

# Sustainable Education in India through Artificial Intelligence: Challenges and Opportunities

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## ABSTRACT

Education and Artificial Intelligence (AI) can be complimentary to each other. Over the period the state of education in India has been influenced by some good reforms in education system and its implications are immensely towards positive side. AI being the latest technological advancement can be an approach for sustainable, smooth and transparent solutions. AI enabled technology can fill the existing gaps in the present education system. This paper traverses the key issues of the Indian education system with the objective of proposing some solutions which are inspired by the AI innovations having the sustainability as a significant part of it.

## KEYWORDS

Education, Artificial Intelligence, Sustainability, Transparency

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## 1 INTRODUCTION

Indian education system is going through a phase of change. Apart from this it has various issues related to planning, recruitment, governance, etc. The access targets has been largely covered in the primary and secondary education, but in higher education it is in initial massification stage. It is one of the sectors in India, which is in dire need of some interventions based on smart machines and related technologies.

Artificial Intelligence is increasingly becoming a part of our daily lives. Its magic is being tapped in many sectors. In case of India it has already intervened in the intelligence, security, and banking areas. One area which really needs it is education. Though some start-ups has come up with some innovative ideas; but the crucial thing is to understand the demand side of it. In other words, it is pertinent to know what exactly is the ecosystem of education

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in India and what are the relevant issues it is facing. AI will be a nothing less than a boon for the Indian education sector. It is the need of the hour to give opportunity to various AI platforms and systems to innovate for the existing problems of Indian education sector.

This paper is exploring the role and intervention AI can play in the Indian education system along with a sustainable approach; to further the agenda of acknowledging the existing concerns thematically, in order to cover the different functions which happens in educational institutions and the related organisations to it. The paper is divided into four parts. First part deals with the literature review or the related work which has been done in the combined field of AI and education. Second talks about the ecosystem of Indian education system, where various existing issues have been thought upon. Third section is trying to understand the scope of AI in education. Final and fourth section has covered the challenges and opportunities which may come upon in this field.

## 2 RELATED WORK

Education sector has been undergoing many changes and facing various challenges in its overall functioning. AI is one of the latest and radical technological intervention in the field of education. In this section literature relevant to the paper has been presented and thoroughly discussed.

### 2.1 Artificial Intelligence and Education: A Winning Combination

This subsection is canvassing the role artificial intelligence has been playing in resolving some of the issues of education sector.

The data driven support for the stakeholders of education will help in their growth and development [5]; however, it has been asserted in one of the study that by the application of statistical models and analysis educational institutions can experiment with their data to get an idea regarding the learning experience of the students and how improvements can be done in future; which can be further measured in the domain of efficiency and effectiveness[6].

In the same league Ifenthaler et al. (2019) opined that the static and dynamic information regarding the learners can be utilized for further enhancing the learning environment. It can also help in assessing it for getting the real-time modelling, predicting and optimizing the learning process. It will smoothen the process of educational decision making about learners [17]. Further, in another study it has reflected that the Artificial Intelligence in Education

(AIED) is basically a research field which imbibes an interdisciplinary approach; i.e.; it includes the contents of psychology, pedagogy, sociology, linguistics etc. to understand and reflect upon through a solution which caters all probable interdisciplinary issues related to ecosystem of education[23].

Chassignol et al. (2018) have reflected that by using the AI based applications such as, Intelligent Tutoring Systems, Learning Management Systems students can be given continuous feedback regarding their performance and it helps to ease the assessment of students. Personalised educational contents can also be made which can cater the individual needs of the students and can efficiently evaluate their performance [7]. AI today is working with many stakeholders for publishing, sharing and accessing the Open Educational Resources (OER) has been discussed in a study of Meca et al. (2019). It also discusses that there are many factors on which the academic performance is based and evaluation should be done in coherence with that. They have given a methodology which can perform the task of students' evaluation and can correlate it with their performance. It includes 30 socio-economic and economic variables along with the final numerical grades; which is represented in two data sets for further analysis[24].

AI based learning can also create collaborative learning platforms based on the learner models. This is usually done via online group interaction. Intelligent Virtual Reality (IVR) uses game based learning environment. Virtual agents act here as teachers, facilitators or students' peers [26].

