

*The Second Prof H K Barua Memorial
Lecture*

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**Challenges of Providing Higher Education in
the 21st century: A personal account**

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It is indeed a great honor for me to be invited to deliver the second Prof H K Barua Memorial lecture. My admiration and respect for the Late Lokaopriya Gopinath Bordolai, the first Prime Minister of undivided Assam has gone up after knowing that he was responsible to attract Prof H K Barua, (PhD Cantab), the then Professor of Rangoon University to come and establish the first department of Botany on 26th January, 1948, which also happens to be the foundation day of Gauhati University. I would be failing in my duty if I do not acknowledge the visionary parents and freedom fighter to have instilled in Prof H K Barua to serve Assam in the field of education. How fortunate were the students who were taught by such an eminent academic figure who came back from greener pastures and served the post independent youth of Assam rather than staying back at Cambridge or Calcutta. I was also fortunate to have been taught by Prof S C Bhattacharya a PhD from Cambridge University. Professors like H K Barua and S C Bhattacharya taught us the basic responsibility to educate the needy rather than serve those who are well educated!

A university teacher's role is like a *STEM CELL*. A *stem cell* has the unique property of not only self renewal but also to differentiate. *Self renewal* in this context means producing another teacher and thereby preserving a small but effective population of teachers. *Differentiation* on the other hand means producing a large population of doctors, engineers, businessmen, sports men and women, musicians etc.

The blood stem cell divides into two cells one of which retains the original property and the other can multiply and differentiate. Differentiated stem cells are red blood cells, T cells, B cells, platelets, neutrophils, macrophages, eosinophils and basophiles. Thus the blood stem cell produces cells which not only provide oxygen to various parts of the cell but also protect the cell from internal and external infection. Unfortunately there are few teachers who have the qualities of a true *stem cell*.

The real challenge of 21st century is to produce quality students to perform various roles and functions. Just like we are not clear how to isolate and identify a true Stem Cell, in the 21st century we do not know what kind of effective teacher we are looking for? An effective teacher can be bench marked by the number of students they have produced by the criteria of Prof Francois Jacob, “to my surprise, those who achieved the unexpected and invented the possible were not simply men of learning and method. More than anything else, they were creatures of amazing vision. Those in the front ranks displayed exotic blends of passion and indifference, of rigor and whimsy, of naiveté and the will power, in a triumph of individuality.”

Sir J. J. Thomson produced several brilliant students of which 8 went on to win Nobel Prize. His student Sir Rutherford produced outstanding students and 13 of them went on to win Nobel Prize.

Prof Linus Pauling went on to win two Nobel Prizes, one for chemistry and another for Peace and inspired not only chemists and physicists but also common man at large. He stood like a rock in his fight for nuclear disarmament in spite of being dismissed from the faculty of the prestigious Caltech University in USA. Dr Fredrick Sanger won two Nobel prizes for sequencing the first protein and the first RNA and DNA and revolutionized the way we teach biology in the 21st century. Dr. Marie Curie is a unique example as she not only went on to get two Nobel Prizes but her own family won 5 Nobel Prizes.

They are all examples of *stem cells* showing the ability of self renewal and produce students who differentiated to create new disciplines and departments which did not exist before.

One thing is very clear that every aspiring youth is eager to acquire new skills so that they can take advantage of the opportunities available in the knowledge driven world. Let us not forget that people who have made major advances in various phases of growth are a product of inspiration of unsung effective teacher.

It is obvious that these teachers questioned the existing dogmas and did not accept any knowledge till they understood it and improved or changed the very basics. Like Max Planck introduced the concept of quantization and gave rise to modern physics.

Our understanding of any system depends on understanding the constituents and their interaction both in the physical, chemical or biological world known as **Reductionist Approach**. The majority of 20th century went in understanding the constituents of atom, cellular constituents, functioning of the living system among many other things.

A cell is a bag of enzymes carrying out synthesis, breakdown, transformation, modification of its contents with or without cofactors. Molecules are imported into the cell by active or passive transportation just like a student enters a school or college. Depending on the environment the cell undergoes evolution. In the same manner a teacher in a school brings about changes in a student who enters its *portals* called school or colleges. A teacher is also a constant learner who keeps abreast with changing environments in his or her life time. Unlike a cell, a teacher undergoes evolution keeping in tune with technological revolutions.

