Interdisciplinary Research: Transforming Higher Education in India

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Abstract: **The Indian education system has a vast, rich and organized history with its chronology starting from ancient Gurukul system followed by colonization of British Empire till its freedom. Post-independence the Government sector is consistently working by formulating policies, framing guidelines and setting up standards for emphasizing quality in education as a primary goal. Since the scenario in higher education is in constant flux with over growing demand and ever changing opportunities in job sector. This paper highlights the crux of adopting interdisciplinary approach in transforming higher education system towards covering and accelerating scientific innovations, developing critical thinking skills, solving complex real life problems, globalization and growing fluidity in employment.**

Keywords: **Research, Higher Education, Interdisciplinary, Trans-disciplinary, Multi-disciplinary, Information and Communication Technology (ICT).**

1. INTRODUCTION

Indian Education System: History and Development:

The history of Indian education system is vast and rich. India was very systematic, developed and organized in imparting traditional and religious education from 3rd century BC. The writing material was palm leaves and tree barks. The main emphasis on oral teaching by Scholars and Gurus. The Gurukul system of learning was more relevant and effective in which students were taught orally. In this system of learning students and teachers resided in the same campus disseminating knowledge through successive generations. The main subjects of teaching in Ancient India were religion, philosophy, astrology, medicine and warfare.

The onset of early millennium and some years anteceding marked the establishment of major Higher education universities like the Ujjain University, Vikramshila University, Nalanda University and Takshashila University. During this period the main subjects of study were Grammar, Philosophy, Law, Logic, Astronomy, Literature, Hinduism, Arthashastra, Buddhism, Medicine and Mathematics. The major universities specialized in a particular discipline, for e.g. Takshashila University imparted courses on medicine, Ujjain university in astronomy except Nalanda which was the only university that imparted courses on almost all the subjects of study. Britishers record states that during medieval times Madrasas, literary societies and library were setup in almost all the villages of India. In the British controlled cities of Calcutta, Bombay and Madras, three union universities on the pattern of London University were established. The colleges which were existing were also affiliated to these universities. The main motto of these universities was to prepare students for careers in medical, law and civil services. The Britishers' established the first Industrial School in Chennai to promote technical education in India.

2. POST-INDEPENDENCE: RATIONALE IN INDIAN EDUCATION

The Modern India education system is deep rooted in the British era. It is in this era that English language was proposed by Lord Macaulay in the 20th century. As a result many missionary colleges were established throughout the country.

Post-independence in 1976 constitutional amendment took place and education sector came under both the central and the state governments. Under the Ministry of Human Resource Development's Department of Education Central government and State government jointly coordinated with the technical and higher education by specifying the standards and formulating the education policy and planning. With this varied history of the higher education system, the current system is chiefly patterned after the British system and few technical institutions in management and engineering follow the US pattern. Institutions of higher education emphasized on English language as a medium of instruction in universities, colleges and particularly in technical courses. English language was rooted in the Indian history and culture and modified as per the currently existing realities, political theories and vested interests.

The aforesaid paragraphs highlight that Education plays an indispensable role in the social and economic development of people and the nation at large. In this regard, the movement of higher education reform' in India in terms of it's linger history of disciplinary and interdisciplinary studies are always debatable. In post-independent India, the disciplinary format was reconsolidated in anew way. The existing separation between arts and science was then restructured into pure (or basic) and applied disciplines. This division of disciplines was thus predicted upon the ends to which a particular knowledge form could be put. Principles that govern and control all the systems in the universe are considered as pure or basic; and instrumentation or applicability of those principles comes under the applied category of concerned disciplines. However, in later time the disciplinary distinctions were no longer simply to do with methods, because by this time, the so called scientific methods had colonized all disciplines, including a conventional humanities subject, such as history. This was the hegemonic moment of Indian educational development.

