

EDUCATION, RESEARCH AND INNOVATION IN INDIA: THE SHIFTING PARADIGMS

Dr. Shilpy Raaj

Assistant Professor, Department of Education, Central University of Jharkhand

Abstract

Innovation is critical to the continuous improvement of education. Different perspectives on possible ways of organising learning that go beyond existing institutional arrangements can help create learning environments that equip people with the deeper knowledge and skills to participate in today's economy and society, and lead fulfilling and meaningful lives. Various factors can drive innovation, for example, Information and Communication Technologies (ICT) hold a powerful potential to transform education. Learning sciences and brain research can improve our understanding of how learning unfolds and provide new perspectives on long-standing challenges, inform new practices or reinforce existing ones. Educational research and the production, sharing and effective use of knowledge is also a vital source of innovation. It can provide a useful basis to inform policy making and professional practice. Enormous efforts and investments have been made to reinforce the quality, production and use of educational research in policy and practice. Despite this, using research systematically and meaningfully in education policy making and practice remains a challenge for many countries and systems. Moreover, the links between research, policy and practice are weak and the dynamics of innovation remain to be fully understood.

Measuring innovation in education and understanding how it works is essential to improve the quality of the education sector. Monitoring systematically how pedagogical practices evolve would considerably increase the international education knowledge base. We need to examine whether, and how, practices are changing within classrooms and educational organisations and how students are using learning resources. We must know more about how teachers should change their professional development practices, how schools should change their ways to relate to parents, and, more generally, to what extent change and innovation are linked to better educational outcomes. This would help policy makers to better target interventions and resources, and get quick feedback on whether reforms do change educational practices as expected. The focus of this paper is to better understand the role of innovation in education through issues such as: how does innovation emerge, how can it be brought to practice and sustained, what are the barriers and drivers for innovation and what can governments do to enable a supportive climate for innovation to emerge and to drive innovation? The paper ends with recommendations on the best practices to integrate education, research and innovation for the benefit of all the stakeholders.

Keywords: educational outcomes, educational research, innovation, learning environments, learning resources, pedagogical practices, professional development.

INTRODUCTION

The higher education sector in India is progressing and transforming gradually and steadily. As our higher education needs are enormous and dynamic, beset by a number of challenges such as population explosion, unemployment, and brain-drain, the need of the hour is to drastically re-energise and rejuvenate the higher education sector through innovation and excellence – both in academics and research. There is an urgent need for reassessment of our research policies, procedures and practices in our country followed by brainstorming deliberations on the challenges emerging out of the fast-changing international scenario. In this very context, there is a need to develop strategies and take necessary measures for enhancing research and promoting quality research at higher education institutions. A goal-oriented and focused blueprint needs to be developed to achieve highest possible standards in research and teaching-learning in order to keep pace with changing global trends.

India has been the seat of learning and abode of knowledge and wisdom since times immemorial. Our natural and material scientists, applied scientists, social scientists, literati, doctors, engineers, technocrats and artists have brought laurels and left an indelible impression worldwide by dint of their strong credentials and noteworthy academic achievements in their respective fields. The higher education sector in India is progressing and transforming gradually and steadily. Even though considerable gains have been made over the past few decades towards improving the higher education sector, several emerging issues are fast gaining momentum and throwing new challenges because of the fast changing international scenario, rise of artificial intelligence and other disruptive technologies related to the impending fourth industrial revolution, globalisation of higher education, tremendous scientific progress made worldwide, global ranking of higher education institutions, an ever-increasing population of learners, constantly rising focus on skill enhancement and employability of the graduates, market utility of academic programs and translational value of research.

Though our higher education indicators including access, affordability, quality, and relevance are fast improving, a lot more needs to be done to achieve excellence in quality through research and innovation. The need of the hour is to drastically re-energise and rejuvenate our higher education sector through innovation and excellence – both in academics and research.