The future is uncertain, but education is all about being trained to overcome the hurdles that come by during our lifetime. A good and effective teacher prepares the youth to face the hurdles in the path of progress in an ethical manner in the long marathon of life. That is why when asked to recall the name of a teacher who was an inspiration, we can easily count them on our fingers!

The 20th century witnessed the impact of Agricultural revolution and Industrial revolution. India had to take a big leap to become an industrialized nation by focusing on technical education. Engineering institutes, medical colleges were set up to become a developing nation immediately after independence. Many advances were possible due to team efforts and group activities. Let me share some of my own experiences

Depending on whether you are an *isolated cell* or part of a *tissue or organ*, the functions are well defined and should harmoniously carry on the function perfectly throughout the life of an individual. The cell and its contents keep growing or dying depending on the environment. Cell is undergoing evolution all the time and may acquire new functions as a process of evolution and technological revolution.

Biotechnology education in India

My encounter with biotechnology dates back to 1970 when the word biotechnology was not yet coined in the way we now know. In the agricultural age and industrial age, man learned to exploit the traditional knowledge to an industrial scale. Only in 1970's man learned to tinker with genes and cells in a precise way to manufacture products which was unthinkable. For the first time Biotechnology could be defined as a mathematical subject which involved addition, subtraction, multiplication and division of bio molecules to produce products beneficial to mankind. For

the first time technology became available to produce a molecule like insulin in bacteria and several diabetics who needed insulin. Remember bacteria never made insulin before. The ability to make bacterial cells to do things that they never did before created the excitement in biotechnology and biotechnology became the buzzword. So when I went to teach biotechnology at Poona University in 1985, it was a big challenge to convey the excitement to students. Government of India established the National biotechnology board which later became Department of Biotechnology. One must remember that introduction of biotechnology at PG level was opposed by other biologists and biochemists. When we framed syllabi, one had to tread carefully as it would be sarcastically mentioned that where is biology? Biology is a must. We created a syllabi and created specializations in Plant Tissue Culture, Animal Cell Culture, Genetic Engineering, Biochemical Engineering and Bioinformatics. It was indeed a bold step and the help we received from NCL Poona, National Institute of Virology, various other departments like chemistry, physics helped us to create a vibrant department. I still recall myself being in the department all seven days of the week and most of the day's students and faculty remained from morning 8.30 till night 10.30. I am saying all this because we were just two which later became three faculties and had to run the program. We were all temporarily housed in Zoology department and the enthusiasms of Prof Sohan Modak, Prof V. Sitaramam were infectious. I always recall this part of my life as the most memorable. Several of the students have made it very big in life. In the first batch 22 students appeared for UGC Net exam and all got

scholarship. When I left to join industry in 1988 we had produced over 56 UGC Net scholars in three years! I myself started my serious research on ubiquitin and its effect on chick embryo development at Poona University. Many of my then students called me up when ubiquitin molecule won the Nobel Prize in 2004. Certainly it was the first attempt to introduce a new course with major emphasis on practical and projects. It was said that light burned all 24 hours in Zoology and Physics department during my time. I am emphasizing this to reinforce that teaching involves a great passion and not simply teaching.

After my stint over a decade in Industry, I came back to academics and started integrated M Tech in Biotechnology at Indraprastha University, Delhi. It was a five and a half year program with the option of getting B Tech after four years in 1999. For the first time we introduced Stem cell technology, IPR, manufacturing, GMP, GLP, Practical classes included a discussion on classic papers on stem cells. Interestingly this year's Nobel Prize work in Physiology and Medicine was taught to student's way back in 2001. The library was well stocked with the latest books and journals. In fact going through all issues of Nature was compulsory. The students benefitted immensely and several students were picked up at Gottingen University in 2004, 2005. In 2005 three students were selected through a worldwide selection! All my students are ready to face the 21st century challenges and most of them are continuing in academics! An education experiment which produced several students who are enjoying being part of cutting edge research of 21st century.

