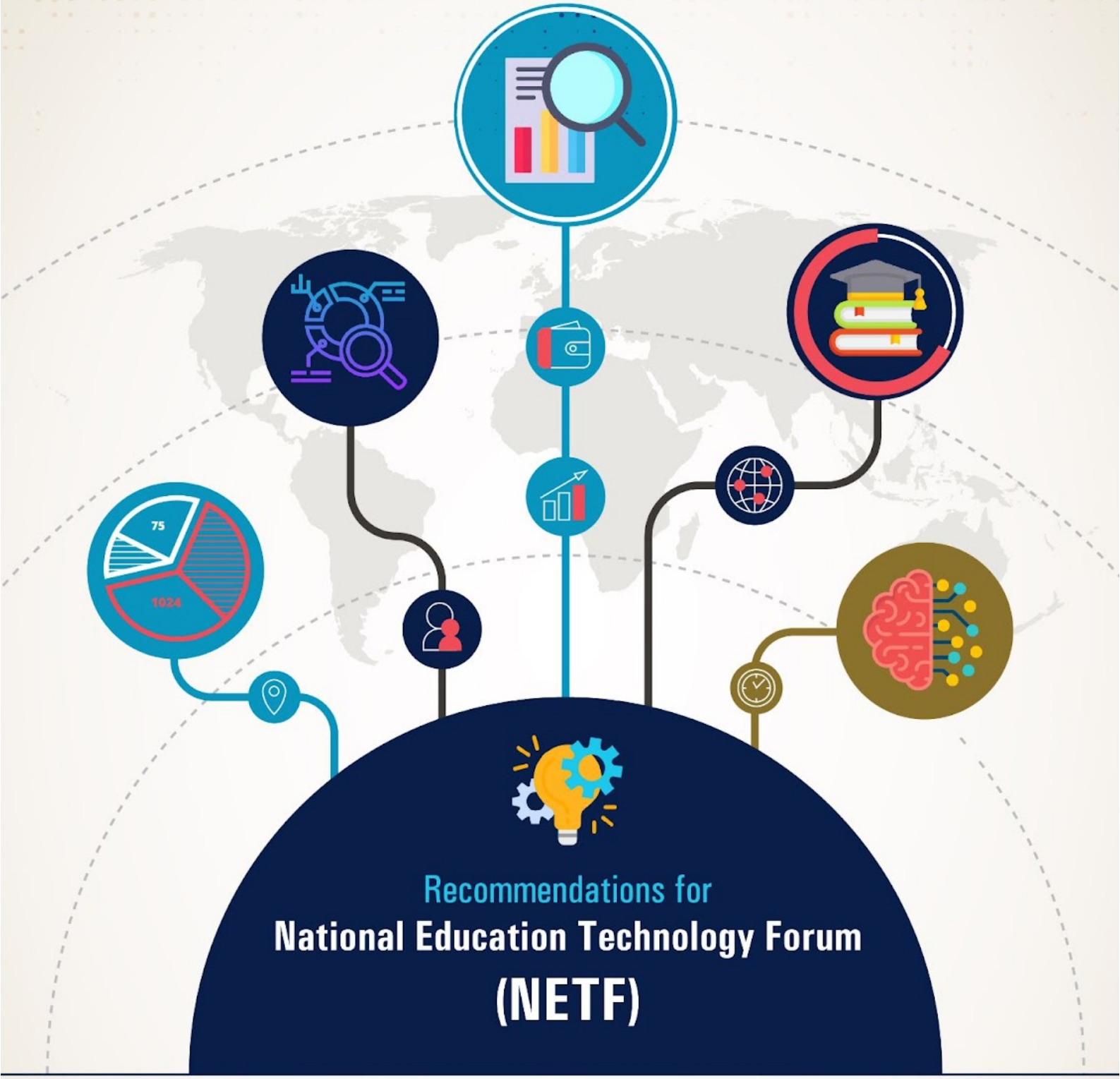

Recommendations for
National Education Technology Forum
(NETF)

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FOREWORD

National Education Policy- 2020 has taken into account the educational requirements of the individuals and Society of our Country as well as the Global perspective. The policy talks about principles, pedagogy, contents, infrastructural requirements and various other aspects relating to the Indian education system. Certain verticals have been suggested by the NEP- 2020. One of them is the establishment of a National Educational Technology Forum. The policy states "Technology in education is a journey and not a destination and capacity will be needed to orchestrate the various ecosystem players to implement policy objectives. A dedicated unit for the purpose of orchestrating the building of digital infrastructure, digital content and capacity building will be created to look after the education needs of both School and Higher Education. Since Technology is rapidly evolving, and needs specialists to deliver high quality e-learning ,a vibrant ecosystem has to be encouraged to create solutions that not only solve India's challenges of scale, diversity, equity, but also evolve in keeping with the rapid changes in technology, whose half-life reduces with each passing year. This centre (NETF) will, therefore, consist of experts drawn from the field of administration, education, educational technology, digital pedagogy and assessment, e-governance, etc."

Since announcement of the NEP-2020 on 29th July 2020, Vidya Bharati Uchcha Shiksha Sansthan (VBUSS), as one of its endeavours, is actively working to help policymakers and stakeholders by providing inputs through in depth study of the issues raised in the policy by organising various level deliberations of the renowned experts of the subjects. The draft on the NETF was prepared much earlier but it required an appropriate design for implementation purpose. For which the team of VBUSS has done a valuable service to the nation by organising a national level dialogue, though virtually, which was attended by well known academicians/ administrators and other stakeholders. The views and suggestions emerged during this discussion have been compiled and are being presented in the form of a book. These can be of high use to policy implementers and stakeholders. I am highly grateful for this effort of the VBUSS team and congratulate them for this.

Dr. Kailash Chandra Sharma
National President
VBUSS, Noida

Editorial Board

Vidya Bharati Uchcha Shiksha Sansthan

Vidya Bharati Uchcha Shiksha Sansthan (VBUSS) is a voluntary organization working in the field of education with a primary focus on policy implementation and structural reforms in India's Higher Education landscape. The core concept and ideal of VBUSS are to address the emerging needs of quality education and to reflect on the framework of Bharatiya knowledge, concepts, practise, philosophy and approach. The organisation has emerged as a transforming voice and movement led by learned, eminent educationists, scholars and concerned citizens of modern-day India. VBUSS firmly believes that a conducive education ecosystem could be developed through contact, dialogue, discourse and coordination among the institutions of higher education. VBUSS has been actively engaged in constructive engagement, developing thought process, policy intervention and recommendations. Engaging stakeholders in synthesising the National Education Policy (NEP) 2020 is one of the activities that VBUSS strongly commits and advocates. In the recent years since its inception, the organisation has been relentlessly engaged in numerous activities to promote, create awareness, decoding NEP 2020. Having done a series of thought process and submitting policy recommendation VBUSS is also playing a crucial participatory role in policy implementation and practice.

Software Technology Parks of India

Software Technology Parks of India (STPI) is a premier S&T organization under Ministry of Electronics and Information Technology (MeitY) engaged in promoting IT/ITES Industry, innovation, R&D, start-ups, product/IP creation in the field of emerging technologies like IoT, Blockchain, Artificial Intelligence (AI), Machine Learning (ML), Computer Vision, Robotics, Robotics Process Automation (RPA), Augmented & Virtual Reality, Animation & Visual effect, Data Science & Analytics for various domains like Gaming, FinTech, Agritech, MedTech, Autonomous Connected Electric & Shared (ACES) Mobility, ESDM, Cyber Security, Industry 4.0, Drone, Efficiency Augmentation, etc. STPI is establishing CoEs/Technology incubators for building India's leadership in the above mentioned technology areas across the country in a collaborative manner wherein

government, industry, academia, and other stakeholders are playing a vital role for providing end-to-end support to startups. STPI has also embarked on launching Next Generation Incubation Scheme (NGIS), a futuristic incubation scheme to offer comprehensive support & services and extend seed funding to startups.

Since its inception in 1991, STPI has been working towards equitable and inclusive IT-led growth pan-India which in turn has helped promoting Software exports, Science, Technology & Innovation (STI) and Software product development. With nine jurisdictional directorates and 60 centres, STPI has expanded its presence pan-India to support IT/ITeS Industry. Working closely with all stakeholders, STPI has played a key role in transforming the country as the preferred IT destination, a fact that aptly proven by the stupendous growth in exports by STPI-registered units from Rs. 52 crores in 1992-93 to Rs. 5,08,000 crores in 2020-21, which is approx. 50% of the national software exports.