In India, the scenario of higher education has been in state of constant flux. Prof. Yash Pal Committee's report *"The Committee to Advise on Renovation and Rejuvenation of Higher Education" in* March 2009commented on regulatory framework for Higher Education — "Where a holistic view of knowledge would demand a regulatory system, which treats the entire range of educational institutions in a holistic manner. All of higher education has to be treated as an integrated whole."It lamented that "What we have currently is a steel box of a system within which there are smaller boxes with no interaction with the outside or with each other." The report further elaborated on the fact that undergraduate programs need to be restructured to enable students to have opportunities to access all curricular areas with fair degree of mobility. "It is highly recommended that normally, no single discipline or specialized university should be created." It would mean that students would be exposed to multiple subjects under the roof of one university or college. Therefore, the report emphasized the need for interdisciplinary experiences and this should help students sustain themselves "when there is a demand of a particular job in the market change". It is asserted that "The steady decomposing of disciplines into specialties, and then of specialties into more specialties, operates across universities as an uncontrollable, self-amplifying phenomenon. Disciplinary subdivision is a powerful pressure for departmental sub structuring."(Auditi,2014)

Now-a-days interdisciplinarity in higher education is often associated with liberal educational tradition, which is related to the cultivation of certain values, leadership qualities, critical thinking, knowledge and ideals, and maintaining academic standard (Fraser, 1998). However, the controversy for interdisciplinarity emerge from altercation/deliberation/reflection surrounding disciplinarity. A discipline is knowledge or a concentration in one subjective field of study or interest. But the accelerating rates of scientific and technological innovation, globalization, hybridization of cultures, new information age, and growing fluidity in employment are among many changes that are portrayed as forces of fundamental transformations in the social and educational landscape and vis-a-vis. As a result, it is required to structure the intellectual and educational field. According to (Auditi, 2014), "Disciplinarity is now out-moded and quickly becoming supplanted by 'multi-', 'trans-', 'inter-'.We will discuss the emergence of the concept of interdisciplinarity.

In Disciplinary study, researcher's focus is on one area of specialization ordomain, gaining confidence and comfort in that particular area, and yet not be able to communicate and share knowledge actively with other neighboring fields. In today's scenario most often problems are less likely to reach up to satisfaction through concentrating only on one discipline. This realization forces us to advance in our thinking beyond single disciplinarity.

In multidisciplinary study, the study material is approached and applied from various angles, keeping in view the distinctive disciplinary context. But at the end neither the theoretical contexts nor the results of the various disciplines are integrated. This results to chaos opening many vistas for discussion without any apparent connection and the researcher gets puzzled and demoralized.

In Trans-disciplinary study, the study material is worked across and beyond several disciplinary perspectives in a unanimously agreed conceptual framework. Here, the theoretical context and results of the different disciplines are completely amalgamated at the end. The problem that can be encountered in the trans-disciplinary approach is that the assembling and recombining of information draws the mind to a puzzle about drawing out relevant connection between the element of information leading to nowhere or creation of a new knowledge.

An interdisciplinary approach, produces its own theoretical, conceptual and common methodological existence. Therefore, the outcome of an interdisciplinary study for a certain problem are more internally coherent and woven intricately. Moreover, the focus on synthesis and integration necessary for the cultivation of proficiency in multiple disciplines cannot easily be taught within the individual disciplines themselves. The new outcome is more than the sum of the individual parts. For Newell and Green (1998): "This process of synthesis requires an appreciation of the full complexity of the disciplines involved, especially an awareness of their often unconscious assumptions, in order to discern the underlying common ground or conflict between their insights. It is in these acts of conciliation and integration of disciplinary insights that the art of interdisciplinary inquiry is fully realized".

Unlike disciplinary programs where only same sort of methodologies materials are drawn. Interdisciplinary programs evolve around multiple methods or theories. Instead students of learning one or two theories or methods in detail, have to learn the core of many and how these can be integrated. Integration is of paramount importance here, because if there is a lacuna in it many theories or methods will be futile for the student. The tenacity in interdisciplinarity can only be accomplished by understand how, why, and what to integrate as a complete whole or promising innovation.

Heckhausen (1972) identifies six types of interdisciplinarity. They are presented in an ascending order of maturation:

1. Indiscriminate interdisciplinarity: In this category students are taught a little of every subject which is related to their allied field from other disciplines. It's a "touch and go" approach in which selected subject matter is delivered to students at the right time without any integration with theoretical basis or the interrelationship among the taught material is not specified.