Preparing students for 21st century calls for ICT enabled teaching to augment the teacher. In 2002 we introduced Biotechnology as a subject for class XI and XII under CBSE. Again the emphasis was on practicals and only schools which invested at least Rs 5 lakhs were permitted to start this program along with mathematics/biology. The text books are already out of print. Many institutions and students are using to prepare for UGC Net exam unofficially. There were only 2000 students but 10000 copies were sold. Though it would have become popular but for the rigidity of Medical Council of India which did not allow biotech students to appear for medical unless they had biology. I wonder how much of botany is useful to MBBS. Sometimes we are too rigid in spite of holding an entrance exam. Why not allow anybody whether with arts or commerce to appear in any entrance exam. The screening happens in the entrance test where a student is tested for aptitude for a particular course! If we want students to compete in the 21st century, we need a new model in school education with a greater emphasis on skill development. Also one should free oneself to take courses in various disciplines including humanities and arts. We need to produce all round students who can appreciate developments in as many fields as possible. Same is true of college education. We are too compartmentalized and we need to free ourselves from creating boundaries. Cross flow of different information is essential for knowledge and wisdom evolution!

Engineering Education

After joining Nagaland University I had to look at what kind of engineering program to start. More than anything else, it was essential to focus on the process rather than product. One needs to instill these processes namely

Thought \implies Feeling \implies Attitude \implies Action
 \implies Habit \implies Personality \implies Destiny

My earlier success with my former students was that they went through this process. Why not plan on similar lines at Nagaland University? Can we take advantage of revolutions in ICT technology? This is where chance meeting with Prof K. R. Srivasthan, Director IIITM of Trivandrum triggered my new thought process. This enabled me to set-up and initiates a paradigm shift in education. Though in the initial stages but certainly worth sharing in this talk. The model is called “The 3- Tier Education Grid Model for NPTEL assisted Rejuvenation of IT and Technical Education”. National Program on Technology Enhanced Learning (NPTEL) is a project on e-content developed by over 320 professors of IIT’s and IISc and funded by MHRD. Necessity is the mother of invention. This proverb is apt as we have more engineers without quality. Unemployable engineers have become a serious issue and I was left with no choice but to focus on quality education; further compounded by the fact that very difficult to attract the best teachers to north east. Conventional methods have not enabled our university to

be part of the mainstream. I also realized that it is an issue even in major cities. Either I accept it or innovate. Meeting Prof Srivasthan gave me the confidence to take a bold step. For this we need an ICT enabling environment. We have created the state of the art facility in a short time. We decided to focus on IT, ECE, CSE, and BT and AT. The concept of Education Grid is a suite of systems and processes over a network of institutions. For each course there are 40 hours of recorded video lectures readily accessible. There is more than 110 such suite of lectures. There are more than 130 supplementary web based courses. In addition there are other open sources available. A more useful web called Semantic Web has been created to enhance the existing World Wide Web (www). Semantic web uses a set of formats and languages that find and analyze the data on the www, allowing consumers and businesses to understand all kinds of useful online information. It is essentially a harmonization where search engine tools convert different formats and languages appearing in the World Wide Web into an internationally agreed common format and language. If one has cough or cold, one is advised to take a particular antibiotic. Advances in understanding biology and reinterpretation of drug activity at molecular and genetic level and creating database of clinical trials has created designer drugs. Semantic web tools that could predict which drugs – and what doses – will work for a given individual is revolutionizing medical practices. By this it is possible to provide custom-tailored personalized, medical treatments increasingly possible.

If machines can do the routine work of searching, compiling, write all the information in a single accepted format, reason and arrive at it logically then what is going to be the role of a teacher? Is the teacher a manager or a leader?

University teacher has not undergone a formal education in classroom teaching and research unlike a school teacher. Teacher development is a continuous process and is possible when teachers are actively involved as researchers in the classroom. Teachers need to do introspection with regard to their own teaching, confront held beliefs and attitudes and evaluate results. Portfolio assessment is one of the many alternative assessment tools that help access rich and descriptive information about the processes and products of learning. In this learners are asked to think about their needs, goals, weakness and strength in subject learning and are enabled to take responsibility for their own learning and in the process enable them to become autonomous learners. It is found that this approach helps to promote teacher and learner reflection vis-à-vis **meta-cognitive awareness**.