Indian Institute of Technology (Banaras Hindu University), Varanasi

The Indian Institute of Technology (Banaras Hindu University), Varanasi is situated in the magnificent campus of Banaras Hindu University at the southern end of the ancient city of Varanasi on the banks of the holy river Ganga. Engineering Education in Banaras Hindu University commenced in 1919 with the establishment of Banaras Engineering College (BENCO). The Institution has also pioneered engineering education by being the First in the country to start degree courses in Mining, Metallurgy, Ceramic Engineering and Pharmaceutics with the establishment of the College of Mining and Metallurgy and the College of Technology in the year 1923 and 1932 respectively. In 1969 these three colleges were amalgamated to form the Institute of Technology. The Institute of Technology, Banaras Hindu University (IT-BHU), has been converted into Indian Institute of Technology (Banaras Hindu University),Varanasi by the Government of India on 29th June, 2012.

The institute aspires to be a harbinger of modern interdisciplinary technological advancement in the country and at a forefront of imparting quality education by use of innovative pedagogy culminating traditional with contemporary methods.

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The New Education Policy or the NEP 2020 proposed an apex body for implementation - HECI (Higher Education Commission of India) with four separate verticals on Regulation, Accreditation, Grants allocation, and Standards setting. In addition, there are other very meaningful provisions which are likely to create a huge impact on the Education System of India. One such proposal is the establishment of the National Educational Technology Forum (NETF).

It is widely perceived that introduction of technology in the education system is initiated by COVID situation, but the government recognized the need for deeper technology intervention in the education system and discussion about NETF goes back before COVID. NEP 2020 recognised the importance of technology in both the school and higher education.

Primary Education:

There are many hurdles in expanding the reach of educational facilities to students, e.g. language barrier between teachers and students, creation of digital libraries, popularising language learning as well as ensuring greater access to education (specifically for differently-abled children), effective teachers' training. Along with the students, other stakeholders like teachers may also benefit through effective teachers' training. Technology can facilitate overcoming all major hurdles and present an effective tool for online teaching as well as teachers' training.

Higher Education:

In professional and higher education, interdisciplinary study, program credits, multiple entry and exits are some of the new milestones which must be achieved. With inclusion of technology these schemes can be implemented with better efficiency and effectiveness.

Undoubtedly, COVID catalyzed the use of technology in education and to meet the immediate requirement various solutions were developed. It is a good alternative in the current situation but certainly not best suited for long term use, standardization for interoperability and large scale implementation. Key objectives of the use of technology are the advantage of scale to bring down cost,

enabling students to choose subjects of their choice and level of that subject, teachers to deliver courses even to remotely located students.

NETF is envisioned to play a catalytic role in the transformation of the educational system by leveraging technology and empowering students and educators by reducing barriers, enhancing reach, inclusiveness and equitable access to education. NETF shall also enable authorities to take timely decisions and plan right interventions as per the requirement.

NETF will provide a platform for the free exchange of ideas for development, evolution, and effective use of technology to enhance learning, assessment, planning and administration as a concentrated effort towards revolutionizing the education system. NETF would act as a facilitator, regulator and collator of ideas which may arise from various institutions, regulators, policy makers, ICT companies and startups.

Purpose

NEP 2020 laid a broad framework for technology use and integration through NETF, its objectives, functions. In order to bring NETF to action further deliberation, discussion and discourse is carried out with key stakeholders across the education system.

A day long workshop of eminent members from various prestigious stakeholders organization (brief profile at the end) was carried out by Vidya Bharati Uchcha Shiksha Sansthan, IIT BHU and Software Technology Parks of India on 26th May, 2021 for identifying and suggesting the next steps to the concerned authorities for carrying out the mandate of NETF successfully. The proceedings of the day along with addresses made by eminent dignitaries of global recognition joining the discussion on NETF along with in-depth deliberations are placed at Annexure.

The editorial board duly constituted to prepare this report further carried out a detailed research and explored the best practices suitable to the scope within NETF.

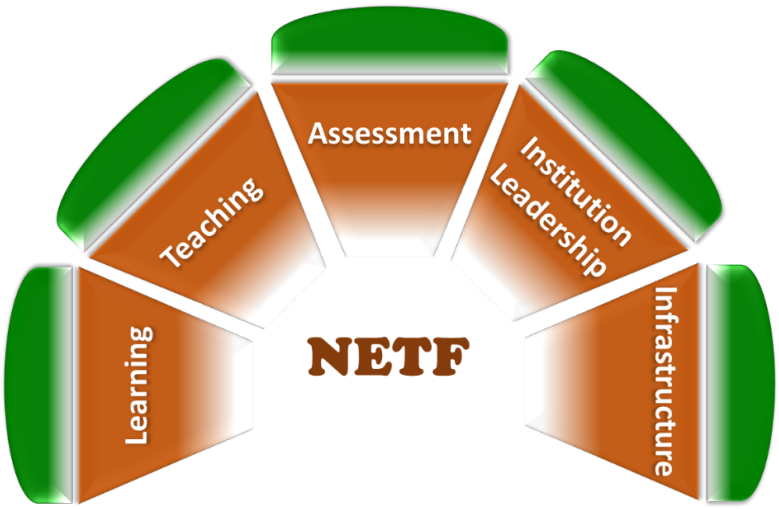
The report captures all recommendations of esteemed members and findings from the research in the form of broad scope and governance structure of NETF.

The proposed broad scope of NETF is as follows.

- Creating standards and best practices documents for ICT enabled education,
- Creating use cases and examples of emerging technology and its integration across the education system, while encompassing best practices adopted in the education systems across the world.
- Creating standards and best practices documents for Digitization and localization of content,
- Providing guidelines to establish requisite digital infrastructure,
- Formulating guidelines and standards for creation & accessibility to the digital repository of content,
- Defining standards and best practices to enable interoperability of Learning Management Systems (LMS)

- Providing standards and best practices to assess students' learning using technology
- Establishing academic bank of credit for flexible education system,
- Creating mechanism to gather feedback/inputs/suggestions for augmenting use of technology in education
- and advising concerned authorities on a regular basis and other focus areas as defined from time to time.

NETF functions shall be broadly categorized under five key aspects such as Learning, Teaching, Assessment, Leadership and Infrastructure. Through which NETF shall give direction to the efforts made by various governments, educational institutes, educators, edtech industry including startups.



Learning

In a revolutionizing digital ecosystem that India is striving for, learning should not be delimited to the straight jackets of classrooms. With emerging technologies like AR, VR, MR & XR, learning can be seamless, tailored, and experiential to meet the contemporary needs of education. Learning should be multi-modal, multi-faceted, and multi-dimensional to realise the vision of NEP. NETF should focus on how learning can be universally accessible to learners across the educational spectrum with greater accessibility & affordability.

Teaching

While learning is incomplete without teaching, it's equally pertinent to focus on the teaching methodologies. As it's witnessed during the pandemic, teaching has

gone beyond the periphery of the classroom, adoption of advanced learning & communication technologies by teachers is paramount. NETF should deliberate how teachers can be tech savvy and quickly skill them up to catch up with the technology evolution in educational space and make them available for the next wave of teaching evolution.

Assessment

Assessment of both learning & teaching is important for measuring the success of progressive education. In the digital paradigm, assessment can be spontaneous, instant, and easy. The assessment of learning should focus on the depth of understanding and applicability of the subject in real-life scenarios. Continuous assessment of processes should be evolved across the learning cycle by calibrating knowledge, wisdom, and application of any discipline. NETF should bring forth a mechanism to ensure how technology can address the challenges of hybrid learning process.

Leadership

Institutional leadership building is critical for global competitiveness. In a connected world, education is not limited to a specific geographic area. Institutions must compete nationally and internationally on various parameters including student-teacher ratio, infrastructure, research, publications, and patent creation. NETF should build up a comprehensive mechanism in measuring success of any institution based on parameters discussed above.

Infrastructure

Modern education cannot achieve the desired results without robust infrastructure including campus, connectivity, collaboration, and computing facility. While a hybrid model is still a preferred option for today's education, virtual learning is trailblazing face-to-face. The pandemic has further fuelled the pertinence of online teaching. Institutions need the desired digital infrastructure to broadcast teaching to mass students at the same time, and this needs a massive ramp up in digital infra. NETF should guide and mentor the institutions on technology adoption for establishing a robust digital infrastructure so that learning can be accessible and affordable for all.