For eg. The vocational training programme in carpentry, welder, fitter, electrician & plumbing helps in developing the skill.

2. Pseudo-interdisciplinarity: In this category while teaching a single course, common instructional tools are used across a variety of disciplines. The tools can be mathematical model or computer models applied for learning.

For eg. A student from any disciplines uses statistical and psychometric tools for interpretation and analysis of data.

3. Auxiliary interdisciplinarity: In this category methodology from one discipline is borrowed to support research in another discipline.

For eg. (i) A business school student is asked to find solution to a business problem by using Information technology tool or,

(ii) Law student is given a case study to analyses the litigation between two software firms suing each other for patent rights, or

(iii) Law student is given a case study to analyze litigation from crime investigation which is dependent upon the report and comments of forensic expert.

4. Composite interdisciplinarity: In this category knowledge of multiple disciplines is applied to draw out a solution for a common societa or organizational problem.

For eg.Disaster Management: In the discipline of disaster management the application of medical, public health, psychology, environment, geography and climatic change are prerequisites to composite and supplement the challenges required to design and implement these courses.There is a dire need for theoretical and practical applications of the different domains towards solving a problem with integrated approach.

5. Supplementary interdisciplinarity: In this category disciplines of the same field are overlapped in subject matter from multiple disciplines based on theoretical integration required. This overlap is intentionally done to provide a better picture of the subject matter.

For eg. An environmental course curriculum is jointly developed with faculty from Applied Sciences, Social Sciences.

6. Unifying interdisciplinarity: This happens when there is a consistency between two disciplines in subject matter, levels of theoretical integration and methods. For example, in areas where biology reaches physics.

In this category subject matter from one or more disciplines is completely integrated to produce a cohesive subject matter keeping in mind the theories and techniques required for implementation.

For eg. Biology and Chemistry is integrated to form Bio-chemistry subject and molecular biology, recombination of DNA technology and Information technology integrates to form Bio informatics subject.

A report titled "Reshaping the graduate education of scientists and engineers" by the National Academy of Sciences' (NAS) Committee on Science Engineering and Public Policy (COSEPUP suggested that the doctoral science students should be trained to become competent enough to indulge themselves and engage into interdisciplinary thinking and practice. (Chris & Hannah, 1999)

The existing system binds students to a single discipline and a supervisor from that very discipline that guides and facilitates research only in his area of expertise. This system inhibits interdisciplinary research by doctoral scientists as the existing system is designed in such a way, as to create silos around their domain of knowledge. Interdisciplinary research involves bringing together people and ideas from different disciplines to jointly frame a problem, agree on a methodological approach, analyze the data and create a new knowledge i.e. fostering creativity in research. There is a strong need to give impetus and momentum to interdisciplinary research and scholarship so that innovative knowledge can emerge in the education sector and it can counter extra specialization and also fragmentation of various fields of study.

A study by Federation of India Chambers of Commerce and Industry (FICCI) and Ernst & Young quoted that, The Indian Higher Education system has made tremendous progress in terms of capacity creation and enrolment in the last decade, but it lags significantly in terms of global relevance and competitiveness. This report was released at the FICCI Higher Education Summit held at New Delhi on 13th and 14th November, 2014. The report further highlighted that low employability of graduates is outdated curricula, shortage of experienced quality faculty, student-teacher ratios is noticeably high, there is a dearth/paucity due to limited institutional and industry linkages and lack of autonomy to introduce new and innovative courses. Indian graduates considered employable are small in proportion. This is reflected in the record that there is a trend of placement outcomes dropping significantly as we move away from top tier institutions.

Another report in 2014 titled 'Higher Education in India: Moving towards global relevance and competitiveness' stated that there is also a low impact research output and insufficient doctoral students in India.