It is no more a particular school of thought as practiced in 20th century. Now anything available in the data base will be picked up and different viewpoints will appear. A student gets exposed to various ideas and evolution of ideas and concepts which non-savvy internet teacher will feel threatened. The ideas of people like Hugh Everett will be available to analyze and comment. Fifty years ago Hugh Everett devised the many-worlds

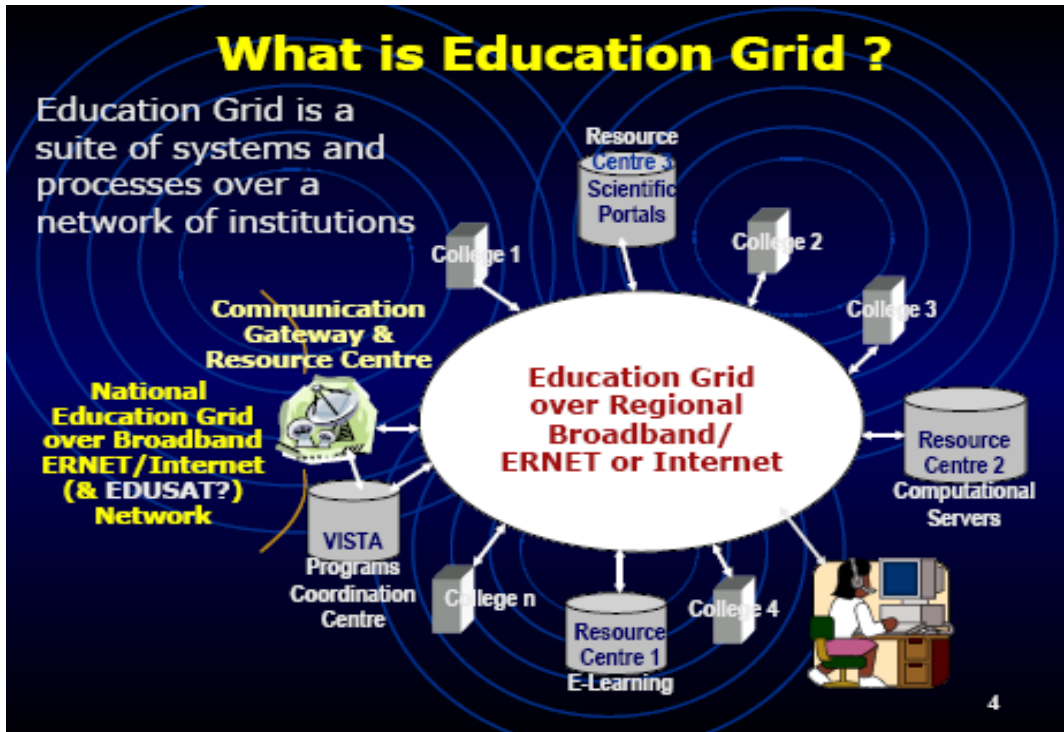
interpretation of quantum mechanics, in which quantum effects spawn countless branches of the universe with different events occurring in each. The concept was thrown out by Copenhagen school of thought who included the famous teacher Niels Bohr simply because it questioned their thinking process. Hugh Everett abandoned the world of academic physics. He turned to top-secret military research and led a tragic life. Similar thing happened to Prof S Chandrashekar in Cambridge in 1936 but he moved to Chicago University and allowed his publications to speak. Two of his students Yang and Lee went on to win Nobel Prize in 1953 but he received his Nobel nearly after 40 years to the idea he proposed in 1936.

The teacher has to provide more time for acquiring information by students. The hours of actual contact teaching has to be tremendously reduced. The teacher will also have to pour through not only all possible sources of information but be able to help the student how to convert information into knowledge. The teacher has to develop skills how to examine and evaluate a student. He or she as a teacher has to move from definition to analysis and interpretation of a given set of data. This kind of contact teaching can take several hours rather than the routine one hour which we assign as time table. The examination has to be evaluation of knowledge acquisition rather than information or rote learning. Through rote learning a teacher is relegated to a non functional entity. That is why tutorial coaching classes are thriving and growing, thanks to the concept of question banks. A teacher has to enable a student to be a thinking person rather than a parrot.

