are encouraged to answer. Correct answers will be awarded with merits and prizes would be given out at the end of each term to the student who has accumulated the most merits. Students become more engaged and enjoy the Q&A sessions.

Conclusion

"To combine the traditional and new teaching strategies together with appropriate demonstration aids; to consolidate the basic foundation but leave room for creativity and innovation" is what I believe to be the most effective way of teaching Physics. I have a dream - "Making the Physics Laboratory as a whole a big teaching and demonstration machine." I wish my dream can come true one day.

Assessment Summary

Enhancing Physics learning through developing effective teaching aids for demonstrations

▲St. Mary's Kitchen in the Physics Laboratory

Mr LEE Chuet-kwan is a dedicated and charismatic teacher, who has very good command of the subject matter and teaching skills. He is devoted to developing teaching aids and setting up an environment conducive to student learning. He is resourceful and keen on exploring strategies to motivate and engage students to think.

Mr LEE is a reflective practitioner. He pursues self-improvement continuously. He produces exemplary teaching aids and laboratory equipment to facilitate whole class demonstration and enhance the understanding of Physics. He has collected a number of household appliances and cook ware in the laboratory to help him explain Physics concepts and the working principles of the devices to his students. Every corner of the laboratory is carefully designed to make learning and teaching effective and efficient.

Mr LEE demonstrated very good classroom skills, attended to students' learning needs and performance and maintained a safe, inspiring and harmonious learning environment. He is always well-prepared for his lessons and he could always link the science concepts he is teaching to students' everyday life. He is able to focus his questions on the key subject concepts of the topic and frame them to promote student thinking. Students participate actively in discussions and they work together to share and develop knowledge. They enjoy his lessons because he is kind and humorous, and he always uses eye-opening tools and equipment to teach. He has won students' love and respect.

In adapting teaching and assessment strategies to help students learn, Mr LEE took into consideration the characteristics of his students and their learning diversity. Graded tasks were incorporated on the e-class system with a "platform and stair" strategy to help students consolidate their learning before making a step forward. Mr LEE also provided multifarious scenarios for students to apply their science knowledge. Students were encouraged to participate in different science competitions through which they became more engaged in learning and learnt to work in groups.

Mr LEE also demonstrated curriculum leadership in strengthening links between Physics and Drama education in his school. He had contributed to the production of special sound and visual effects for the school drama, helping to fascinate and appeal to the audience. He also trained up students to operate lighting and sound equipment, helping them to put into practice what they had learnt in Physics. These Audio-Visual Prefects also assisted in the provision of AV services for other school activities.

Way of Obtaining Information of the Teaching Practice

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http://www.smcc-canossian.org

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