Proposed Governance structure for NETF

A. Governing Council

Governing council with 12 (this number needs to be discussed) members will act as the core team of NETF. All the members will be nominated by GoI through the ministry of education. All the members will normally be nominated for three years. In the beginning, four members will be nominated for one year, four for two years and four for three years. The Ministry of Education shall nominate four new members each year as replacement for the outgoing members.

The members will select a chairman every year among themselves based on consensus and if needed by 2/3rd voting majority i.e., at least 8 members should vote for the elected chairman. The chairman will be for a duration of one year.

All decisions will be taken at least by support of 2/3rd of members. Ideally, all decisions should be taken by consensus and voting should be used only in extreme cases.

Governing council will receive the proposals for discussion in working groups and assign them to appropriate working groups. If needed, new working groups can be created. Governing council will also appoint a chair of the working groups. The council will also monitor the progress of working groups periodically.

B. Working Groups

NETF will be operating through multiple working groups. Members can participate in any working group of their choice. Each working group will also maintain their working document based on the discussions in their forums.

Each working group will have a chairman and at least five members nominated by council. In addition to them, anyone interested can participate in the working group activities.

Each working group will maintain the working draft documents based on the ongoing discussions over mailing list, online meetings, and offline meetings. Once a consensus emerges over the draft document, the same can be recommended to the Governing council for adoption as standard/ Best Practice Document.

Broad scope of NETF

A. Creating standards and Best practices documents for ICT enabled education

ICT is continuously evolving like any other science and technology area, thus its use will also evolve with time. All actors in the education process (i.e., teacher, learner, administrator etc.) will evolve and innovate in the use of ICT. Their inputs will define the path of evolution of technology, and the availability of technology will also guide how they innovatively use the system to achieve the objective of education - providing skills to gain insights and solve problems creatively on their own.

The NETF will provide a platform where experiences can be shared, leading to dissemination of understanding. All these need to be captured as working draft documents. These documents will be released as either standards, or best current practice documents. These documents will also guide the government whenever it needs to intervene to enact laws or to regulate.

B. Digitisation and Localisation at Every Level

Content is the key to the education system whether online or offline. Since offline education is an established mechanism and a lot of content is developed, but online medium is considerably new. To address the need of 33 Crore students located across various corners of the country should have access to content in their vernacular language. Due to cultural and linguistic diversity, the translation of existing content and/or development of new content requires skill and training to make it suitable for online teaching.

NETF shall ensure availability of machine translation of the course content to handle diversity of languages. For monitoring and innovation there is a need for many non-English speaking people/resources as problem solvers. A strategy may be designed to bring up a lot more vernacular language learners through a mix of English and local languages - an example being SpokenTutorials. They will better understand the problems faced by their brethren. Unfortunately, however, most problem solvers do not come from these sections of society. The vernacular language users will be able to relate to issues faced by students under these languages.

At the college level, most education currently takes place in English. The quickest way to produce the above said problem solvers is to translate what is available in English to other languages. It is important to keep English as well, so as to retain employment opportunities. This will ensure that people from the mother tongue medium also reach high levels of the society, and that they have a say in decision making.

To achieve the above quickly, we should translate the English course content into our languages. The procedure to do this for video lectures is outlined first, because we do have a lot of content of this type for which intellectual property rights (IPR) may not be an issue. As a first step, translate the audio, but keep the English videos unchanged. As our languages are possibly verbose, this requires some effort. We outline one method to achieve the above for already available English videos:

1. Transcribe the audio of English video lectures.
2. Translate the audio into our languages, keeping the length of translated sentences the same. In many cases, this cannot be achieved in a straightforward manner. The following steps are proposed for this:
    a. Rewrite the English script obtained in 1 above to simpler sentences. Avoid difficult words. Such simplified sentences should not be longer than the original sentences. Ensure that the simplified sentences are short, and do not exceed a pre-fixed length. In the Spoken Tutorial project, this recommended length is 60 characters, and no sentence can exceed 80 characters. Any grammatical mistakes, or incomplete sentences, etc., should be corrected at this stage.
    b. Correctness/equivalence of the script obtained in a) above should be established.
    c. Short sentences and simple words will help ensure that the translated sentences are not longer than the original. While translating, it may be required to retain English words, especially technical words, where necessary.
    d. Correctness/equivalence of the script obtained in c) above should be verified with the script obtained in a) above.
3. Record the translated sentences obtained in b) above.
    a. Stitch the audio obtained in c) above with the original English video.

b. Where the simplified English sentences in a) sound a lot better than the original English audio, dub the original English also.

Some projects have taken an easy way out by giving an audio file separately, as this will obviate the need to sync the translated audio with the original video. Unfortunately, this will make it difficult for the vernacular language based learners. It is likely that such audio files will not be seen by many people. As a result, it is even possible that the quality of the translation does not even get checked – in some cases, we have seen machine generated audio being given, although costing may have been done for manual translation and voice rendition.

Any dubbing done without worrying about the sync is a wasted effort. Modifying it at a later stage to provide the sync can become very expensive.

Giving mother tongue subtitles in a video lecture delivered in English is not at all useful. Should the reader be trying to read the contents of the video (for example, diagrams, derivations, etc.), or trying to read the subtitles? In this case, there is a lot of load on the video channel of the reader, with the audio channel not being used. Why should the vernacular language learner be made to do a lot more work than English language based learner? As a next step, slides used in the English videos can be changed into mother tongue, and the video can be re-edited. It seems doable, but we have not done it in the Spoken Tutorial project.

The above method is suggested also for school level software. Spoken Tutorials are already available for many school level software also. These have English videos with voice dubbing in our languages. Some of the topics covered in this section are used in colleges also. Some examples are C/C++, Java, Python, Scilab, and Moodle. The subject matter experts who are popular for social initiatives in teaching shall be engaged with the content development & translation initiative. Depending upon the capability they can be utilized in development, review etc.

For other school level education, we already have a good tradition of vernacular medium teaching. This should be strengthened. Digital tools should be made available to help this community.

Additionally, consumption of content also happens from open sources. In order to divert the consumption towards high quality content, grading is necessary. Grading will help students make an informed choice about content.

On digitization of content, availability of the same at common repositories shall be ensured. Central repository will ensure easy access and circulation of content in an easy manner. Each beneficiary may have one login credential to access this repository therefore, relevant content can be pushed.

C. Devising methodologies for ICT enabled education by leveraging emerging technologies

Creation of Learning Management System (LMS) and centralized digital depository

In an online setup, classrooms, student services and resources are replicated into electronic lessons, discussions, processes and documents via asynchronous and synchronous delivery systems. A mix of tools may be used for the purpose of interactions. The selection of tools however will depend on the kind of interaction required i.e., whether the interaction needs to take place in "real time" or asynchronous. Synchronous delivery systems demand relatively high bandwidth, sophisticated hardware, and software.

Standard features of present-day virtual/ online learning environment include:

- Student registration.
- Content delivery in multimedia formats.
- Course scheduling and organization.
- Management of class transactions.
- Assessment and evaluation.
- Student tracking and report generation.
- Content assembly and authoring tools; and
- Virtual and collaborative learning tools.

In addition, following advanced features also are now prevalent in learning management systems:

- **Big Data, Educational Data Mining –** learning analytics, skills gap analysis, profiling, and mapping of personalized learning paths, recommendation systems

- **Artificial Intelligence -** Intelligent Tutoring Systems, Personalized Learning, Al Tutor/Teaching Assistant, Adaptive Learning Approaches and Natural Language Processing
- **Virtual Reality/ augmented reality-** immersive learning experiences emulating real- life situations with virtual labs, robotics
- **Chatbots**- efficient, intelligent teaching assistants with Chatbots or Conversational Al
- **Blockchain Technology-** improve record keeping and maintenance, seamless payment transactions

There is an urgent need to have a **unified Learning Management System (LMS)** covering the **complete learner lifecycle** right from registration to certification and beyond integrating Centralised Depository and Academic Bank of Credits. The LMS needs to be preferably **indigenous** with customisation suiting Indian educational requirements and **supporting all regional languages.**

The platform should include the following components from the teaching learning perspective:

- Individual self-study and reflection, and engagement in activities/ tasks relating to specific learning objectives.
- E-Counselling/ mentoring
- Virtual classes/ Webinars.
- Scheduled discussion forums for interaction and feedback
- Course-wise assignments (TMA, Quizzes, games)
- Synchronous and asynchronous, and individual and group interactions.
- Hands-on/practical work through virtual labs, simulations etc.
- Access to additional learning resources (NDLI, e-SodhSindu etc.).
- Social Media integration for collaborative learning and interactions.
- Functionality for 2-way communication

The following suggestive components may be considered as per the requirements of the course/ programme from assessment and evaluation perspective:

- Computer-marked assignment (online quiz)
- Tutor-marked assignments (TMAs online)- long or short questions
- Discussion forum
- Interaction: Community of practice integrating social media

- Online workshop: Virtual Practical, hands-on practice through simulation
- Online presentations, term papers
- Online individual/ group projects
- Project/ Dissertation management
- E-portfolio for evidence-based assessment.