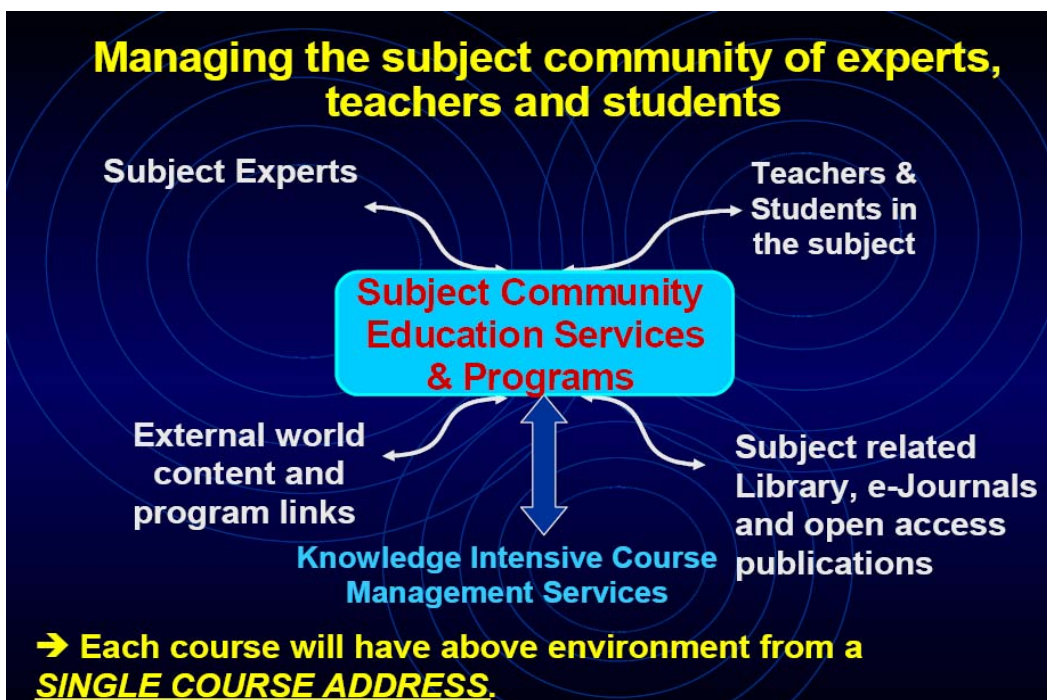
Education is a lifelong marathon rather than a 100 meter dash. Unfortunately we treat education as a 100 meter dash and I don't know whom to blame. We need a new education policy which is implementable.

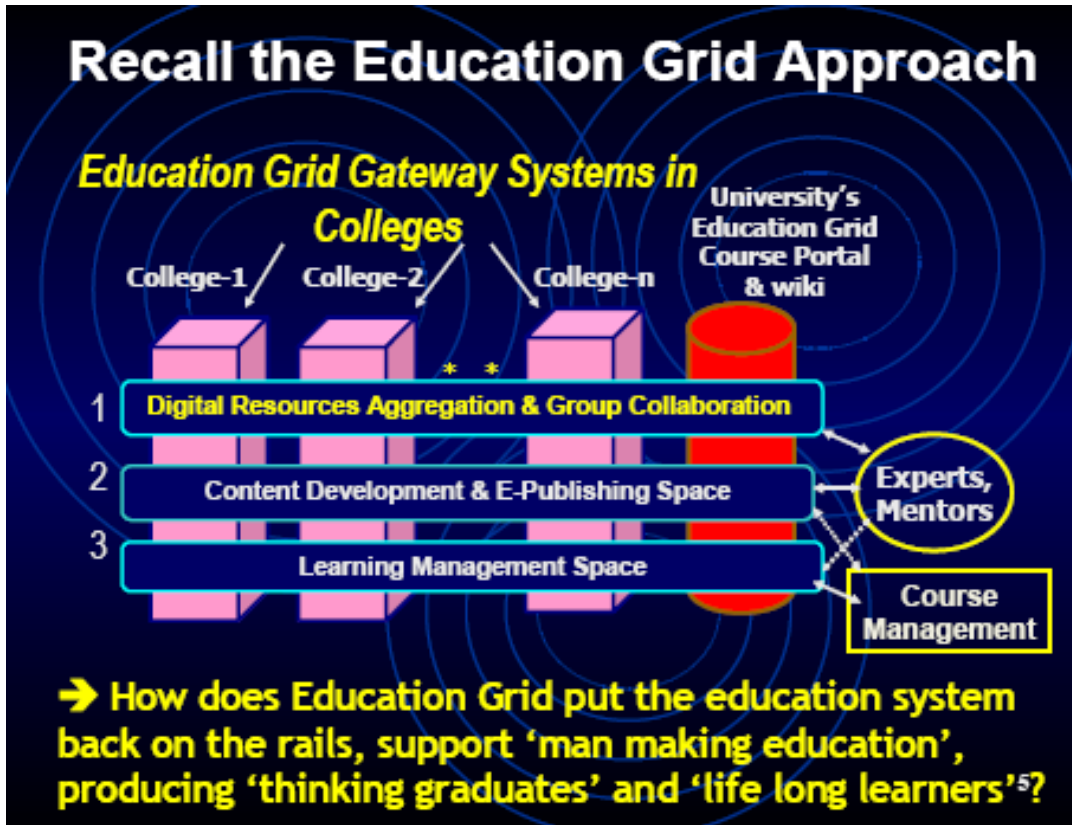
The New Education Policy of 1986 is brilliant on paper but lacked the will to implement. We need to seriously address the issue of *apoptosis* of effective teachers.