Under Graduate education should not emphasize on delivering graduates who would further indulge into in- depth research or continue to study for extra specialization rather, the need of the hour is to give students a greater variety of experience, so that many career option are open for them throughout their professional lives and they can spread their wings wherever they want to in an another track of major or minor degree as per their aptitude and desire for enhancing their professional lives in that field of study. Students should be equipped with interdisciplinary knowledge, experience in collaborative subjects and capacity to ideally fit in the continuous transitory global job market.

Interdisciplinary research is a path to propagate scientific knowledge, wherein researchers/students from various disciplines harmoniously work in groups for a common goal by techniques and methods from other disciplines integrating and applying into a unified productive whole. It leads to creative and critical thinking. This is the hard currency of the time and those who can think in the right direction at the right time will become winners in the 21st century.

Looking at above mentioned requirement for today's graduates' interdisciplinary approach is the buzzword in education. Interdisciplinary approach varies from multidisciplinary and trans disciplinary approach on the basis of the number of disciplines involved, manner of interactions, goals and skills involved. Multidisciplinary involves working with several disciplines and members from different disciplines work independently with individual goals. They use separate methodologies and outcomes is the sum of the individual efforts. Trans disciplinary involves working across and beyond several disciplines. It involves members from academics, non-scientific and stake-holders. All of the members from different disciplines share common goals and skills towards holistic approach and collaborative outcome.

Interdisciplinary is the best examples of team work in which all members get together to work as an integral whole to design new curriculum and develop novel tools to evaluate pedagogical techniques towards more rapid, efficient and timely skill development. This way of teaching and learning pays long dividends by building democratization of knowledge thereby empowering learners in the society. This will benefit in upbringing and harnessing tolerance towards peers, cooperation & collaborative skills, leadership skills, strong personality and methods for assessing pedagogy with a more balanced approach. The technical outcome is long lasting learning and acquiring higher order skills with holistic development of students. The student's become inclined to wider disciplines, wider knowledge, wider tools & techniques can think on bigger perspectives of interdisciplinary sciences. This will in turn develop in students more confidence, greater inspiration and motivation to think out the blue and create new knowledge.

Interdisciplinary approach nurtures in students more versatile talent, adaptability and ability to integrate methodology and pedagogy in a balanced form. The outcome of it is that learners are more multitasking, multifaceted in approach & develop multi-skill with deeper understanding of technical updates. Students who have acquired interdisciplinary skills will be an asset to our future and they will be more in demand by colleges and entrepreneur or any other industry. These students will be at priority for admission to top colleges as the nurturing of interdisciplinary skill in them will lead to demanding discoveries and innovation. It will activate their personal growth and academic skills.

We can generate an example of an environmentalist, who is involved with a team, tries to solve the problem of "Cleanliness Drive for a River". In order to be a successful, he may find it just necessary as will any practitioner of interdisciplinary study to develop an understanding of affecting disciplines ranging from geography, social sciences, impact assessment to the culture of that area. The interdisciplinary research should be promoted by generation of knowledge through new stipends and scholarships, the faster reliable social network across different disciplinary, through liberal approach among people by fostering research attitude, inspiring culture of asking support and offering help to others by open mindedness and positive discussions.

Another perspective of Interdisciplinary Research in academia is as under:

(i)   Researcher tends to lose focus on the core areas of research.

(ii)   The researcher feels isolated from his peers Rahul Kanakia (2007) said that"In contrast, interdisciplinary studies focus on the fringes of a field, which lowers an academic's reputation in the eyes of his peers and hurts his chances for tenure".

(iii)   Choosing a supervisor who can help in developing his professional relationships is very crucial for the student.

(iv)   Mastering tremendous, knowledge, information and methodologies is essential to a researcher for producing its research in depth.

(v)   Difficulty in achieving Research Goals as integrating divergent discourse is not everybody's cup of tea. A student during Ph.D Research can go off track as the epistemological stones of disciplines vary and it leads to challenges and misunderstanding.

(vi)   An interdisciplinary student needs to find faculty who can provide intellectual input and peers to provide emotional support, and a safe arena for synthesizing and honing new ideas. Student feels intellectually homeless, without a place to share interests and long-term goals.