The Term End Examinations can be conducted online in a proctored environment or through remote proctoring with a required secured environment in place as per the online regulations.

The proposed unified LMS will need to have the following basic components:

- Online registration and admission
- Integrated multimedia courseware (personalised learning space)
- Online counseling/ mentoring (web conferencing, webinar, text-based chatting etc.)
- Online interaction with faculty and peer group (synchronous and asynchronous)
- 24×7 learner support (grievance redressal system)
- Assignment/ Project Management System
- E-tutor based practical
- Group based online seminar
- Online Term End Examination (proctored)
- Learning Analytics with reporting system
- Online Certificate/ Degree generation with digital signature and integrated with NAD and ABC.

Action points for NETF

- NETF needs to promote indigenous research to find cost-effective and affordable solutions for ICT enabled education.
- Conduct research on learners' choice of devices, platforms, tools, pedagogical issues related to e-learning and online learning etc. to develop appropriate LMS and other educational tools.
- Provide incubation facilities and support start-ups for developing unified LMS platform preferably open source which can be easily customised as per institutional requirements and develop other educational tools which can be integrated with the LMS as per requirement.

- Technologies like AI-based Individualized instructional models, blockchain and the Internet of Things (IoT) are being recognized as future educational technologies. Therefore, NETF needs to invest in research in these areas, find ways for integration, and ensure the reach to the last mile of the country.
- Develop a repository of free and open-source tools, games, software etc. for easy access to individuals and institutions across the country.
- Conduct pilot studies for testing appropriateness of technology tools/ applications for different learner, teacher, and institutional requirements.
- Aid in building intellectual and institutional capacities in educational technology.

D. Integration of available educational technology platforms for better outreach among teachers and students

There have been some efforts made earlier by MHRD (now MoE) for an integrated platform. The activities started in 2006 with an effort to develop a one stop portal with the SAKSHAT Portal in which the concept of 4 quadrant approach was brought in. The portal was launched by the then President of India Late Dr. APJ Abdul Kalam in October 2006. The portal started with hosting of High School level courses in 4 quadrants in which NCERT textbooks were enriched with videos, animation simulation etc. along with self-assessment. The portal had a live chatting facility where School Teachers identified by CBSE were available through live video chat before the Board exams and the response was quite positive.

After the launch of NMEICT in February 2009 major effort was made towards development of the e-content in different disciplines in Higher Education and the School Education part was taken up by the Department of School Education. Apart from the e-content development other major projects focused on developing virtual labs, ERP solution (Brihaspati and Samarth), Cloud Infrastructure (Badal), Robotics in Education (E-Yantra), access to e-resources through N-LIST (now we have e-ShodhSindhu with merger of INFLIBNET INFONET, INDEST and N-LIST), Expert Database and National Research Network- VIDWAN, Indian Research Information Network System (IRINS), A- VIEW conferencing platform etc. were initiated. In recent years we had three major projects SWAYAM (India MOOCs), SWAYAM PRABHA (34 Educational DTH Channels) and the National Digital

Library of India (NDLI) and were added under the NMEICT which had a major impact.

There are also major MOOCs initiatives taken at different institutions, such as IIT Kanpur, and IIT Bombay. IIT Kanpur has been extensively using the MOOCs platform mooKIT, developed at IIT Kanpur. IIT Bombay has developed the MOOCs platform IITBombayX, based on Open edX. There could be other MOOCs platforms as well, developed in other institutions. There should be a survey of such platforms, and all such good platforms should also be brought into the unified platform, proposed above.

Over the years major content has been developed across disciplines and also NPTEL Online Courses, SWAYAM and SWAYAM Prabha projects further enhanced the teaching learning process. Consolidation of all the efforts in one platform will strengthen the usage of the rich collection of e-resources developed till date.

NTA testing services and the NAD were two other major initiatives undertaken by the Ministry of Education (erstwhile MHRD) apart from the NMEICT initiatives.

Surprisingly all the platforms are working in isolation and so far no effort has been made for integration of the platforms to provide seamless learning experience for the learners. The platforms are using different technology and architecture and integration will be a cumbersome job through APIs with single sign on facility.

The **Proposed Integrated platform** need to have the following features:

- **From Learner perspective:**
  - One stop access to barrier free (in terms of language and accessibility) web-based learning resources, other e-resources such as e-books, e-journals etc. uniformly across the country.
  - Repository of a world class interactive multimedia learning content for all discipline areas and all levels, integrating all the e-content developed under different projects NPTEL, ePGPathshala, CEC e-content, Spoken Tutorial etc. mapping across curriculum.
  - Virtual Labs for online practicals.
  - Web-based guidance, mentoring and counseling through synchronous and asynchronous modes of interaction across platforms viz. web based, mobile and DTH.

- Online testing services.
- Online career counselling facility.
- Platform for preparation of competitive examinations.
- E-portfolio to showcase achievements, resume builder and linked to job portals for placement.

- **From Teacher Perspective:**
  - Free access to repositories of tools, games, software faculty and institutions across the country for developing multimedia content, animations, simulations, augmented/ virtual reality etc.
  - Platforms for remixing, repurposing, adapting OERs.
  - Access to LMS, web conferencing and other teaching tools.
  - Online assessment tools such as question bank preparation, question paper generation, conducting online tests, online evaluation etc.
  - Plagiarism checking tools
  - Access to e-resources including licensed full text databases.

- **From Institution Perspective:**
  - Monitor the progress of learners through AI based analytics on the performance and provide customized and personalized learning paths through suggestive learning resources and online tests.
  - Platform for delivery of online programmes
  - Dashboard/ MIS/ ERP for administration, finance and other educational administration activities covering complete student lifecycle.
  - Translation tools for translating content into different languages
    ORCHID like platform for tracking research output of individual faculty and research scholars.
  - Linkage to Academic Bank of Credits and NAD for storing and verification of certificates/ degrees.

The proposed **Integrated Platform** needs to include all aspects of learner lifecycle, faculty requirements of programme/ course delivery and institutional academic as well as administrative requirements.

The platform needs to be user friendly and intuitive with a single sign on facility which provides access to resources, services and application tools across platforms and is role based.

Action Points for NETF:

- NETF will need to assess from the point of view of technology used, platform and architecture, capacity for scaling up for national requirements etc. of all the available platforms across the country for consolidation into an integrated platform.
- Provide support for upgradation of the platforms with state- of- the- art technology.
- Identify gap areas where applications, tools platforms need to be developed.
- Pooling up of applications/ tools for content development, assessment, course delivery etc. for easy access of faculty and institutions.
- Support in developing APIs/ web services for integration of all the existing major platforms like SWAYAM, SWAYAM PRABHA, NDLI, e-ShodhSindhu, NAD, NTA Testing Services etc.
- Build awareness of different platforms, tools and applications available at national level for optimising their usage.
- Conduct capacity building programmes for stakeholders at all levels for early adoption of technology platforms.
- Develop culture for using open source applications/ software developed at national level.
- Monitor development of different platforms to avoid duplication of efforts and integration with the Unified platform.

E. Creation of requisite Digital Infrastructure

Traditional models of education have for long dictated the frames of learning such as time and place. For instance, the majority of academic activities happen in the bricks-and-mortar confines of a school within a stipulated 8–10 hours of a day. E-learning does away with such frames enabling students to learn anywhere, anytime. Similarly, while books were once the chief source of learning, aiding only the visual learners, the EdTech sector has opened up a whole new world with the introduction of multimedia content, including immersive experiences such as augmented and virtual realities to cater to all kinds of learners.

These tools challenge the passive one-way lecture-mode of learning, helping learners to take a more proactive role with hands-on learning, flipped learning and peer interaction. Teachers have now become facilitators, monitoring students' individual performances and helping them with personalized feedback/recommendations.