MEASURES TO ENHANCE RESEARCH QUALITY AND OUTPUT

Funding for Research

One of the most important requirements for research is the availability of adequate funds. We need to explore possibilities of funding for research at regional, national and international levels through public institutions, private industries, Non Governmental Organisations (NGOs) as well as through opportunities for public-private partnership. National level funding agencies like Department of Biotechnology (DBT), Department of Science and Technology (DST), University Grants Commission (UGC), Indian Council of Agricultural Research (ICAR), Science and Engineering Research Board (SERB), Indian Council of Medical Research (ICMR), etc., in addition to funding opportunities from the industry, academia and NGOs need to be tapped to their fullest. However, in certain cases, funding from national public and private agencies might not suffice, in which case international funding agencies like World Health Organisation (WHO), World Trade Organisation (WTO), World Bank, United Nations Organisation (UNO) etc. need to be approached for research grants.

Infrastructure for Research

We need to develop research infrastructure for enhancing research and improving research quality drastically. This can be made possible by identifying and establishing research institutes and research centers within those institutes that are capable of undertaking high quality research. Besides adequate, trained manpower, these centers need to be fully equipped with sophisticated instruments required to conduct high-end research, databases that are required to undertake systematic literature reviews, meta-analyses, access to literature through databases like Scopus, Science Direct, Pubmed, Medline, Toxline etc.

Manpower for Research

Apart from funds and infrastructures, it is the trained manpower that really makes the things to happen. Adequate, qualified, trained, well-oriented and specialised manpower is needed in the right numbers to run the research centers and carry out research in identified thrust areas. For developing such manpower courses related to research, methodology needs to be incorporated into the UG and PG curriculum at college as well as university levels so as to develop a research culture and harness a research temperament among our students and scholars. Even at the school level curriculum should be inquisitive enough to promote creativity, critical, analytical and innovative thinking among our students who in later course of their life could emerge as ace researchers. Specialised training needs to be imparted to the selected manpower on need-basis depending upon the prioritised thrust areas of research identified by the experts.

Policies for Research

We need comprehensive, goal-oriented and focused research policies at the institutional, regional/state levels as well as the national level for enhancing research and promoting quality research in tune with fast changing global trends. Such policies should be contextual and need-based and address the most intriguing problems faced by our society. As envisaged in the National Education Policy, 2020, we need to develop research universities and autonomous colleges for carrying our intensive research on thrust areas identified by the experts. Such policies should be evidence-based and practiced and implemented in a time-bound manner.

Incentives for Research

While good research needs to be encouraged through appropriate incentives, making its use in appointments and promotions of teachers is debatable since introduction of API (Academic Performance Indicators) based assessment of teachers by the University Grants Commission in 2010 has come under criticism since it is thought to have resulted into mechanisation of the research output and led teachers towards a rat race of accumulating API points in pursuit of promotions. Quality of research must receive priority over quantity of research under all circumstances and the peers and experts in the field must evaluate the quality of research-based on their experience and by using journal metrics like impact factor and citation index. Further, there is a lot of debate going on whether research output should be used for providing financial incentives to teachers, awarding fellowships and giving recognition to them in academics or it must be reserved only for the quality of new knowledge added to the existing body of literature.

Collaborative Research

In epistemological terms, the concept of inter-disciplinarily research may be regarded as a form of cooperation between various disciplines, which contribute to the achievements of a common end and which through their association further the emergence and advancement of new knowledge. Based on the degree of integration of disciplines in research, it is considered that the quality of inter-disciplinarity depends on the degree of influence exerted by the respective

disciplines in the cooperative process. If one discipline is dominant, quality will be poor. If the influence is balanced, quality will be high. For instance, trans-disciplinarity is a state of complete balance of influence between all relevant participating disciplines at the highest possible level of co-ordination.

Depending upon the balance of influence between different participating disciplines, collaborative interdisciplinary research can be further classified into cross disciplinary, pluri-disciplinary and multi-disciplinary research. Collaborative research needs to take into account these different levels of interdisciplinary involvement and collaboration between different participating disciplines for the sake of clear definition of their respective roles. However, it goes without saying that carrying out interdisciplinary research is the need of the hour since knowledge cannot be compartmentalised and confined to disciplines. All such boundaries need to be dissolved and knowledge needs to be liberated from all such confines and made freely available to all those who seek it. Education is passing through the era of undisciplining of knowledge from the shackles of disciplines and we must not lag behind in this progressive endeavour.