(vii)   Didactic training of faculty as interdisciplinary does not mean simply recomposition of old studies—conventional method of work assembled under a new heading. It requires strategies for faculty preparation and support to the researcher.

(viii)   Overcoming Fears as research student often perceive their options to be restricted. They are significantly dependent on faculty and as a result, students often act fearfully and avoid taking risks.

(ix)   Another fear is that the traditional academic job market is now more difficult to enter and most jobs are located in traditional departments, and students whose work is hard to categorize in traditional ways may be at a disadvantage. (Chris & Hannah, 1999)

(x)   A challenge at the institution level is that the interdisciplinary curriculum needs an approval from the Academic Council or other administrative committee for implementation. Presently, there is no system for development of cross curriculum in Educational Institutions.

(xi)   The academic system is still very much structured on the concentration of specific majors as disciplines and the integration of interdisciplinary studies have become unusual to the traditional fields of study.

(xii)   Although interdisciplinarity is a buzzword in academia, but not many universities have been able to pay more than lip service to this emerging discipline as it very natural for academia to resist studies in interdiscipline.

(xiii) There will be many concerns about the quality of interdisciplinary studies.

Thus, looking at the above perspectives it becomes necessary that higher education in India needs a makeover which is inevitable, if we desire to create better opportunities for employability, growth, ingenious and innovative research in the country.

In 1995 a pioneer model on Interdisciplinary research was established in the name of Centre for Clinical Science Research at Stanford University (USA). The building was designed to support and promote emerging trends in biomedical research. This building has few walls with the vision that instead of researchers grouped in lab benches they can intersperse among themselves in the entire building freely interacting and exchanging their ideas. This building has had a significant impact on the architecture of research facilities around the globe. They have set new international technical standards and represent an innovative research environment. Here interaction between disciplines and individuals is encouraged as an essential part of daily working life.

Thus, interdisciplinary approach develops on the base of disciplinary knowledge to produce new knowledge and solve difficult problems. This approach aims at cultivating skills like adjustability, adaptability, critical thinking and ingenuity. An ability to ponder and work across various disciplined boundaries is becoming more demanding than ever. An outstanding interdisciplinary programme in addition to focusing on new ideas for solving problems uses critical thinking skills desired of most liberal arts programmes should also work to develop in students capacities to assimilate or synthesize disciplinary knowledge and styles of thinking.

To cultivate and promote interdisciplinary approach, higher education institutes in India have to revamp their system as in the forthcoming years interdisciplinary research would be the key word for creation of new knowledge. The existing higher education system will have to work on the following strategy to enhance interdisciplinary research as this is a pressing demand in the academia.

Firstly, planned expansion and implementation of differentiated university courses termed as choice based credit system, flexi credit system and an academic curriculum which will focus on being centers of excellence for the creation and dissemination of new knowledge and also to emerge as leaders in research output and intellectual property.

The expansion should be planned in terms of broad based highly accessible holistic approach to develop highly skilled mass of graduates playing a major role in promoting research and innovation.

This planned expansion help to solve problems of required infrastructure and human resources availability development to develop knowledge based ecosystem in society.

The designing of spaces for fusion of disciplines – Efforts to be made for creation of Social and physical spaces where people with continuously come into contact with people outside their field of study in a conducive natural, social setting repeatedly. This will enhance social interaction and networking which will result into a source of cognitive inspiration and creativity for achieving interdisciplinarity.

The University Campuses would play a major role in building strategies that foster cross-disciplinary interactions within academics of medicine, humanities and social science as whole, which will work and research together under innovation incubators and young enterprise startups toward ideas grooming up into solution providers and product developments. It is necessary that at graduate level one should think of becoming specialized and fully indoctrinated into the academic realm mindset, which leads to whole university population to mingle and exchange their creative ideas.

Secondly, the transition from teacher centric to designing student centric learning where teacher will act as a facilitator in opposed to be an instructor in order to develop greater zeal and passion for acquired learning and also encourage them to take greater responsibility in the job sector.