A report named Horizon Report 2019 Higher Education Edition states that there is probability of 43% growth in the AI for education from the period 2018-2022, having specific choice for the AI based teaching and learning applications [3]. Intelligent Tutoring System (ITS), is an important aspect of the AI based use of education technology. It helps in personalised tutoring. It is based on the learner models, algorithms and neural networks; which creates a specific learning path for the student by engaging itself with the specific needs of the student. This is possible in most of the virtual classrooms for the students. Also it can be attached to a common platform for learning via social interaction i.e. peers.[18]

## 2.2 Education, Sustainability and Artificial Intelligence: The Need of the Future

This subsection is discussing the sustainability factor linked to the induction of Artificial Intelligence in education sector

UN in its report Transforming our world: the 2030 Agenda for Sustainable Development (2015) stated as, *Quality education: Obtaining a quality education in the foundation improving people's life and sustainable development*. Similarly, Akcapinar et al. (2019) have supported this by saying that through AI there are good probable chances of minimising the daily tasks of teachers which eventually supports the teaching-learning process and enhances the learning experiences of the students[2].

Cedric Villani in his report of 2018 (being chair of the French committee) stated that education needs transformation[34]. Also, Tuomi et al. (2018) in the report *The Impact of Artificial Intelligence on Learning, Teaching, and Education* discussed the different aspects related to learning and AI [32]. In one of the position document of Organisation for Economic Co-operation and Development (OECD)

in 2018 it has been discussed that there is need to transform the education through technology; which has also been covered in the Sustainable Development Goal 4 (in September 2015 it was adopted by the United Nations). AI is being addressed by the communities in multidisciplinary way, UN, European Union and many other organisations have been funding researches on it, having the significant target of making AI useful for the education.

It is an emerging industry, and will have a bright future; de la Higuera (2019) discussing the report of UNESCO Information and Communications Technology (ICT) competency framework for teachers of 2018 stated *the 6 aspects of a teacher's work are scrutinised with respect to a goal of making use of ICT for better teaching: A1 Understand ICT in Education: how ICT can help teachers better understand the education policies and align their classroom practices accordingly; A2 Curriculum and assessment: how ICT can allow teachers to better understand these questions but also intervene and propose new modalities; A3 Pedagogy: how the actual teaching itself can be positively impacted through the informed use of ICT; A4 Application of Digital skills: how to make use of the new skills acquired by the learners to support higher-order thinking and problem solving skills; A5 Organisation and administration: how to participate in the development of technology strategies at different levels; A6 Teacher professional learning: how to use technology to interact with communities of teachers and share best practices*[13].

## 2.3 Artificial Intelligence and Indian Education Sector

This subsection is presenting the current status of Artificial Intelligence in the Indian education sector.

Artificial intelligence is already there in various manufacturing and services sector in India and has proved as a game changer. In recent years it has started touching the education sector also; but it has not reached to the level of disruption and radical change [29]. There is ample of scope that AI will be a boon for the education sector as well in India going by the size of the market which it can provide to improve the learning and life outcomes for students.

In the document of National Education Policy (NEP) -2019, the Ministry of Human Resource Development (MHRD), Government of India has envisaged that AI will play a very significant role in the coming years of Indian education system; right from the kindergarten to the PhD level of education. AI will strengthen the current working force and the resources available in the Indian education system[28].

The AI in Indian education system has recently emerged; its wider use will definitely bring out significant changes in the overall experience of the students. It will affect every aspect of the education, from governance to the experience of teaching and learning[8]. Massification, especially in higher education sector of India has been happening in recent years (though it is already there in school education), will be a booster for the induction of AI in various areas of functioning of educational institutions because of workload.

AI can play a very prominent role in Indian education system in providing feedback and guidance to the students, learning analytics, evaluation of curricular material for their quality, adaptive learning etc. There is huge potential to infuse the AI in various domains of education sector creating a unique experience for learners[4].

There is lack of teachers in the education sector of India. *Data from research firm Tracxn recommends that more than 300 Indian startups use AI in their core product. About 11% of them are a part of the educational sector.* With the coming time it is going to take up the pace in market through customisation, data crunching and through various modifications in present structure of functioning of education sector [15].

### 3 INDIAN EDUCATIONAL ECOSYSTEM: AN OVERVIEW

An important aspect of the needs in education sector is the variation it possesses. To accommodate the diverse requirements of the educational organisations, first approach is to understand it thoroughly. This section will give a glimpse of the issues which Indian education system is facing.