Preparing students to be successful for the future requires a robust and flexible learning infrastructure capable of supporting new types of engagement and providing ubiquitous access to the technology tools that allow students to create, design, and explore. The essential components of an infrastructure capable of supporting transformational learning experiences include the following:

- **Ubiquitous connectivity**: Persistent access to high-speed Internet in and out of school
- **Powerful learning devices**: Access to mobile devices that connect learners and educators to the vast resources of the Internet and facilitate communication and collaboration
- **High-quality digital learning content**. Digital learning content and tools that can be used to design and deliver engaging and relevant learning experiences
- **Responsible Use Policies (RUPs)**. Guidelines to safeguard students and ensure that the infrastructure is used to support learning

Apart from the key components of a digital infrastructure that must serve as the foundation of the overhaul that is being aimed through NETF, factors like data privacy and security, quality devices that are competitively priced for students along with availability of quality digital content are matters with utmost pertinence.

Type of Infrastructure Required

The type of infrastructure that is envisaged as part of the NETF may be classified under two major categories:

- Hard Infrastructure
- Soft Infrastructure

Hard Infrastructure

The hard infrastructure that will serve as the definitive and tangible framework to achieve the mandate of digitization aimed through NETF. The following key components are proposed as part of the essential hard infrastructure:

- **Internet Connectivity**: The learning management system or any online teaching platform will have a heavy reliance on reliable internet connectivity. Therefore, no matter how basic it is when we hear about internet connectivity in this day and age, a vision for ubiquitous, affordable, reliable high-speed internet connectivity has to be the bedrock of any online teaching platform. It has to be understood that the introduction of varied devices with varied capabilities of effective transmission and receiving information in the most lucid way will require robust internet connectivity across the country.
- **Hybrid Clouds**: As the EdTech sector proliferates further, organizations/ companies offering learning services must focus on upgrading their data centre infrastructure. **Environment Supporting Digital Transformation**: An extension to the point mentioned above, every institute needs an environment that supports digital transformation from every point on the network. Hybrid cloud and network environments, SD-WAN and high-speed broadband are just some of the technologies that can enable institutes to better manage their sensitive data and systems across multiple locations, while networking components such as WiFi and unified communications can ensure teachers and students have the resources they need to be productive and ready to learn.

  Like Hybrid cloud is a term used for a mixed environment that uses a combination of on-premise data centers, private clouds, or public clouds. For example, a large organization might have infrastructure and basic access management on-premise, HR applications running on a private cloud, and a public cloud environment for the product development technical team to use for their testing and production environments.

  A hybrid cloud environment combines the best aspects of each solution: The scalability and speed of the cloud, with the familiarity and control of existing on-prem data centers and private cloud solutions. The companies offering learning management systems may look for cost effective solutions to use Hybrid Cloud solutions.

- **Web Whiteboards**: An online whiteboard is a learning space where both teachers and students can write and interact. Digital whiteboards (the big touch screens placed at the front of a classroom) must be looked at as the tool of the future that will replace the traditional whiteboard and marker. The web whiteboard allows the same experience as a traditional whiteboard but it is also connected to the internet and digitizes the content written on the online board.

  A web whiteboard allows instructors and students to interact on the same online whiteboard web page at the same time from anywhere. Firstly, they can be accessed by any device, secondly, they can be displayed in a physical classroom with a simple projector. The online accessibility of the whiteboard makes it an ideal learning companion for the instructor and the student.

Soft Infrastructure

The most important aspect of this proposal that must be looked into as it serves as the nucleus of the digital infrastructure required under NETF is a comprehensive Learning Management System. Unfortunately, there is more than a thin line of difference between a meeting platform and a learning platform that must first be understood.

Need of a Learning platform over a meeting platform:

- It is understandable that the using a meeting platform like Webex and Zoom one can assemble students together and an interactive session that is restricted to sharing of documents can be organised. But these platforms act as a broadcast pipe that only allows information to pass.
- This is where a comprehensive Teaching platform built to cater to the needs of the learner and the instructor excel. Whereas a meeting platform dictates when and how, an online teaching platform is flexible – they bend to the needs of learners. On a platform like this, you get the full experience of a media-rich session anytime you want as if the session were still being held live. It opens sharing and communication streams that contribute to a session –video, teacher-to-student and student-to-student chats, hand-outs, etc. that are accessible at any time.
- The assessment is another key element of any teaching platform. It cannot be repudiated that formative assessment through an online learning

platform can be easily accomplished. But what separates an effective platform from others is the ease with which summative assessments/ evaluation like tests and quizzes can be conducted.

Learning Management System

As the difference between the meeting and teaching platforms is established, the key facets of the Learning Management System are expounded as under:

- **Standardized Course Description Format**: A good course outline allows students to assess the course with their learning needs, understand what is expected of them and how they will benefit from the instruction. It is equally imperative for the instructors to compare two different online courses through a standardized course description format.
- **Credit Transfer System**:
    - It is important for an educational institute to authenticate a candidate's degree credentials issued by another institution. A simple blockchain based credit transfer system, or centralised systems like the Digilocker can serve as hard infrastructure that will securely enable Institutions to ensure veracity of documents.
    - Similarly, the course curriculum that a student has undergone in the previous institution may also be available to his/ her current institution to ensure mapping of the course that the instructor needs to cover or during the defined period.
- **Teacher Avatar:** A learning management system must comprise of a teacher avatar which will serve as the virtual replica of the instructor for students. Avatar-guided programs allow instructors to train in a virtual classroom without the risk of making mistakes in front of real students. The instructor will have to spend time to develop that avatar based on his/her teaching principles. Once the avatar is developed, the AI backed avatar shall be able to respond to one particular question differently based on the understanding of the student asking the question (through the corresponding student model). The avatar shall be responsive to participate in discussions and also be equipped to answer individualized answers.
- **Student Model:** A student model derived from the academic background of the student (extracted from his/her performance in tests/quiz, attendance in class, course coverage) shall pave a path for achieving a more personalised experience for the student. This is derived from the understanding that every student has varied capability and aptitude for

learning. Therefore, every student cannot be put into one bracket of learning. A teacher avatar (as explained above) that will be developed will heavily rely on the corresponding student model.

F. Academic Bank of Credits

Generally a degree to a student is awarded when s/he passes certain courses as per a predefined course structure. The course structure has few compulsory and few elective/optional courses. Students earn a few credits after passing a course. For award of degree, regulators specify a range of credits to be earned for the award of degree. They also specify a few groups of subjects. Students need to earn a range of credits from all those groups.

New education policy mandates multiple entry and multiple exit for a student. It means a student can take a break in a degree, S/he can also study at different institutions for one degree. Degree from more than one institution is still possible in the current system but this facility is quite limited and generally needs MoU between two institutions. Whereas in the proposed system students will be given more flexibility for a general case. To provide such flexibility a repository has to be maintained where the record of credits earned by a student can be maintained. The repository has been termed as **Academic Bank of Credits (ABC)**. While talking about **ABC**, the assumption is that credits earned at aunty institute is equivalent to any other institute for the same degree. The **ABC** should have the following features.

Universal Accessibility

Credits from **Academic Bank of Credits** should be easily accessible for anyone after the proper authorization. Unified Payments Interface (UPI) may be one model that can be used for the same. If some agency wants to access the credits of a student, they should be able to do so after the student's authentication. This will facilitate the easy transfer, redemption and verification of credits.

Distributed Storage of Credits

The credits should be stored in distributed fashion on the servers located at different places. Blockchain may be used for security of data, This will lead to scalability and avoid single point of failure.

Minimum Duration

To avoid complications and possible misuse of the system, A minimum duration of degree should be defined.

Equivalence and Structure

Though, while proposing the credit bank, it has been assumed that credits earned at two different institutions are equivalent, but this seems little far from reality. Therefore, for effective implementation of credit banks, it is necessary to have some kind of equivalence method for credits. Standardization and accreditation can be used for finding equivalence. Further, a course needs a structure of courses. Therefore, credit banks should preserve the structure of credits. For following this structure, the courses in one basket may vary from institution to institution. The credit bank should have equivalences of these courses as well and transfer should happen accordingly.

Conclusion

The national level dialogue touched upon many dimensions and the requirements of 33 crore or more learners across the country and presented the need of technology led affordable solutions along with necessary approaches to ensure inclusive and equitable learning. The robust & integrated platforms; vernacular contents; technology led pedagogy, content creation & delivery, skilling, assessment, compliance, governance, and requisite digital infrastructure are required to strengthen the overall education system. It is deliberated upon that NETF should be formulated in a planned manner so that it can play a pivotal role in expanding the base of learning and disciplines through intervention of cutting-edge technologies and help realize the vision of NEP 2020.

