

The Quantum Confusion : what to teach?

Standing in our ancestor's future, I reflect upon what would have transpired in a FQXi essay in the 1600's. How did "that" humanity steer "this" future we are standing in? How did science and technology become so separated by a chasm? When did Physics of the real become a "luxury" of a handful? We may still be stuck in economic poverty without finding a way out of it. But we are also blind enough to dig our own grave, big enough to eat up our road ahead. So our job, I believe is to steer away from digging such a hole, thus steering us away from a dystopic future to a motivated one. And so we come to the next question. How do we achieve that? Well, for starters, let us focus on the most staggering ideas our world has come up with: Quantum Information, The standard model of particle physics, Gravity as the very space and time fabric, and the search for a quantum theory of gravity. But what is the percentage of people in this world who are aware of and understand the limitations and successes of these theories? If I may make an educated guess, I would fix it to less than 1%. And with this my friends, we enter the world of the intelligentsia.

If we go down the history of the ages, there have been times when great theories were propounded, Zero was invented, Newton gave his laws of motion and Kepler gave his laws of planetary motion, electricity and magnetism were unified and using all these, huge technological advancements were made. The general public knows Newton and how he came up with his theory of gravitation. The general public knows Einstein and knows that he is God. And what happened after that? Quantum Mechanics came into play and we thought we understood it and then came relativity and we said, yes, okay, I can deal with that. But soon, we ran into singularities and infinities and we started facing blank walls. In order to fix our ignorances, we started propounding theory after theory, which no one understands fully. The theories are not even understood totally by the scientific community let alone by the general public. It cannot be harnessed into technology as anyone who has not had a graduate degree cannot have a hope of harnessing the mystical powers. The creamy layer and the common mass has never been so distanced as it is now and the distance is nowhere so vast as it is in physics. When we are ignoring this, we are ignoring 99% of the brain power on this planet. Small questions are ignored and we talk in Jargon making sure that the world feels even more alienated.

To make the idea that I am proposing more accessible, let me give you some concrete examples to draw a clear picture of what I am hinting at. Today, in the world where superconductors are built and optical instruments are fast being changed into better by utilization of quantum phenomenon, where two level systems and tunneling and quantum computation is being utilized in instrumentation, in the world where we are building quantum computers, the syllabus till higher secondary is woefully lagging. We are still being taught the same classical phenomenon till Newton's time. I do understand and respect that the world we see is highly classical and so we deserve to learn the mathematics and techniques required for this world. But we have also

removed the veil of classicality as an absolute phenomenon from the eyes of the intelligentsia, so why not from the public. There is a lot of redundancy in the present syllabus that we would be okay not knowing about. Or maybe we could specialize in aspects of classical mechanics later on during graduation.

What I propose is that we teach quantum mechanics at the school level from the very foundation, which will allow children to grow up familiarized with the techniques and mathematics. The job is not to remove classical mechanics from the syllabus but teach both quantum and classical as a wholesome package. Now my worthy opponents and critiques might argue that we only understand what we see around us, so how would we describe and make a child understand the basic postulates of quantum mechanics? To counter this argument, let me present forth another example. When we learn classical mechanics, we have the idea that all things commute. Now when we introduce non-commuting objects in quantum mechanics and go to operator algebra, how would a child understand this foreign concept? This prompts us to provide the example of matrix multiplication and remind them that matrices do not commute over multiplication. And then we have simplified life and go ahead with our calculations.

What if we introduce matrix multiplication right after 5th or 6th grade in school and then we introduce quantum concepts. This will allow the general public around the world to come into contact with at-least the basics behind today's cut throat research topics. More awareness implies more discussions, which in turn imply increase in the number of ideas which in turn implies that we will discover the truth behind nature's mysteries faster. Now, we realize that the proverb "too many cooks spoil the broth" is not applicable here.

There can be other arguments against the present proposal such as the ones one of my good friend was able to point out. 1. In the times when the world is talking about unburdening school children, I am talking of increasing their work load. 2. All the classical mechanics is needed as a primer to understand and carry out the complicated mathematics of quantum mechanics. 3. The soft mental condition of school children will make it hard on them to learn such hi-fi concepts.

I will take a minute here to counter each of the above points and convince the reader to the contrary. 1. Academic burden depends on the amount of material in their syllabus. Now what I am proposing here is changing a vast amount of the syllabus in keeping with modern times and removing redundancy. Thus, it will not add to the burden. 2. All of classical mechanics is not really necessary as a primer to quantum mechanics as QM is a new language in itself. It is based on completely different initial assumptions. Moreover, the mathematics and concepts of QM while foreign to the mind after rigorous belief in all classical phenomena, will not be so much foreign, if children are used to it since their wee ages. Along with this, we all will agree that the basic algebra of quantum mechanics is even simpler than many of classical mechanics calculations. 3. Moving on to the next point, as my friend pointed out later, that such a statement is indeed an insult to the minds of the school children. Since studies have proven that most of the

mental growth takes place in the school going age-group, I believe that this is the right age to mold your minds to even unconventional ideas as the mind will be more open and accepting.

Last but not the least, the introduction of quantum mechanics into the school syllabus will open and change the overall outlook of the general public motivating them to follow and participate in scientific discussions all around the world. A more aware world, I believe will be a healthier world scientifically. The crux of the matter remains here, that sometime “Ignorance is not bliss, it is oblivion”.

References:

The author has utilized her knowledge from basic undergraduate texts of classical and quantum mechanics and her own ideas to put forth the proposal.