Recruitment of students in the presence of inadequate infrastructure with high student-teacher ratio<sup>1</sup> creates difficulties for the teachers and academic staff in performing their duties effectively [30]. While one reason for this skewed ratio is the shortage of teachers in India and since most of the academic interactions happen in face-to-face format, it severely affects the quality of such interactions. This process requires a complete overhaul change in the teaching-learning activities happening in the educational institution.

While there is a dire need to divert most of the attention of policy makers and other stakeholders involved towards lowering the student-teacher ratio, technological interventions with the emergence of modern methods such as artificial intelligence have an ever increasing role to play. In this context, focusing on providing personalised learning experience for the students can be a good option. Another good step can be making the Open Educational Resources (OER) available for the students in accordance with their needs, further linked to their continued evaluation and assessment.

Another major issue is the alleged unfair recruitment of students. Most of the interdisciplinary subjects can be applied by students of any background (stream); entrance exams usually include Multiple Choice Questions (MCQs) following with an interview. Teachers have experienced that majority of the students do not have the required intent and zeal to undertake and proceed with the interdisciplinary programs, as the screening process of using the objective method of MCQs and interview is not enough to understand their intent of choosing a particular course or program. If there will be an AI based platform which can gather the data based on some variables from the applicants when they apply for the program; it can significantly improve the process of understanding their intent in a less biased and transparent way.

Guidance and counselling of the recruits/students in an educational institution is a determining part in maintaining their work-life balance. There is already massification going on in the Indian educational institutions which represents students from different religious, caste and ethnic groups which is leading to more inclusive educational campuses. With the increase in Gross Enrolment Ratio it is being estimated that in coming time it will be more from the

category of first-generation learners. In this inclusive nature of the educational campuses there is also need of proper guidance and counselling[33]. Students do face a lot of professional and personal issues in their work-life which needs a healing approach to counter those issues. For example, if a student is facing issues in his/her personal life it may get reflected in the grades. But most of the time it does not get into the notice of administration/teachers. A conducive platform which will be able to track the issues students are facing in personal and professional life and also their mental health will be very useful for initiating the guidance or counselling process. There is need to consider the relevance of guidance and counselling services in the educational institutions of India. Policy makers have to give importance to this for improving the overall experience of students in the educational campuses.

Conducting examinations for the students and doing evaluation accounts in the list of functions which educational institutions have to carry out. It is a very hectic and lengthy work for both the teaching and non-teaching staff; and needs some new ideas through which it can be made less tiresome and can be conducted in less time than the existing one with transparency. Also, the examination system which is pen-paper based (usually happens at the end of the session or end of the semester) cannot evaluate the students properly; and the process of grading the students based on their performance is not transparent enough too. The existing system of examination in Indian educational institutions needs drastic revision, otherwise major issues related to execution of whole examination process will persist[14]. Academic community and policy makers have to be more cautious about it and must look for the proper remedies and alternatives. It is important to focus on continued evaluation; and through the intervention of some technology.

Quality assurance in the educational institutions requires a lengthy process of monitoring and evaluation of their performance, involving lots of paper work, which many times leads to corruption because of minimum or no checks and balance on the whole process. This whole process is related to funding also. There are ways and methods which state that quality has to be linked to funding of the educational institutions. In India, National Assessment and Accreditation Council (NAAC) keeps the track on the quality issues of the higher educational institutions in India and based on the recommendations of the team's appraisal report grading is done[11]. But there are many said and unsaid complaints regarding the biasedness of the team members. For this there is need of a system/platform which based on variables of different quality parameters (which can give a holistic picture of the performance of the institution) can assess the performance and allot the grades with transparency.

The interaction in the classroom between teachers and students is a significant part of the educational institutions including university education. *This is the model that has effectively been in force for about 1,000 or 6,000 years depending on whether one sees Bologna or Nalanda as the initial reference point; also Classrooms above a certain size can become ineffective....* Teaching-learning process in the educational institutions, a pressing issue which students usually face is which course/paper to choose? They hardly get a platform where they can get answers to their probable queries related to their choice. Many times they go ahead for the choice either by the peers pressure/influence or sometimes by consulting their teachers,

<sup>1</sup> A report of India Today news portal mentioned about the student-teacher ratio in India, where it said that India is behind Brazil and China in maintaining student-teacher ratio

subject to their availability for discussion or interaction separately. Students will definitely like a platform which will provide them answers to their queries for the selection of course/paper. So, with time and the changes that are taking place in the educational institutions regarding the increase in the strength of students there is need to discover other alternatives in terms of educational technology for the interaction between teachers and students[27].

