**PERSPECTIVE**

# Learning Outcome Based Science Education – Avoid 'Old Wine in New Bottle' Approach: Lessons from the Past

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## Abstract

Our country has made progress over the decades after independence, yet a lot remains to be desired, despite periodic formulation and revision of policies in Higher Education and S&T. The commentary here deals with current changes in looking at the policies of the past and the learning-outcome-based higher education, in brief. Suggestions are made in shaping learning outcome-based UG and PG education by providing a specific example of a subject area.

**Keywords.** Higher Education; S&T; Policies; Learning Outcomes; Disruptive

As important as the question of 'what expectations do society and government have from science and scientists and vice versa', raised by Singh and Joshi (2017), is the concern that has been in circulation about the quality of teaching in colleges and universities (Bamezai 2012a, Bamezai 2012b, Lakhotia 2018). The younger generation is confused about the purpose of higher education since it has either become a process to secure certificates to financially rewarding careers or has invariably generated a human resource which remains an un- or under-utilized asset (Bamezai 2012a, Bamezai 2012b). Public opinion, incidentally, also supports this view. Divorcing, in practice, the policies of Science and Technology (S&T) from Higher Education, especially in relation to science education and its expected outcome, has

been one of the disappointments. Also, there has been a lack of clarity and objectivity at many levels of political, educational, scientific, social and, last but not the least, bureaucratic institutions, which have been heavily draining. Barring a few rays of hope and some light at the end of the tunnel in the areas of atomic energy, space, and to some extent, dairy and agriculture, the latter with a limited futuristic vision due to the onslaught of pesticides, we have had little new knowledge generated, especially in biology. What is usually claimed is mostly a deconstruction of the known knowledge base.

The reasons for such a state in biology are buried in the history of scientist-politician tie-ups confined to some given areas ( Krishna 2009 ), leading to selective global visibility. In addition, there has been a failure of institution builders through the 1980s and 1990s to position themselves effectively and succeed as some of their predecessors were able to. Contributions in a patchwork manner, not enough to make a sustainable difference in biology globally, and sporadic efforts only from a few within the country, have been additional factors. Unfortunately, a lot of talent remained untapped due to the personal, instead of a national, emphasis in these institutions, besides the lack of appropriate direction and path. This resulted in losing out on the contribution of almost a generation, except that of a few individuals (this is a personal view based on 40 years of work experience) (Mehrotra et al 1983). The governments and the people at the helm of affairs need to take the blame for not having created 'a mega-science' performing space for the subject of biology, as was possible in atomic energy and the space sciences. An interesting convergence of this multidimensional problem could be seen in the lack of clarity at the national level and the mundane reasons of human factors playing a predominant role. Therefore, it is essential to build a perspective for capitalizing on the existing talent for generating a 'Mega-Science' space for biology, and attempt to gear S&T policy for meeting the challenges in shaping Higher Education in the sciences and vice-versa.

No one would deny that doing good science is dependent on the quality of human resource available and the way it is nurtured, for achieving set goals, defined after a wider participation and serious brainstorming. In the prevailing ecosystem, we need to tap our existing strengths accordingly and avoid rediscovering the wheel again and again (Mehrotra et al 1983). In the area of biology, how far we succeeded in translating the policies and what they emphasized for self-reliance, sustainable and equitable development (DST 2013), is anyone's guess. The slogans of 'sustainable,' 'self-reliance' have been verbalized in the past in several statements of the Prime Ministers and the Science and Technology Ministers (DST 2013), yet the ground realities have remained dismal. The basic minimum needs of society in terms of health requirements; avoiding waterlogging, drainage overflows, efficient and cost-effective processing of solid and electronic waste, besides the control of all kinds of pollutants of air, water, earth and the whole atmosphere, have not been attended to effectively for the past several decades. Now that we have several 'Abhiyaans' operational from Swachh-Bharat to Skilled and Digital India besides others (Ahuja 2018), it remains to be seen if the ground reality would change and the participation of scientists and the educated contribute to the transformation as desired. The human resource trained now on has to move beyond 'rote-learning with a successful career of no use to the society', to measurable learning outcomes

that need to be put in place in future curricula. The knowledge thus gained has to be applied to sorting out and finding solutions to the issues highlighted already, besides contributing to new knowledge, inventions and discoveries.