Contextual, Need-based Research

Addressing needs of the society through contextual research is the need of the hour. In developed nations, universities organise research fairs and establish research shops that allow community members to visit them and register their problems, based on which research projects are prepared and research undertaken to find solutions to their actual problems. Similarly, timely and regular communication about research output to the masses is equally important for greater transparency of our research activities. Research institutions must consider these best practices apart from establishing entrepreneurship and innovation-incubation cells within their research centers so as to harness the spirit of entrepreneurship through research. These cells must provide sufficient start-up grants as seed money to the budding entrepreneurs for incubating their innovative ventures.

Translational Research

Merely carrying out research is of no use unless the evidence generated out of scientific inquiry is translated into policy and the policy is practiced and implemented to resolve day-to-day issues on the ground. It is generally observed that the evidence generated through our research hardly translates into policy and whatever little translates into policy is scarcely implemented in actual practice, which makes the whole exercise fruitless and results into confining of research dissertations onto the shelves of our libraries. There is need for greater coordination between researchers and policymakers for incorporating research findings and recommendations into our administrative policies. Researchers need to be made part of policymaking for better productivity, effectiveness, and robustness of the government policies.

Integrity in Research

Maintaining integrity in research is of paramount importance and therefore young researchers need to be imparted adequate education about related issues like plagiarism, duplication, gift and ghost authorships, salami publications, outsourced publishing etc. at an appropriate level of their training. It is hard to achieve quality in research unless awareness about the importance of integrity, transparency and accountability is promoted and incorporated as an inherent component of the research. Problem of predatory journals (under API pressure) that has alarmingly surfaced over the past few years needs to be countered and controlled effectively.

Any cases of malpractices in research need to be dealt with severely to set an effective deterrent.

Ethics in Research

Just like integrity, ethics in research is a high priority area for maintaining quality and high standards of research. Prime importance needs to be accorded to the issues like confidentiality, privacy, non-maleficence, beneficence, autonomy, and justice without which no credible and substantive research is ever possible. Awareness about these components needs to be created from the very beginning of research and Institutional Ethics' committees need to be vigilant, proactive about any such malpractices in research and therefore be strict in ensuring full compliance with ethics in research. Unless integrity and ethics are maintained, no substantial gains can be made in achieving high standards of quality in research.

It is universally agreed that high quality of research refers to a process that covers all aspects of the object of study by raising pertinent questions and arriving at reliable answers, which significantly enhance the prevailing knowledge base and create new knowledge. Its parameters are as under (UGC, 2019):

- Significant questions, which can be investigated, empirically as well as conceptually;
- Independent, balanced, and objective approach to the research problem with transparency;
- Use of appropriate methodology to address the research problem;
- Proper conceptualisation of the research problem and reliable measurement of variables;
- Engagement with internal and international intellectual networks and learned societies.

In our endeavours towards re-imagining our Indian universities through research, innovation and excellence, we need to adopt the following strategies:

- redesigning and remodelling our course curriculum;
- re-engineering our academic and research infrastructures;
- restructuring and re-orienting our human resources;
- redeeming and restoring our glorious past in education;
- revamping the organisational structure of our educational institutions;
- re-examining and rethinking our future goals, objectives and plans of actions;
- revisiting our vision and mission statements;
- reviving and re-energising our faculty improvement programmes and student welfare culture and practices;
- refurbishing our student and teacher amenities and on-campus facilities; and
- re-aligning and repositioning our journey towards growth, progress, and development.

These strategies would be effective in establishing benchmarks in education, research and innovation in our country.