Student loan system in India mostly caters the need for technical courses. Many times students face issues in getting their loans sanctioned from the institution. It is usually based on the criteria of low income of parents/guardian; but this criterion alone is not enough for sanctioning and continuing with the scheme. Hence variables related to their performance in academics and other non-academics can be utilised for keeping the process more efficient and transparent. A technological platform which is transparent and efficient in covering this issue will be a boon for this.

Planning is another dimension which lacks efficiency at present in Indian education system. At the level of regulatory authorities, they are not able to advice the concerned educational institutions to update their curriculum regularly. It is because they are either overburdened by other works or the people who are taking care of it are not much competent to understand these issues. A platform which can identify the issues, that whether the curriculum is updated or not? Since how long it has not been updated? And also can focus on the contents of the curriculum which is no more relevant. It can suggest to the educational institutions that what is to be removed, replaced or updated in the curriculum content.

Administrative procedures of educational institutions plays a crucial role in their functioning. For example, it includes the applications (as part of grievances, leave etc.) submitted by the students or other stakeholders of the institution. However, since there is a hierarchical decision making involved, the students usually face harassment not only in terms of time taken for the overall process but also in terms of the embarrassment they face on daily basis for their applications to get processed. It is important to address these issues through some technological innovations and making the administrative processes convenient and transparent for the students.

Performance and accountability of teachers in educational institutions has to be ensured for the proper functioning of the teaching-learning process. It is also significant for the career growth of the teachers, through Academic Performance Index (API) scores it is evaluated. But the API score process is not smooth; teachers specially taking up the undergraduate classes have a very hectic schedule and do not get time to fulfil all the criteria of API score. Summarily, there is disenchantment for the API score process amongst the teachers. Also, the process of getting the feedback of students is very old and mostly pen and paper based, many times not transparent[10]. Further Das and Chattopadhyay (2014) said, *In a system which thrives on malpractice, and the inherent problem of quantification of academic performance, increasingly, teachers are resorting to alternative means to accumulate points that are best described as unfair. There has been a proliferation of journals, most of which lack credibility. Paying for publication has become common. The participants in a seminar are now more interested in certificates for participation and presentation rather than active engagement in meaningful deliberations. The renewed vigour among teachers and*

*young researchers to publish is explicable by the need to score points. Though the API seeks to curb malpractices, in reality, there are an increasing number of cases of rampant abuse of the system*[10]. If there will a better technological platform to replace this process or do some innovations within this API score process it will fetch satisfactory results for evaluating the performance and accountability indicators.

Macro level administrative issues are existing where there is need of proper coherence and coordination amongst various regulatory bodies, educational institutions and policy making bodies. For example, if a new course has to be started the particular department of the concerned educational institution has to take approval from various regulatory bodies; organisations and the process is so complicated that many times the funds which are supposed to be allotted for the same gets diverted for some other work because of the delay in launching of course by the department (because of the lengthy and tiresome process of getting the approval). The department has to wait for the funds for one or more years. There are several other issues which arise out of the consequences of not having coherence and coordination amongst various regulatory bodies, educational institutions and policy making bodies. A system devised for resolving this issue of coherence and coordination amongst various regulatory bodies, educational institutions and policy making bodies will be an advantage for smooth and transparent functioning of the system.

Non-teaching work of teachers is one of the prominent duties or organisational tasks which they have perform in the educational institutions. It may be related to evaluation, some paperwork for the students, weekly/monthly reports, order and procurement of study materials, interaction with parents, etc. Much valuable time of the teachers goes into these non-teaching activities. If these activities and functions can be processed through the AI based systems it will be a boon for the teachers and they can get more time to focus on their activities. AI systems can do give a first-line interaction with parents and provide access to resources for proper feedback as per requirements.

## 4 SCOPE OF ARTIFICIAL INTELLIGENCE: THE ROAD TO FUTURE

In the context of the Indian system of education there is enormous potential for modern disruptive technologies to make an impact. While one of the reasons is the emergence of straightforward rule based procedures which simplify most of the ambiguity in administrative procedures, there is absolutely no doubt that the rise of data leading to data driven policy making has brought the idea of analytics at the centrestage. We will attempt to explore the potential of artificial intelligence as one such emerging and disruptive technology in the domain of education by viewing it through the spectrum of various pillars supporting the educational ecosystem.