NETF should also enable a forum along with necessary structure to stimulate discussions through wider participation. Based on consultations, feedback and data received from the various stakeholders, NETF may advise MoE to take timely action for improvising/augmenting the technology for education system:

1. NETF should have a feedback mechanism to receive the suggestions and grievances from different stakeholders (students, teachers, Technical personnel and regulators etc.) and to respond in a time-bound manner.
2. The feedback mechanism could be integrated in such a manner that all people should be able to see the feedback and grievances from all stakeholders along with the suggestions of others.
3. Formation of a Digital Learner Community.
4. NETF should provide a platform for learning from each other and sharing their experiences. In course of time, this may become a self-sustaining learning platform.
5. NETF forum should have inbuilt mechanism for safety of data uploaded and protection of privacy of Individuals.
6. WebLink could be provided to:
    - Availability and access to digital library resources
    - Availability and access to Computational software
    - Translation & Dictation facility
    - Access to Editing/ Photoshopping/ Software
    - Introductory Video contents for accessing and using different types of digital resources

Prof. Kailash Sharma, National President, VBUSS, Noida

If NEP 2020 is implemented completely, we will see a paradigm shift in the education system. Recommendations on multidisciplinary education, professional education, vocal education, skill development, engineering & technology are critical. We need a robust system to facilitate the technology under the aegis of NETF. Regarding this NETF, which needs to be established, we require details of this forum and the basics about this are yet to be developed. I think in different webinars organised by Vidya BVUSS, we have gathered the ideas and recommendations. These recommendations will be shared with the government and different forums.

Dr. Omkar Rai, Director General, STPI

NEP 2020 is an ambitious policy, which talks about an education by 2040 would be second to none and it will transform from a quantitative education to qualitative education in an equitable manner. NEP 2020 is also a result of wider consultations with several stakeholders. From a technology point of view, NEP seeks to transform the pedagogy, content, content creation, dissemination, maintaining equity and inclusivity all across the divergent demographic groups, the social strata, and economic status of people. It seeks to transform the academic administration in terms of credit bank, digital locker for degrees, revolutionise the quality of education in terms of literacy, and create content in all leading languages. It also talks about interdisciplinary things and flexible curriculum creation. The most important aspect of NEP 2020 is the envisaging the formation of NETF.

NETF talks about advancing government and technology-based influence to bring educational technology to envision thrust areas. To do those things, we have to see what kind of tasks that NETF can deliver and for that we have to discuss and deliberate. If we look at the whole transformation that has to take place, that is quality education to all in an inclusive manner. Therefore, we need revolution in the creation of great content, deliver the content. The entire pedagogy, the entire content has to be transformed and to be more immersive, innovative, collaborative in times to come. We need to have digital content so that everyone

around the world can access and learn. Therefore, the digital repository that is required to create should have a robust platform. The entire pedagogy has to be transformed, the classrooms need to be smart, the content has to be very immersive, so that the young boys and girls in our country can learn numeracy and literacy to make them better people.

Labs have to be virtual. To make a physical lab with apparatus and facilities for every student will be difficult. We should create an immersive platform and labs so that students can learn the experiments live. NETF has been a vibrant, agile forum, which may be private, state-owned or autonomous. They have to indulge with industry, entrepreneurs and young boys and girls in a big way. They could keep the pace with technology, they could create use cases. For example, blockchain is a very good technology in the field of education because of its unique role in ensuring trust and traceability. Therefore, this body has to be such a vibrant and agile and whole indulgence with people and stakeholders, the technologies so that we can keep pace with changing technology landscape all across the world. We also know that the whole administration of NEFT and NEP 2020 would require a very robust technology platform. So, it's leading towards the creation of India EducationStack, which has to be centrally managed and administered. NETF also requires these things. NETF is also to be envisaged to do cutting-edge research, set the standards, and it has to continuously grow up within emerging technologies. NETF is also to be entrusted to recommend policies so that we could get an equitable dissemination platform in the country. Whether it is town, whether it's a down-trodden area would be able to access the internet. This policy will be successful only if we are able to disseminate the content to the people wherever they are. Therefore, we need a very robust digital communication platform and for that NETF has to continuously work toward this.

Prof. K K Aggarwal, Chairman, NBA

Education, teaching, and administration are to take place in a very meaningful shape. NETF is altogether a separate vertical in that sense to put all the universities to get a technology platform is a great concept. NETF has two components, one is the teaching part. We have to take the online teaching to the real online teaching. Online is not speaking to the class and speaking to the computer. We have to do a lot of research. The online teaching should be imparted in a manner that can integrate teachers, students, and environment in a seamless manner through cameras, and then the content is to be delivered.

Administration is very necessary for this platform. This is a great platform for giving dynamism to the universities completely and still we can have an eye on them. Work independently and capture enough data to retrospectively find out others go wrong. We should give autonomy to the universities but also have to capture broader data to see that things are going fine. And that data can be used by regulatory bodies and education bodies.

The policy says the accreditation will be a new norm of regulation that means gradually in five years, seven years whatever all unaccredited institutions will exist in the country; they all have to get the accreditation from one or the other body. When I look at the NBA, I find data capturing is a real issue. I have spent half of my time verifying the data of teachers, given by the institutions. We are working on this with very limited success on "one data, one nation". I use this NETF as a technical platform for making sure whenever there is a change in institution, it should be captured in NETF. So, some data capturing mechanism we have to deal with. Then accreditation will have some meaningful outcome.

Secondly, when you talk about the diversity of subjects, on the strengths of NEP, people have to choose various subjects, you will have to maintain the data. Then based on that data you can assign a teacher a teacher. Finally, we have a centralised technology forum, and it can be done easily. I think if there is no centralised platform, it will be very difficult for us to manage things properly. Now, we have to think about education, administration, and accreditation, and especially online education. If we can create a system to deliver online education to students by shifting from the classroom teachings, we can serve the needs of the masses of the country.

Prof. Anil Sahastrabuddhe, Chairman, AICTE

NEP, technology, and NETF may be linked in a manner so that it can bridge the digital divide, leverage technology to create access, and build equity amongst all. The first one is to create interdisciplinary research universities or multidisciplinary programs. Since independence when universities were truly multidisciplinary, India started moving towards unidirectional technological universities and medical universities, and this policy again calls back to the origins of being multidisciplinary. Now the challenge is how to convert a small technical domain university or medical university to interdisciplinary.

SWAYAM courses can be used by a technological university to deliver courses on music or social engineering. That will enable students of any type of education to take courses of any other type, and that's the beginning of multidisciplinary nature. This is one empowerment that has already been started through the SWAYAM. Earlier, several courses were available. One of the important things is the experience of students. In a classroom, a student listens to the teacher, and then asks questions, satisfying his/her thirst for knowledge. Deliberations must be done on how this will happen in an online world. SWAYAM has four quadrants. Delivery of lecture in the form of video, the second part is additional reading/learning material, which is available in the forms of .pdf and many others, so one can learn on his own. Lifelong learning is embedded in this. Third part is a very significant one that is a group wherein you can interact. All the students who are part of this course can discuss with each other. Some of the nuances which you do not understand can raise a query. Teachers watching the discussion can bring it back to the track if there is any diversion from the course. Large scale discussion between teachers and students can be possible through technology. You are teaching a class of 50-60 students and you can also teach 10,000 students and still satisfy their hunger for trying to learn new things. That's the power of technology used in the third quadrant of the pack. The fourth quadrant of the SWAYAM is the conduct of examination. Whether it's intense examination by short term or short answer questions, or if you have assignments in real time examination which is to be evaluated whether you are doing well, or not doing well, or you want to do further. So, multidisciplinary and lifelong learning is possible through one single platform which has been created since 2017. National indigenous platform with more than 3.5 thousand courses, 1.5 crore plus students who are using it, and that's the first part of the technology envisage.