INNOVATION OF COURSE CURRICULUM AND TEACHING PEDAGOGIES

Course curriculum that is being taught at our universities can be modified in light of the remarkable technological changes taking place worldwide. The higher education system has not gone through substantial reforms and changes vis-à-vis curriculum innovation over the past several years. We continue to offer same post-graduate programs in Science, Arts, Commerce,

Social Science and Education faculties for decades with little innovations, although their internal review and up-gradation is carried out from time to time. Multidisciplinary campuses of private universities that are coming up across India are offering some of the most innovative and modern courses, however, the public sector universities are lagging behind in keeping pace with them. The rigidity of our course curriculum, organisation, implementation and evaluation of curriculum content and its little relevance to the needs of our society are some of the problems associated with the higher education system. For any meaningful advancement to be made in the education system, a mid and long-term strategic orientation of curriculum needs to be undertaken and some time-bound goals need to be fixed to achieve the desired results.

Curriculum renovation that is realistic and student-centered, quick in rejuvenating and revitalising hope and passion for acquisition of broad-based knowledge that is worthwhile for a learner should be the focus of the higher education structure. Methodology that will aid self-discovery and problem-solving ability, allows learners the opportunity for creativity, should be entrenched in the curriculum. Quality and relevance are the two main features that curriculum development in the university system needs at present in India. At the same time changes and innovations of our higher education system must involve the emergence of elastic curricula models and educational policies which emphasise interdisciplinary courses, open-ended systems, inter-generational and inter-professional relationships and sustainability (Parashar and Parashar 2012).

Lack of initiatives, innovation, skills, independent constructive mindset, and creative ideals characterise today's system of higher education. We need to shift from a set up that encourages memorisation in learning processes and theoretical explanation to areas that need practical implications (Darling, 2019). The present system favours cognitive development above other domains of education. Therefore, we need to keep pace with brisk technological advancements in teaching learning process. There is need to modify conventional teaching methodologies and introduce recent advances in technology into the teaching-learning process. We must switch over from chalk and talk to more interactive modes of teaching and learning by making use of smart classes with audio-visual aids, e-contents, databases, e-learning objects etc. We should not lag behind in adopting the latest technology in every sphere of our education system, be it in teaching, devising syllabi, evaluation methods, certification and automation.

The role of a teacher in education should change from knowledge disseminator to that of knowledge creator. At university as well as college levels, innovation and greater diversification of courses and disciplines are the need of the hour. We need to offer more specialisations in all existing subjects and faculties and introduce new subjects wherever not available at present, so that a broader choice is made available to the students and they emerge as specialists in one specific area rather than ending up being generalists.

There is need to innovate our programmes and course curricula by starting new courses like industrial production, biomedical technology, nanotechnology, fashion technology, microprocessor technology, embedded systems, nuclear science technology, hotel management, microbiology, polymer chemistry, textile chemistry, hydro-chemistry, petrochemistry, electro-chemistry, chemistry of natural products, astrophysics, geophysics, nuclear physics, optical physics, particle physics, economic botany, phytochemistry, phytomedicine, disaster management, rural and urban management, hospital management, investment management, education management, enterprise management, entrepreneurship

development, business law, e-commerce, corporate tax planning, consumer protection, rural finance and credit, advertising, international business, agricultural marketing, genetics, microbiology, cell biology, molecular biology, biophysics and structural biology, immunology, biostatistics, radiation biology, virology, privatization and deregulation, environmental economics, political economy, public policy and regulation, resource economics, visual communications, travel and tourism, interior design etc. just to name a few.

INNOVATION OF METHODOLOGY, DESIGNS AND GOALS OF RESEARCH

Academic research should focus on the creation of new ideas, perspectives, and arguments. We should promote critical, analytical, and creative thinking among our researchers at all levels in order to generate innovative ideas and solutions to the research problems. The research process is not simply collecting data, evidence, or 'facts', then piecing together this pre-existing information into a paper. Instead, the research process is about inquiry—asking questions and developing answers through serious critical thinking and thoughtful reflection. Research process is recursive, meaning that the researcher regularly revisits ideas, seeks new information when necessary, and reconsiders and refines the research question, topic, or approach. In other words, research almost always involves constant reflection (William F. Ekstrom Library Website).