### 4.1 Recruitment

In India, for the Joint Engineering Entrance (JEE)- Main April 2019 exam, a total of 10,51,508 candidates had registered. For Paper 1, 935741 candidates registered and for Paper 2, 115767 number of students registered. Each of these individuals will be acting as unique individual data points with information distributed across many

attributes such as personal attributes (for e.g. age, gender etc), performance attributes (for e.g. marks scored in each of subjects and under different topics), demographic attributes (for e.g. place of residence, place of examination etc.) and many such features. The idea of having such a massive amount of recruitment information while at once leads to analytics for data driven policy making to improve performance of under-performing demographic regions as an example, it also calls for utilising the data gathered to create personalised recommendation systems to aid during the recruitment. Such a recommender system has enormous potential to reduce the dropout rates from higher educational institutions where students mostly suffer from the lack of interest about the assigned course or program and institutions suffer from the double dilemma of deciding the criteria for prioritising students for various courses and then monitoring their performance for any possible transfer.

## 4.2 Guidance and Counselling

Some challenges that still pose grave threats to the healthy functioning of an educational ecosystem are the phenomenon of dropping out and committing suicides. While in India, the dropping out still remains at large a significant problem, the suicides have also been emerging as a serious concern. There are various reasons for the dropout ranging from socio-economic attributes to lack of interest in education. To get the early warning regarding the dropouts can be taken into consideration for countering this issue of dropouts. As many as variables can be formulated to make a system which can track and predict the early warnings regarding the students who can dropout in future so that maximum retention can be achieved. While predicting these phenomena remain at large in the hands of academic instructors directly in contact with the person at risk, technological solutions emerged recently have drawn the attention towards some early warning methods using artificial intelligence and machine learning models based on the academic performance and extracurricular data of the person-at-risk. In this context, methods similar to the one adopted by the US Army, known as Army STARRS[20] shed some light. Similarly, there have been some success in predicting dropouts in the Massive Open Online Courses (MOOC) [22]. Such methods are highly scalable and maybe adopted in the context of educational institutions as their worthiness is already proven in e-learning context. However, it is a well known fact that such early warning systems are effective only when there is a significant participatory effort from all the stakeholders involved in the interaction. It is therefore necessary that mutual trust building must be encouraged simultaneously than mere functioning of the technological interventions deriving intelligence out of such interactions.

## 4.3 Examinations

While there is already a significant amount of progress in adopting some of the best practices for conducting examinations for various examinations and appointments, there is still a long way to go. At the present, the limits of technological interventions are restricted to the domain of objective question answering based on multiple choice questions where optical mark recognition methods are already deployed and operating since long, however, there is not much done for evaluating subjective question answer based

schemes which still constitutes a major chunk of examinations conducted in the country. The recent advances in Natural Language Processing (NLP) powered by fast computing capabilities of the cloud have already lead to creation of frameworks which are able to generate question-answering models. Such models once trained on the examination-specific corpus may act as model answers of questions and the candidate answers may be scored on the basis of similarity of content with the model answer. It will not only reduce the workload of the academic staff but also has the potential to improve the quality of examinations where individuals can be evaluated on both objective as well subjective standards which at the present seems difficult to enormous time and material resources needed to conduct subjective examinations.

## 4.4 Teaching and Learning

The idea of a course recommender system based on the skill, past performance of the student and the majoring subject as features is long debated but still awaited by the students in institutions of higher learning specifically. The application of machine learning algorithms for recommending courses in e-learning based environments has already been a major success [1, 9]. Such systems take into account the historical course selection records by the student. Now, when most of the institutions have already adopted to their own enterprise resource planning platforms [35], these intelligent systems have the potential to build robust models using the data of such platforms. These systems have the potential to improve talent management where students will chose the courses they may study based on their career track and majoring subject instead of following only their peers while enrolling for semester courses.

## 4.5 Finance

In the recent years, a huge boom in the digital payments and credit issuance has been observed. One of the reasons behind that is the emergence of various Application Programming Interfaces (APIs) providing a variety of validation data about an individual's attributes. The providers of such APIs range from governments and huge corporate to even emerging startups. Such an ecosystem has facilitated the approval and sanction of credit cards using machine learning methods which is one of the reasons behind the digital payments being popular [12, 21, 31]. Educational institutions have a huge potential to benefit from the arrival of such technologies as they may go digital for their student finance procedures which includes deciding most relevant candidates for scholarship sanction and renewals, prioritising students for decision making for granting financial aid etc.