The second part that NEP talks about is multiple exits and entries. You better take a program and you feel that you are not fit for this. So wants to change his track. Today, what happens is if you are in any course like science, engineering, arts, or medicine, after two years, you need to start from the scratch again. So, multiple exits allow someone to get a certificate for something one already has learnt rather than having empty-handed. Whatever credits that one has in the area of education can also be used for another fora. If you have transferred from one state to another state, you can use the credits that you have earned in your previous university. This is also the power of technology. Multiple entries and multiple exits can be facilitated through this mechanism, and the academic bank of credits

which is worked out, we are all aware of the National Academic Depository through which all the credits can be stored and entire degrees will be located. Whether a student is genuine, whether he did a course from a particular college or university can be available on the National Academic Depository. Whether a student does 3 credits in a particular subject, 4 credits in another subject, can be accumulated like a bank account for yourself and you can encash it somewhere else. All the credits that you have done through various universities can be encashed. There are multiple possibilities in the academic bank of credits.

Accessibility is another aspect. You can access different languages, states, different regions, that is one form of accessibility. Therefore, there is a scope for learning a mother tongue in not only primary education, but also in higher education. There is also the possibility of using mother tongue in engineering and medical education in this policy. There are so many regional Indian languages, which are constitutionally approved languages. There are initiatives by IIT Madras and AICTE to translate engineering courses in regional languages. We developed an automated tool for translating an English content initially into 8 Indian language, starting from Malayalam, Tamil, Kannada, Telugu, Marathi, Guajarati, Hindi, Bengali, and we have expanded it to Punjabi, Assamese and Odia so that major 11 languages of the country are covered and all books, all possible literatures that is required for learning very parts of learning will be available in these languages. Students can learn their respective languages and learn engineering in their mother tongue. That is the power of mother tongue.

We have a huge population from different backgrounds. Let's make use of crowdsourcing. It is very important that technology can simply enable that. How using vocational education can be part of technology. Classing example of NEAT. AICTE started this two years ago. NEAT encompasses emerging technologies like AI to create personalised learning. This is the power of technology. So, in a classroom if there are 60 students of different levels, some are fast to catch up, some are slow, they don't understand quickly at all. How do we take care of all of them? And that is where I come back to accessibility. It's about how students have different learning disabilities. For example, dyslexia students cannot be in the same class as other students. How do we take care of them? User technology is much easier to handle and this can be part of the platform. The National Educational Alliance of Technology (NEAT) platform can address the needs of various students of different learning capability.

Accessibility is how about all students categories from different backgrounds and it can be addressed through technology. Converting a powerpoint presentation into braille language. Conversion of content into sign language is important for enabling disabled students. These are not done today, but there are powerful ways of doing all of this. Capabilities can be established, and therefore when we say accessibility, it should be in multiple formats. It's not just in the form of language or region, but SLTs and PWDs can be the essence of education.

Physical labs are turning virtual. These labs have existed for over a decade. The extension NPTL comprises 7 IITs and other institutions that are enabling simulation-based experiments. In a physical lab, only 3-4 students can use the apparatus for a particular experiment. In virtual labs, thousands and lakhs of students can conduct the same experiment simultaneously in their respective places. Because these labs are based on the coding that is done and the experiment is simulated in the way that is exactly done in a physical environment. The other thing is the use of AR, VR & XR. In AR & VR, one can conduct an experiment that is even bigger than the laboratory. In mechanical engineering there are cut-section models. Through AR, VR & XR, one can go inside the machine, it can be part of the turbine blade. One can move along at different speeds. Technology can help learn faster, reduce the time requirement for skilling, and lower the cost involved. So, technology enablement is also very important. Skill-based training, vocation-based training, integration of different things, skill education, general education, plus teacher education, and these are very significant. AICTE has already done 8 modules of the teacher certification program, but under which one completes 8 modules, cannot be regularised in the teaching. Teachers can find the entire lifecycle of a profession from lecturer to emeritus professor. The entire form of courses is done through MOOC courses. Therefore, using technology we can reach out to 4-5 lakh teachers. So, the use of technology to train teachers through SWAYAM is significant and equally important.

The regulatory framework is equally important for governance of institutions. The new policy also wants regulations to be light and tight. Create trust, and ask the institutions to declare that they have all the facilities. All these facilities are reflected on the website as a self disclosure mechanism, and if anything that can falter, then there is a complaint. The regulator then comes in with a stick in hand and takes away the approval those are given to the institutions. This is also

possible through technology. All the information being made available and all the data can be collected. Unfortunately, this still has not happened. Institutions are providing the same data to 7-8 organisations. There should be a single platform on which institutions are supposed to provide data with proper validation that is also the need of the hour. Accreditation can also be collected on a single platform and there should be a mechanism to oversee how teaching and learning are taking place. We can visit any institution, any class, and see how classes are going on there.

NETF can be the forum not only restricted to the center, but every state, university, and college should have their one, and the guidelines that are given by the central body of NETF should be taken up by the state council, from there to the university level and the college level. And the suggestions, feedback that come from any quarter, anyone who has some brilliant idea can also support. Those must be used for continuous improvement of our educational system.

Vineet Joshi, Additional Secretary, Ministry of Education

Following roles of NETF were clarified.

- Have a far reaching impact on education in India by leveraging technology.
- A platform for providing access to technology and ICT-enabled education.
- Empowered by ministry level.
- Cover different dimensions of education & training of teachers to make them skilled to teach with the modern technology.
- Take care of the issues like bandwidth infrastructure required for technology-enabled services, availability of devices and providing a user-friendly ecosystem.
- GoI will make suitable provisions in the proposed NTTF so that the second important component of online and technology based teaching i.e. assessment of the students, will be eased. All possible issues related to online assessment and evaluation of the examinations, assignments, and other such inputs by the students would be addressed.
- Prepare the leadership in education institutes to develop infrastructure for learning and teaching and also to implement different schemes of Bharat Sarkar.
- Be a facilitator rather than an implementation organisation for the various stakeholders.

- Anticipate emergence of new technology and prepare all the stakeholders for adopting the same.
- Coordinate with the proposed National Research Foundation in order to materialize their findings and convert the same into products to make them useful for the education fraternity.
- Channelize the efforts of all the stakeholders contributing in technology education and to have the synergy.
- Incorporate administrative suggestions received from all the channels and use them in its operations.

V. V. Subrahmanyam, IGNOU

- NETF should provide a 3 pillar system for the dominance of services, the three pillars being 'use of infrastructure and its availability', 'Use of proper softwares and its availability', 'Robust platform to handle all possible issues which may arise from time to time'.
- We need cloud services to have repositories and e- contents management.
- Open source education should be provided with the help of virtual reality, augmented reality and mixed reality.
- NCERT is maintaining e-pathshala and its repository.
- Sharable resources should be given more importance from school level to higher education label.

Shubham Chauhan, Akhil Bharatiya Vidyarthi Parishad

- Entrepreneurial education in various domains in Schools and Higher Educational Institutions is important to make India Self-Reliant via NETF.
- Plan for an early orientation, structuring, capacity building and global competence for students to pursue for Innovation, Technology, Research & Development or Startups in various domains via NETF.
- There should be a favorable and pleasant environment for these Innovators to significantly build their capacity and come up with disruptive innovation through their Ideas, Innovation, Technology, Patents, Startups, Research, Prototypes, Proof of Concepts, Science and Business Models etc.
- Build / Enhance platforms to help with the education and awareness of the real world compliances in every domain.

- Integrate these Innovators or Changemakers in their respective field with the mainstream Startups, Niche Ecosystem, Organizations, Communities, Economy, Industries, Institutions, Government etc.
- Technology Adoption for making the above happen.
- Make a vision document or a policy through NETF for focusing, shaping, monitoring and implementing key measures to be taken to enhance India's capacity in every domain as per the global competence in terms of Innovation, Technology, R&D, Infrastructure etc.

Sridhar Srivastava, NCERT

- NCERT is transforming the curriculum for use in virtual medium teaching. It is developing content with the use of technology.
- NCERT supports 'One nation one data' proposed by Professor Anil Sahasrabudhe for minimizing the governance related to various regulatory agencies, and filing compliance from the educational institutions in various forms. There should be a simple and non-repeated report submission system from the academic institutions so that they can be more focused on academics and less on the compliance reports submission formalities.

Prof. Rajeev Sijariya, Atal Bihari Vajpayee School of Management & Entrepreneurship, JNU

- NETF should provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning, and administration.
- It should be an autonomous body that deals exclusively with technology-led education and assessment to enhance educational access for disadvantaged groups.
- It should be a one-stop-shop to discuss and strategize the use of technology across all levels of education.
- NEP promises the availability of all resources through school complexes and clusters. NEFT can ensure the creation of world-class resources in terms of technology-based teaching. A well-furnished ICT laboratory backed by the access of a digital library has a wide range of standard reading material for content development. The studio facility needs to be created for preparing audio and video content with graphical presentation and animation effects.