If one were to take it up as a case study to understand if higher education policies, especially in the sciences, have been designed keeping the S&T policies in perspective or vice-versa, one finds that there is apparently no such thought in circulation. In addition, in higher education, one realizes that our policies have resulted in an uneven institutional infrastructure of colleges and universities which function with different roadmaps. Thus, we have different syllabi, teaching methods, hands-on training, and different learning outcomes. Introducing uniformity, whenever and wherever tried, has obviously not worked. Added to this, the failure to keep up with the advancing knowledge base, half-hearted engagement and integration with other disciplines, and poor transfer of skill set to the students to negotiate the changing needs, have made it essential to change from incremental inputs of syllabi revisions to disruptive approaches. This approach and attitude is required to reshape the subject-specific course structures, with measurable learning outcomes. However, the exercise should not result in 'filling old wine in new bottles', where syllabi in different subjects are just tweaked here and there to justify the change brought in to cater to the Learning outcome based undergraduate and post-graduate education.

There have been periodic debates through the Education Policies: University Education Commission (1948); Secondary Education Commission (1952); Indian Education Commission (D. S. Kothari) (1964–66), National Policy on Education (1968); Draft National Policy on Education (1979) National Policy on Education (1986) and National Policy on Education (1992). [1] Though wonderfully stated on paper, some of them providing extremely relevant direction for the times, they remained poorly implemented and monitored for the deliverables in terms of excellence. In a recent declaration on a process of reform of the regulatory agencies for the better administration of the higher education sector, an announcement has been made to constitute the Higher Education Commission of India (Repeal of UGC Act) 2018 to reform the regulatory framework to monitor and disburse funds to colleges and universities. This has raised issues (Lakhotia 2018) related to the independent functioning of established organizations such as UGC, AICTE, etc., which have not been functioning as expected and desired. An opinion to oil these well and to hold them accountable, instead of replace them, has also been in the air. The fear is, the new mammoth of Higher Education Commission may in due course suffer from the same ills as the existing organizations. The solution, therefore, lies in rectifying and tightening the functioning of the existing institutions without wasting time in rediscovering the wheel. We have done the least as a country to find talent and nurture and support them, till breakthroughs emerge, save for a few exceptions that catered to small numbers. The scale that such an exercise demands and the capacity building needed for diverse requirements remain to be worked out. Most of those in the corridors of power are on

a roller coaster. They need to be in deep 'Chintan and Manan' for needful design and execution which serves everyone alike.

There is an opportunity as the country prepares through MHRD, involving UGC as one of the organs, for free online, easily accessible education through SWAYAM. The task at hand is to develop online modules under Massive Open Online Courses (MOOCs) and Learning Outcome-Based Curriculum Framework (LOCF), for UGs and PGs in different disciplines. [2] This process has been in place in many countries for a long time. Meetings of a core committee (in which the writer is a member) and subject-specific experts have taken place to develop a framework, with an aim to circulate the framework for debate, moderation and final adoption. I feel this is an opportune moment to bring a qualitative difference to the course structures within different subject areas of the sciences, where learning outcomes are defined precisely and evaluated objectively to match with the aspirations projected in the S&T policy of the country. The course structures need to be designed in an integrated, interdisciplinary and cross-disciplinary manner, bringing together a wide spectrum of scientific disciplines to solve complex problems and to develop new methods, concepts, and approaches. The approach, if and when adopted, to create a balance between the S&T and Higher Education policies, may generate opinions amongst teachers and students that resist the change. On the other hand, it could also be seen as an opportune moment to shape higher education by preparing human resource of relevance to the societal needs and for discoveries and innovations.