Further, we need to foster trans-disciplinary approaches in research. Development of common science instrumentation centers for joint utilisation by research centers in its vicinity that will foster interdisciplinary and collaborative research needs to be promoted in the higher education institutions. Such centers should be well equipped with sophisticated, state-of-art science instruments for use by the teachers and scholars of all educational and research institutions in a particular area. Trans-disciplinarity is a state of complete balance of influence between all relevant participating disciplines at the highest possible level of co-ordination, which in this sense entails an optimum use of cross-contact or cross-communication. The extent and quality of co-operation are both so advanced that a new discipline may be established analytically and socially. The level of coordination, cross-communication and balance of influence progressively declines as we move down from trans-disciplinary research to inter-, cross-, pluri- and multi-disciplinary research. Multi-disciplinarity is considered to be the least developed form of inter-disciplinarity; it represents a potential for future connection and a milieu for an unrealised potential that could later be mobilised towards a common end. It is the simple juxtaposition of different disciplines without any apparent connection between them (UNESCO, 1986).

Owing to the vastness of our country's educational landscape, for any meaningful innovation to take shape, there is need to devise a comprehensive investment policy for the higher education sector in India. For this purpose, our education sector must be segregated into school education, college education and university level education or primary, secondary and tertiary education in order to develop and clear roadmap for progress and development and clear distinction of the goals and targets in these three sectors. Intended goals of the investment policy may further be divided into short-term goals, mid-term goals and long-term goals in order to fix definite timelines for their fulfilment. Such type of classification will make the policy more robust, goal-oriented and focused. There will be no overlap of policy initiatives among these three sectors and accomplishment of goals will become easier.

These are important times for education throughout the world. The never-ending search for competitive advantage in the global knowledge economy has led all public policymakers to focus on education as a key factor in strengthening competitiveness, employment, and social cohesion. This is an inevitable consequence of the increasing complexity of all our economies. Indeed, the pace of technological change worldwide is now so fast that, to a large extent, we must plan for the unknown. The only certainty is that education needs to drive these changes. Therefore, investment in information technology and e-governance in the higher education sector should not be ignored in the proposed education investment policy.

Further, the higher education investment policy should make sufficient allocations on advance technologies like Block-chain Revolution, Big Data, Artificial Intelligence, Robotics, Internet of Things, etc., in higher education. We are at cross-roads of the fourth industrial revolution and in order to keep pace with the fast-changing global scenario, we must start thinking in this direction and invest well in advance towards developing sufficient infrastructure and manpower required to adopt and assimilate these emerging technologies in higher education both in terms of teaching pedagogy and teaching technology. We need to strengthen our e-governance structures for incorporation of Management Information Systems in our teaching-learning process as well as in the management of higher education institutions.

FRAMING SCIENCE AND TECHNOLOGY POLICIES FOR FOSTERING INNOVATION AND ENTREPRENEURSHIP

Substantial progress in Science and Technology is the key to sustained development of any nation in the 21st century. Keeping in view the contemporary developments in Science and Technology at the international level, Indian universities too need to enunciate a comprehensive policy framework to synergize science, technology and innovation (ST&I) in order to achieve faster, sustainable and inclusive growth and foster, promote, sustain cultivation of science, scientific temper and scientific research in all spheres with special emphasis on innovation that are the essential drivers and sustainers of socio-economic transformation. There is need to promote science and technology innovation and application in our universities in order to create favourable conditions and an enabling environment for innovations to occur. Being part of a cohort or being co-located builds a great community feeling amongst the entrepreneurs. This camaraderie makes entrepreneurs actively contribute to each other's success through ideas, networks, and resources. We need to create necessary framework for enabling integration of ST&I.

Science and Technology departments in every Indian state and union territory, and every university in the state/UT should establish a vibrant consortium of innovation incubation centers where ideas are allowed to germinate. Incubation centers of different universities and research centers of the state must not duplicate research and development activities in common areas, rather different institutions of the state must focus upon different areas and sectors and utilize the facilities liberally amongst themselves allowing open access to students and scholars to common facilities without any delays and painstaking procedures. This will save a whole lot of resources that can be used in promotion of STI activities. Scientists and technocrats should be involved in the formulation of premier Science, Technology and Innovation Policy for each state/UT and the existing gap between primary stakeholders including the government, scientists and citizens needs to be bridged by fostering greater interaction and collaboration at all levels.