Thanks to advances in technology it is possible to establish an alliance of academia, industry and government to modernize the higher education system through Technology Enhanced Learning and Teaching (TELT) in the universities, colleges. Institutions and through open distance/supported learning. One may call it Education Grid Global (EGG) alliance.



Curtsey IIITM Kerala





The approach is to take advantage of IT, connectivity, internet, content and service TELT in the tertiary education sector. It should be possible to deliver education at the door step of the student and through video conferencing have a real time synchronous learning. Already NIIT is delivering lectures through this process in 11 centers spread all over India. So essentially we need a place where students can do hands on practical and develop their skills to become a researcher, product development, business, doctor, engineer etc.

With an explosion of information in all fields, a student can pursue several courses simultaneously provided they are exposed to a holistic approach. The under graduate program should be broad based with courses in science, arts, commerce, humanities and culture rather than just one area as is being done presently. Platform technology knows no boundaries and each field can take advantage of technology like computer and software are having impact in all fields. Education should provide flexibility and adaptability rather than rigidity. Everybody need not pursue education to do PhD but should have access to skill development and earn their livelihood. Thanks to the ability to connect and communicate, there is a room for each person to bring out the best in them rather than being pushed to become only a doctor or engineer! The world has become flat and any student who has risk taking ability can make giant leaps like Sergey Brin and Larry Page of Google Inc.

As part of industry, academia and microcredit financing we have recently initiated training men and women in carpet weaving and we expect to export the first four carpets abroad. This will enable a skilled and trained worker to earn Rs 3500/ month on the average for an eight hour work. We are in the process of creating an SPV model for green technologies. In this we are planning to create incubator facilities to train youth in food processing, plant tissue culture, entrepreneurship, quality control, GMP to name a few. Besides conventional higher education we are also focusing in a major way on vocational training through skill development. Recently we set up the School of

Engineering and School of Management. We have plans to start BVSc and MBBS in the near future. The university is focusing on creating infrastructure to provide an enabling environment. We are fully aware of the importance of indigenous knowledge and are in the process of recording innovations and attempt to protect through IPR. University has tied up with National Innovation Foundation for the same.

I hope that this lecture will inspire a future generation of teachers to be part of the actions of 21st century and create a new brigade of technology savvy trainers. We need students as autonomous learner, researcher in fields untried and untested. They need to develop thinking process, sieve information, interpret and make it useful to present social contexts. This is what I practiced and found as a working model for 21st century where pedagogy produces entrepreneurial leaders.

Thank you all for the patient listening. Special thanks to Prof Amarjyothi Choudhry, Honorable Vice Chancellor, Gauhati University, Prof S K Borthakur, Head, Department of Botany, GU, Dr T C Sarma, President, Botanical forum, GU.

*Wish you all a very happy
and prosperous 2008.*