I provide here a glimpse of a subject area, as an example, to show how the purpose of S&T innovation could be encouraged by tweaking the syllabi with defined and meaningful learning outcomes. As a case study, let me pick up a subject area in biology, i.e., Zoology, common in traditional colleges and universities. In order to bring such a change in the subject in UG and PG course curricula, the intention should be to understand the subject of Zoology in the evolving biological paradigm in modern times, where, living beings need to be understood at the level of atomic interactions. The comparative systems of organisms need to be studied through a prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner workings of different organisms at the morphological, cellular, molecular, interactive and evolutionary levels. The syllabi could be shaped with a customised approach, depending on the institutional infrastructure and geographical location, yet it should cater, in principle, to the expected learning outcomes more or less uniformly. For example, in diverse geographical domains with diverse skill sets, examples illustrated in detail for teaching and hands-on exposure and fieldwork could differ by involving the study of available species across the ladder of evolution, yet the comparative biology taught should provide a uniform level of understanding of the subject. After all, the purpose should be to facilitate an understanding of the inner workings of living beings by comparing various systems within invertebrates and vertebrates i.e., from a single cell protozoan to multicellular humans, and to develop a comprehensive understanding and appreciation of the differences through ICT tools

[1] History of education policy in india- e-PG Pathshala [epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/.../ET/145258955205ET].

[2] UGC Public Notice reg.: Learning Outcome based Curriculum Framework (LOCF); UGC website-www.ugc.ac.in

and well-designed hands-on practical exposures, along with fieldwork. In other words, if the same principle is followed for understanding different phyla through the ladder of evolution with cardinal features compared for classification involving both morphological and molecular tools, along with associated field and lab work, the final product would be better trained without being simply subjected to rote learning. Diversity in life forms needs to be understood by a Zoologist for their socio-economic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology; by a career-researcher to understand multiscale hierarchical systems, where chemical and physical principles would apply from molecules to self-assembled and organized organisms. A comprehensive knowledge of a structure-function relationship at the level of gene, genome, cell, tissue, organ, and systems, through development, would further add to the knowledge base and the learning outcome in terms of editing of genes and genomes for industrial application and pure research purposes. Short dissertations could be designed around these problems to give the students hands-on training and equip them with skill sets of use in the future, in the areas of future applied aspects of Zoology. The vibrancy to synthesize from the knowledge gained and come out with disruptive outcomes would define the learning outcomes of the future UG and PG students. Such a human resource will be well equipped to cater to the future needs, both in the so-called basic and applied research; which should not be seen as dichotomous any longer. Incidentally, the approach adopted would optimize and reduce the burden of teaching on mentors, though initially a little hard work to shape the contents of the curriculum is required. Teachers would need to be trained for the same as well for a uniform approach to deliver and communicate.

While the above mentioned attributes may be expected of a UG/PG student of Zoology, who studies a specific subject in an integrated and cross-disciplinary manner, in the context of all living systems, and their inter-relationship within the ecosystem, the scale, character and rigour that the student experiences may vary from one institution to the other. The same is likely to be true for other subjects as well. Regardless of the subject, it is mandatory to bring uniformity to the learning outcomes involving the discipline and the corresponding 'social skills.' Within the broad-range skill sets related to the discipline, what would be required is to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. These are part of a defined set of attributes to be demonstrated by a UG/PG in any discipline, as put forth by the Core Committee on LOCF of UGC.

The approach of teaching different topics across diverse disciplines of sciences, if adopted, connecting the topics with the scope of an application or an appreciation for the same, would instil faith in the public and in future generations as societal needs will be fulfilled. Those who show potential for investigative research can be geared to attempt to answer unique questions of their own curiosity, rather than perform repetitive research of no relevance. After all, the education received and its learning outcome has to result in either the generation of new knowledge or in indirect and immediate societal benefits, or both. Let us not forget that the so-called 'basic' of today may attain an application value tomorrow. Clarity in basic and integrated conceptual understanding of subject areas is the key to inventions, discoveries and innovation. It is time to shape curricula and learning outcomes in the higher education system to cater to S&T missions and nation building.

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