Science and Technology departments must promote student-exchange and faculty-exchange programs within and outside the state for greater exposure of the youth to opportunities and ground realities in entrepreneurship and innovation. We need to accord due importance to innovation as an instrument of policy and for this sufficient and suitable mentorship needs to be made available to the entrepreneurs and innovators. Curriculum and teaching methodology at different levels of education must address the needs of budding entrepreneurs and inculcate an entrepreneurial culture, scientific temper and innovative mindset. Academic curricula and research programs need to be novel and innovation driven that promote constructive mindset and creative outlook among the students. There is also a need to bridge the gap between academia, society and the industry in a manner that promotes need-based and community-centric research besides generation of evidence by the academia, formulation of comprehensive and all-encompassing policy by the scientists and effective implementation of the policy and its conversion into practice by the government.

Consortium of innovation incubation and entrepreneurship centers must help entrepreneurs turn ideas into viable businesses and thereby help convert knowledge into value and wealth. Such centers should not merely be dumping grounds for applications and ideas, but also active facilitators for networking with mentors, corporates, development agencies, buyers and investors, and thereby cultivate a rare breed of entrepreneurs by seeding, incubating, accelerating, mentoring and funding innovative start-ups. Joint efforts by Science and Technology departments and Innovation Incubation Centers of the universities must aim at building sectoral expertise within the network of relevant experts. They must have in-house teams of accounting, HRD, R&D and administrative professionals to meet the basic needs of budding entrepreneurs. We need to have strong investor networks and dedicated staff that can help new ventures raise funds.

Science and Technology consortium with innovation incubation centers must provide adequate risk capital in the form of prototyping grant, seed-funding and venture funding. Entrepreneurs must benefit from this consortium in multiple ways during incubation, acceleration, or post-investment phases. There should be an equal emphasis upon both supply side interventions and demand based investments. The top ten sectors of high impact potential may be identified for directed STI intervention and deployment of requisite resources that may include energy and environment, food and nutrition, water and sanitation, telecommunication, affordable healthcare, skill building and unemployment. Innovation for inclusive growth implying equitable access, availability, and affordability of solutions to as large a population as possible must be the key to ST&I Policy of the state. Emphasis should be upon bridging the gap between STI system and socio-economic sectors by developing a symbiotic relationship with economic, industrial, ICT and other policies of the state.

The complex value chain of innovation – from idea to market – calls for STI intervention at all levels including research, technology inputs, manufacturing and services and the policy must enable a holistic approach to intervention, support and investment (GoI, 2013). Government must take steps to address the inadequacy of STI funding which has handicapped the progress of our universities in the past, and should increase public expenditure to achieve the ends of the renewed commitment to use science and technology as major drivers of sustainable economic growth. It must make appropriate arrangements for financing the science and technology developments and delivery systems. STI policy must aim at enhancing skills and

competencies for applications of science among the youth from all social strata besides making careers in science, research, and innovation lucrative enough for talented and bright minds. It must trigger changes in the mindset and value systems to recognise, respect and reward performances that generate wealth and value from S&T derived knowledge.

CONCLUSION

In order to achieve quality and excellence in academics and research, we need to innovate each and every sphere of our higher education sector holistically be it curriculum design, teaching pedagogies, research designs and methodologies, community outreach and extension activities, publishing practices, faculty improvement and enrichment programmes, student and teacher exchanges with foreign universities, performance linked incentives and career progression, student feedback mechanism, assessment and accreditation, national ranking criteria, skill enhancement practices, vocational training programmes, green campus initiatives, student placement opportunities, deputation regulations, development plans and long-term strategies for progress and growth of our higher education institutions. Unless all these areas are addressed simultaneously on a war-footing through well-documented policies and procedures, it is hard to re-imagine, redeem, and rediscover our universities as world-class institutions.