## 4.6 Planning

Generally, the idea of planning is considered a participative process. However, due to lack of adequate infrastructure and resources, it remains restricted in the hands of the top brass to plan for the entire organisation which goes against the ideas of participative and decentralized planning. Artificial Intelligence has immense scope to make planning more inclusive by considering the reviews and feedback which institutions receive in-house or from external sources and analyse them to make demands of every stakeholder visible. Such a process utilising Named Entity Recognition tools

of Natural Language Processing can be deployed for making and updating topics and courses in syllabus based on student demand or to decide which areas to allocate more resources for the infrastructure development of the institution. With the rise in the demand of explainability mechanisms, such tools will not only promote inclusiveness but also ensure transparency.

#### 4.7 Administration

Routine administrative procedures also have a lot of scope to gain from the recent advances in artificial intelligence. For example, the application of artificial intelligence for making smart decisions about sanctioning loans has already been implemented and being used by many bank administrations [16]. Therefore, the idea of having a smart system that can decide the sanction of student applications for leave, course change or even foreign exchange seems feasible and relevant. Most of the organisations already have in-place procedures to process such applications digitally which makes available a huge volume of data for training sophisticated machine learning algorithms if there is a need to go beyond the simplified rule based decision making. Now, although it appears exciting to hear about the automation using the data, it must not be forgotten that in such administrative procedures, the most important phenomenon is the idea of human accountability. Therefore, while implementing such mechanisms, it must be assured that systemic accountability is ensured along with a human in the loop mechanisms to periodically review the grievances against the automated systems.

#### 4.8 Accountability and Performance Monitoring

Almost all of the educational institutions have a practise of reviewing the capabilities of the academic staff in terms of post-semester reviews in which all the stakeholders participate how had been the part of the specific educational ecosystem. In such reviews, often there are questions based on both quantitative as well qualitative indicators. While the quantitative responses are fairly easy to analyse, the qualitative responses are often extremely difficult to understand in an environment where deadlines are rigid. For example, it is a difficult to analyse polarity of the textual reviews about a particular faculty teaching a specific course but it becomes worse when we attempt to make a sense of bad reviews only in order to create target the deficiencies and eradicate them by drafting guidelines for all the academic staff. Now, such difficulties can be addressed by involving the sentiment analytics based polarity scorer which can be coupled with entity extractors to extract specific reasons for the criticisms or appreciations. It can not only improve the present system but will also make the system more fair, accountable and transparent. However, even such systems are not fool proof by assuming that decisions are made by computer which is generally assumed to be unbiased. Since, it is the data based on which the decisions such as sentiment scoring are made, it is therefore essential to identify and mitigate any human bias in the data before it is used for modelling.

## 5 CHALLENGES, OPPORTUNITIES AND CONCLUSIONS

While we have discussed some of the major challenges in the education system in the context of India, such challenges are equally valid for most of the developing economies. The ideas of having applications of modern technological advances in artificial intelligence pose a great hope for making educational sustainable not only for India but for the world as a whole. However, in order to exploit most from this available opportunity, we need to have institutional frameworks along with government interventions. In other words, for developing algorithms for smart decision making, either based on rules or driven by data, we need either well established rules for decision making or extensive amount of data for training models.

In the context of India, the Government of India has adopted to institutional frameworks which allow for structured formats for data collection across a wide spectrum. Such interventions have led to the creation of National Institutional Ranking Framework (NIRF) [25], Unified District Information System for Education (UDISE) [19] (initiated in 2012-13 integrating DISE for elementary education and SEMIS for secondary education is one of the largest Management Information Systems on School Education covering more than 1.5 million schools, 8.5 million teachers and 250 million children) etc. Further, the adoption of National Strategy on Artificial intelligence by the National Institution for Transforming India (NITI Aayog) is another welcome step in this regard.

However, despite having such huge data-sets and policy based interventions, the procedure for applying artificial intelligence is not as simple as it appears. There are inherent challenges associated with artificial intelligence algorithms which must be addressed. Some of them are described here-

- (1) Privacy and security
- (2) Fairness and Bias Correction
- (3) Interpretability and Transparency
- (4) Governance, Accountability and Legal Frameworks
- (5) Human Resource and Finance

It is therefore important that we must begin the debate on the ethics and safety of intelligent systems instead of merely developing large scale applications which are designed without considering human rights and issues of public importance.

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