By motivating and giving freedom, flexibility to students to learn in a self-directed manner will lead them to be independent and critical thinker. This paradigm shift in the education industry will enhance the countries entrepreneurial ambitions as well as innovative capacity that will result in landing up and fostering more research oriented approach to develop strong human resource base thereby changing the work culture. The more active and trained learner will help out in developing a dynamic and agile workforce for the country.

Thirdly, ICT integration in the curricula will be a boost to interdisciplinary research. It is noticeable that we are living in an age of information outburst. Even a single discipline cannot hope to apprise students with the full knowledge of disciplinary research. In such a dynamic environment, education should not restrict itself on the transmission of a set of facts or silos. Rather, it should stress on acquiring skills such as querying the right question, knowing from where to delve for information, and knowing how to use it via internet etc. The interdisciplinary process engages students into such skills, and is therefore, explicitly well suited to the needs of current students.

Fourthly, Interdisciplinarity helps in Solving Real Life Problems– Student's mastery of interdisciplinary research practice will gear them to do well for life as life itself is an adventurous experience. Programs that can demonstrate success in acquiring interdisciplinary skill not only serve their students but fulfills the broader mission of universities to prepare students for life in an intricate/ tangled world.

This can be achieved by creating more opportunities that will bring together scholars from various disciplines and it would hopefully create a desired for academics to look on the surface beyond publication counts and allow their work to see how their research can be utilized in solving real world problems.

According to Klein and Newell, 1996, (p. 395) "A process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession . . . Interdisciplinary studies draws on disciplinary perspectives and integrates their insights through construction of a more comprehensive perspective."

Fifthly, Interdisciplinarity is the only paths which activates/ ignites the cognitive domain to critically examine one's own disciplinary work from the angle of another disciplinary work.

Sixthly, interdisciplinary research work is the only work which calls for cross functional and collaborative approach to learning. New pedagogies of learning like communicative approach, peer tutoring, constructivist approach, cooperative learning and blended learning are actively implemented.

Seventhly, the global challenges across the world are - Environmental Governance, Sustainable Development, Human Rights, Climate Change, Wildlife Conservation Water Preservation and Conservation, pollution can be dealt with a new comprehensive problem solving approach. Thus, some *common platform* needs to be realized that would assemble the understanding of various disciplines. This will lead to intuitive knowledge, creativity and inspiration. History of science reflects on many scientific discoveries resulting because of creative reflection and integration of ideas in a dynamic mind and bringing out the bestout of the intangible thought to tangible assets in the form of intellectual property.

Eighthly, Low doctoral education capacity will get a boost with interdisciplinary research. Students will enroll more as in the near future interdisciplinarity will be a passport for emerging white collar jobs in the contemporary job market. It will also uplift the research capita in the country.

Lastly, interdisciplinary research will awaken the dormant talent of an individual. We know that every individual possesses some talent of which he is not aware. Students due to lack of guidance enroll in a course in which they do not have an aptitude. This type of research is a gateway to indulge into one's area of interest simultaneously stimulating in the minds of the researcher a passion to create new knowledge.

The various interdisciplinary programmes running across the country and abroad, In US a new interdisciplinary degree called Professional Science Masters (PSM) is in high demand and advertised with the main aim of this course is to impart professional knowledge in humanities sciences and social sciences. The eligible graduates will acquire both disciplinary competency and business proficiency skills. In India, Jadavpur University has created twenty one schools of

interdisciplinary studies to develop in students, what American development psychologist Howard Gardner calls a synthesizing mind. Calicut University in India, switches to school of study system. The school system has been introduced to promote closer collaboration between related subjects and to encourage students take up interdisciplinary studies.

3.   CONCLUSION

Interdisciplinary research is a crossbreed of many disciplines which is very dynamic and responsive to the rapidly changing job market. Interdisciplinary studies can foster in students creativity, adjustability, adaptability, critical reasoning, collaboration, etc. Skills to negotiate today's complex, information-rich, dynamically-interconnected world. Through exposing students to two or more inter-related disciplines, they can better comprehend the complex interconnectedness playing out in real life. Also, they learn how best to negotiate and contribute to a vibrant global economy. Interdisciplinary education is essential to develop research trajectories that do not conform to standard disciplinary path.

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