However, through persistent brainstorming, policy-planning and timely execution of our mission statements, it will not be unrealistic to think about converting most of our universities into future-ready higher education institutions of global standards within a span of 10-15 years. All that we need to transform this dream into a reality is dynamic political and academic leadership, visionary governance, and dedicated workforce of our higher education institutions. Together, we can make this happen by the end of this decade. This would herald new beginnings in education, research and innovation for our country.

REFERENCES

- Barnett, R. (1992). *Improving Higher Education: Total Quality Care*, Buckingham: SRHE&OU.
- Berliner, D. C. (2002). Educational research: The hardest science of all. *Educational Researcher*, 31, 18-20.
- BIS (1988). *IS13999 Quality System Vocabulary. IS 14000 Quality System: Guidelines for Selection and Use of Standards on Quality System*, New Delhi: BIS.
- BSI (1991) *Quality Vocabulary Part 2: Quality Concepts and Related Definitions*. London: BSI.
- Chickering, A. W., & Gamson, Z. F. (1987). Seven Principles for Good Practice in Undergraduate Education. *The Wingspread Journal*, 9(2), 1–15.
- Dale, B.G. and Plunkett, J.J. (1990). *Managing Quality*, Hertfordshire: Philip Allan.
- Darling-Hammond, L. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*. (Accessed on 22.02.2020, Available at :[https:// www.tandfonline.com/doi/full/10.1080/10888691.2018.1537791](https://www.tandfonline.com/doi/full/10.1080/10888691.2018.1537791)).
- Fullan, M. (2015). *The New Meaning of Educational Change*. New York: Teachers College Press.
- Gall, M.D., Borg, W., & Gall, J. (1996). *Educational Research: An Introduction*. New York: Pearson.

- GoI (2013). The Science and Technology Innovation Policy. Department of Science and Technology. Ministry of Science and Technology, Government of India, New Delhi.
- Kirkland, K., & Sutch, D. (2009). Overcoming the barriers to educational innovation. Bristol: Futurelab.
- Lagrosen, S.; Seyed-Hashemi, R. and Leitner, M. (2004). Examination of the dimension of quality in higher education, *Quality Assurance in Education*, 12(2), 61-69.
- Licht, A. H., Tasiopoulou, E., & Wastiau, P. (2017). Open Book of Educational Innovation. Brussels: European Schoolnet.
- MHRD (1985), the Teacher and Society, Chattopadhyaya Committee Report (1983-95), MHRD, Government of India, New Delhi.
- MHRD (1986), National Policy on Education, MHRD, Government of India, New Delhi.
- NCERT (2005), National Curriculum Framework, NCERT, New Delhi.
- NCERT (2006), National Focus Group on Teacher Education for Curriculum Renewal, NCERT, New Delhi.
- NCERT (2008), Innovations in Elementary Teacher Education, University, News, Association of Indian Universities, Vol.46 No.45 November 10-16, 2008.
- Owlia, M.S. and Aspinwall, E.M. (1996). A framework for the dimensions of quality in higher education, *Quality Assurance in Education*, 4(2), 12-20.
- Parashar A.K., and Parashar, R. (2012). Innovations and curriculum development for engineering education and research in India. *Procedia – Social and Behavioural Sciences*, 56: 685-90.
- Passi B.K., Tyagi S.K., Gupta C. (1992) Personalized Teacher Education: Lending Flesh to an Idea, a monograph, Indore, IOE, DAVV.
- Pillai, C.R. (2006). Understanding quality in higher education, Personal communication to NAAC.
- Rogers, E. (2003). *Diffusion of Innovations*, New York: Free Press, 5th edition.
- UGC (2019). Improving the quality of research by faculty and creation of new knowledge and strategies for improving research culture in colleges and universities. Report of the committee constituted by UGC. July, 2019.
- UNESCO (1986). *Interdisciplinarity in General Education: A Study by Louis d'Hainaut following an International Symposium on Interdisciplinarity in General Education held at UNESCO Headquarters*. www.unesdoc.unesco.org
- William F. Ekstrom Library. *Critical Thinking and Academic Research*. William F. Ekstrom Library. UofL Libraries. University of Louisville . Louisville (Accessed on 22.02.2020, Available at: <https://library.louisville.edu/ekstrom/criticalthinking/info>).