Clockwise from above left: Carl E. Wieman (Stanford University), John Rogers (Phillips Academy Andover), Leslie Medema (Green School Bali), and Michael Schratz (University of Innsbruck).

Lindau Nobel Laureate Meetings

Don‘t lecture me!

A discussion of active learning with Nobel laureate Carl Wieman

By Wolfgang Huang

The Lindau Nobel Laureate Meetings bring together about 600 excellent young scientists and 30–40 Nobel laureates every year. Traditionally, every Nobel laureate may give a lecture on a topic of his or her choice. There are, however, also very many occasions for small group discussions and social interaction. We asked all Nobel laureates for ideas on how to improve the programme, and Carl E. Wieman made the most radical suggestion: Get rid of all lectures. Next year, more than 60 Nobel laureates will come to Lindau – and none of them should be allowed to give a lecture?

This idea of Wieman can be easily understood in the context of the decades of research that he has undertaken into how to teach (physics) most effectively. Some of the most eye-catching results were published in the seminal Science journal article ‘Improved learning in a large-enrollment physics class’ (Deslauriers, L., Schelew, E. & Wieman, C. *Science* 332, 862-864 (2011)).

So how does active learning work – and is it really better than currently used methods? What are its strengths, what are its weaknesses? To discuss these questions, Carl E. Wieman and several education practitioners and experts met in Lindau during the 69th Lindau Nobel Laureate Meeting. The results are available as a video – see the link at the end of this article.

The active learning approach

Carl Wieman is quick to point out that he neither invented active learning nor has he developed a special ‘Wieman method’. Rather, the technique is used by several hundred people across the world and it has been described in a large number of studies and publications. The main steps and components of active learning are shown in the box on the opposite page.

Simply put, the idea behind active learning is that the brain needs to exercise continuously to form new neural connections, which strengthen decision-making and in doing so rewire the brain. Passively listening to lectures (maybe even while being distracted by your smartphone, chatting with colleagues, or the lecturer’s anecdotes) does not help the brain to exercise. Actively thinking about right or wrong explanations and paths to follow does exercise the brain.

> *This method is better for all students with a human brain.*
>
> Carl E. Wieman

In science and engineering fields, decisions to be exercised and made are usually: What concepts and models are relevant? What information is relevant, irrelevant or needed? What approximations are appropriate? What method(s) can be used to pursue potential solutions? What criteria can be used to test results?

But Wieman also claims that active learning works equally well in non-STEM disciplines, where common questions

include the following: What is worthwhile scholarly work? What is valid information? What are suitable arguments by which to arrive at conclusions from basic facts? What are appropriate forms of presentation of work?

Active learning in the real world

Active learning methods have been implemented in various departments and courses, for instance, in the Science Education Initiative headed by Wieman at the University of British Columbia, Canada. The vast majority of active learning cases have involved implementation at the (undergraduate) university level in the United States – so the obvious questions are a) Is the approach applicable to other levels, and b) Is it transferable to other countries and cultures?

Wieman tells the anecdote of how he once explained his method at the University of Tokyo, and all faculty members told him that this would never work in Japan because of cultural differences. However, when he was talking directly to and with the students they very actively engaged in the discussion and did not hesitate at all to engage in active learning. It seems that even though teaching practices may vary widely around the world, learning may be more universal – although this subject has not yet been studied intensively. "It is all about changing the norms of the classroom," concludes Wieman.

As for earlier stages of education, such as kindergarten or elementary school, he admits that again not a lot of research data are available and that active learning definitely becomes more difficult to measure because there are many more factors in play and settings are not as controllable as those in a university setting. The cognitive and neural mechanisms of active learning should, however, apply equally to all ages in principle.

John Rogers, dean of studies at Phillips Academy Andover, USA, notes that some version of active learning is absolutely the norm at institutions like the one he is teaching at, and teachers no longer just practice lecture-style instruction and set tests. But is that also the norm at public schools and regular universities? In any case, Carl Wieman claims that it is not a question of money. Active learning requires some extra training for the teachers, but does not cost more money or require more time than traditional teaching. It also works with large class sizes up to several hundred students. Further, all educators who have been trained in active learning prefer the method to their previous approach.

Leslie Medema, head of the Green School in Bali, also has a lot of practical experience with active learning. At her institution, teachers and students jointly decide what and how they are learning. But she reminds us that not all students are the same, and that some are more introvert than others and need other ways of being taught. "For a majority of students, active learning is probably most powerful, but we can't forget about those of us who sat in that back row", says Medema.

Evaluation of teaching

"The quality of teaching is not something that university administrators are rewarded for and correspondingly know or care about. If they improved the quality of teaching by 100% and in the process reduced the amount of research funding and publications by 1%, they would be penalized, since the latter is carefully measured and compared across institutions, while the former is never measured", says Carl Wieman (Westervelt, E. "A Nobel Laureate's Education Plea: Revolutionize Teaching" www.npr.org (2016)).

Right now, the evaluation of teaching is extremely, to put it diplomatically, terrible.

Carl E. Wieman

"Without a good assessment, we can't really measure if we are doing what we are trying to do," adds John Rogers.

But Michael Schratz, professor of education at Innsbruck University, Austria, emphasises another point: "If you only use evaluation sheets, what evidence is that? It is an immediate impression, but it is not about the sustainability of knowledge, and this is what matters." Carl Wieman agrees because he has done some research spanning a two-year period (where students taught with active learning methods still perform better). However, studying the long-term effects of teaching methods is very complicated, and therefore has not yet been carried out systematically with regards to active learning.

What we need to learn has dramatically changed over the past couple of hundred years, from algebra and writing to very complex and extensive topics that are currently taught at universities. The question remains: Why have teaching methods not changed accordingly to adapt to this new complexity?

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ACTIVE LEARNING 101

1
Advance reading

Students are given some reading assignments ahead to ensure a basic understanding of the topic and terminology. Alternatively, a class may begin with a very short introduction.

2
Initial question or challenge

Next, students are given a (solvable) question or challenge that they need to think about or solve themselves, thereby activating and training their "brain muscles".

3
Vote

Students are then asked to vote on the correct answer, using clicker devices or smartphones. The instructor can see the results.

4
Discussion among peers

The answers given are then discussed for several minutes in small groups. Students have to explain how they voted and justify their answers. Their peers provide feedback. The instructor would walk around, listen to some of the discussions to get a feeling for how the discussion is going and also provide feedback.

5 & 6
Revote & show results

Students then vote again, and the results are shown.

7
Discussion

In the following discussion, the instructor responds to questions and explains right and wrong approaches (including why they are right or wrong).

Three videos are available on active learning in the Lindau Mediatheque or at **www.lindau-nobel.org/al/**

Don't Lecture Me

Taking a Scientific Approach to Physics Teaching and Learning

The Future of Education in Sciences