- Well trained technical staff are to be developed and deployed to support teachers as well as students for the effective use of technology. PCO and Cyber café like public facilities run by such independent trained persons can be opened where the deprived section of the society may take advantage of modern facilities on minimal payment. Such facilities can be created at a commonplace in villages and blocks being connected by optical fibres.
- International digital journals and other publications have restricted access at a very high cost. A mechanism is to be devised to procure the same at a central place and also to pool other similar resources.
- Present efforts of the government to create and make available useful content at their official platforms are not sufficient. Much quality content available in an open market. The same should be graded and students may be informed about the grading to enable them to select the appropriate one for their use.
- Independent teachers who are very much popular on the social platform may be involved in content development.
- Setting up of Multidisciplinary Education and Research Universities (MERUs) envisioned in NEP requires the creation of expert laboratories, libraries, faculty etc. for a variety of disciplines. Here, the concept of the virtual laboratories will be important.
- A pool of super specialty subject teachers at the national and regional level should be created. Their lectures should be coordinated and scheduled in a manner that benefits a majority of the student population.
- Recruitment norms in academic institutions may be revised to fit into the new normal.
- Apart from the resource creation and resource management, NETF should also address affordability issues, i.e. costs of devices, data usage, operation and maintenance.
- Copyright issues may need to be addressed.
- A proper system of registration and listing of e-content is to be worked out.
- A complaint and grievance settlement system will be required to address issues related to validity, authenticity and ownership of the content.
- A system may be developed to help and guide new users of technology. All the registered academicians could be provided a toll-free number, website, call centre backup etc.

- NETF should note that, today, technology-based and online learning is taking place for content related to all walks of life, e.g. home care technique of 'patient care,' preparing immunity booster drink, taking vapours in corona or use of the prone technique in case of low oxygen level.

Prof. Heerman Tiwari, JNU

How to Maximise Digital Technology in Teaching and Learning

- Our ancient Indian knowledge system paid greater emphasis on human memory to store, protect and transmit knowledge.
- In Indian philosophical systems, memory plays a significant role in acquiring true knowledge, *prajñā*. Memory is an indispensable aid to a valid means of knowledge. Let us use that memory to assess the modern digital technology and see whether we can use it to enhance our capacity to store and transmit knowledge to a wider audience.
- There are at least three immediate benefits that digital technology can provide: space, time and width.

Gaurav Singh, Educationist

- NETF is useful for long term measures. One should not jump from this to a new platform because of non-fulfilment of the objectives.
- The platform should be instructor controlled but learner centric so that maximum efficiency can be worked out.
- It should also be affordable to achieve wide access and reach for the greater outputs.
- An integral mechanism should be developed to have coordinated efforts with the available tools and techniques.

Amrendra Behra, Joint Director, NCERT

NETF will strengthen use and integration of technology to enhance quality of school and higher education and contribute to Atma Nirbhar Bharat. Further, it will help in creating a robust, resilient and coherent system of education, including Digital Education in our country, even in the pandemic situation. It will facilitate in the following:

1. Digitisation and Localisation of contents at every level

- Ours is a diverse country. Apart from 22 VIII th Scheduled languages, five distinct language families with about 1652 languages are spoken in our country.
- Development and digitisation of textbooks and other e-resources need to be done in multiple languages in mission mode through machine support and integration of AI. For this purpose, along with involvement of professional Govt. organisations, NGOs, Corporates, CSR, Community, teachers, volunteers are equally important.
- To maintain quality, guidelines / standards should be evolved for the development of eContents, and ETBs and stakeholders need to be oriented.

2. Creation of Learning Management System (LMS) and centralised digital depository

- Teaching - learning - assessment needs to go hand-in-hand even in pandemic situations. A robust LMS needs to be designed and used by nearly 90 lakh teachers and 33 crore students in school and higher education institutions (15 lakh schools, 1000 Universities and 50000 colleges).
- The courses and course platform should be of high quality, interactive and provide synchronous and asynchronous communication facilities. It should support proctored online, offline examinations, certification, credit transfer facilities on a real time basis. It should support pilots, scaling, multiple entry and exit. Guidelines for designing, running courses need to be developed for quality control purposes.
- Registry and tracking of students and teachers from nursery to tertiary is possible through an integrated LMS.

3. Integration of available educational technology platforms for better outreach among teachers and students

- Several digital education initiatives are undertaken with implementation of digital India campaign. SWAYAM, SWAYAM Prabha, NDL, DIKSHA, ePathshala, NISHTHA, PMEVIDYA etc. are some of them. However, these platforms function in watertight compartments and integration &

interoperability is a major challenge resulting in confusing the learners, students and teachers. Whether it is delivery of digital books, audio, video, interactives, virtual labs, or digital games, a single platform needs to harbour these resources and track learning and support in imparting quality education. AI-based solutions need to be designed with integration of available educational technology systems, platforms and solutions. Necessary standards and guidelines need to be developed.

- The NDEAR (National Digital Education Architecture) being developed by MoE and MeitY may be a stepping stone towards realising the goals of NETF under the broader vision of NEP-2020.
- The Hon'ble Prime Minister of India has very rightly said that for achieving the triple goal of skill, scale and speed in a country like ours, technology is the key and can help us bridge the digital divide.

Prof. Uma Kanjilal, Pro-Vice Chancellor, IGNOU

IGNOU has undertaken several digital initiatives to enhance the remote learning ecosystem. These initiatives include online education by leveraging emerging technologies, integration of technology platforms among teachers and students, and digital infrastructure. Technologies are being used for delivery of content like online learning, channels, and audio-video content. Digital content has been delivered to students through online platforms accessible to all learners across the country. IGNOU has also designed a content app, which can be downloaded from the app store through which all content can be accessible. IGNOU is also using the SWAYAM platform for online programs. IGNOU wants to build technology solutions on top of the platforms wherein the support from NETF is required. IGNOU is widely using social media platforms like Facebook and Twitter to reach out to students and learners. Since 2009, IGNOU has been using online platforms for governance and admission. The major challenge is using several solutions and platforms in silos. Integration in a seamless fashion is required so that things can be done through a single platform. IGNOU is looking forward to the integration of the latest technologies. The applications of AI & ML in the education sector and how it can help identify, assess the learning and student capability, and enable teachers to teach accordingly are also being explored. Things are being done in bits and pieces; it should be done in a consolidated manner. Technologies like AR & VR can also play a major role in content creation and delivery. As NEP talks about online education, it’s logical to think how content

can be prepared and delivered to all students in a seamless manner by using the latest technologies.

Blockchain in education can be used to integrate academic credits and transfer of credits from one institution to another. Single sign-on platform is important to get rid of several applications and solutions. The entire life cycle of education including students' information, teachers information, institute information, learning material, administrative activities, examinations, and certifications should be available through a single platform so that there would be a seamless learning experience. NETF can intervene to build mechanisms to address the future challenges. Flexible learning, online learning, availability of tools, so that a one-stop solution for all learning requirements. It is also important to integrate academic banks or credits. All the activities starting from registration to certification should be integrated on a single platform. Strengthening the digital infrastructure of universities is paramount. Each institution should have a content creation facility. NETF should focus on ICT infrastructure, e-learning & blended learning, and e-governance.

Bala M S, Digital Transformation Leader, Board Director & Advisor, EdTech-Fintech mentor, Former MD, Blackboard; Former Chairman, NASSCOM GCC

- Transformation in education is not only about the curriculum, learning delivery, student support and research; it is about the back office, the operating model, the technology and, fundamentally, the sum of capabilities that reside in the organisation.
- Competing at scale - One of the extraordinary developments in today's economy has been the rise of the platform business. Seven of the 10 largest organisations in the world can be described in this way.
- The country that can provide on-demand learning, at scale and personalised to the needs and wishes of the student, is the country which can build resilience into its future.
- The problem lies in the inability to scale up under the current, largely face-to- face, model of education and the country culture that surrounds it. Our Govt. under the able leadership of Hon. PM has been moving digitally successfully in every sector / industry. We have started zero to 1 in many fields. The country is ready to adapt to it.

Creation of Learning Management System and centralised digital repository

1) A complete digital experience of Teaching and Learning - No business can ignore Customer Experience (CX). Education is starting to see this in universities, although KPMG education specialists argue that this should be developed into a more complex idea of Student Experience (SX), which adds in Learner Experience (LX) and Personalised Experience (PX)

2) A user-friendly platform to be available on all devices (Computer/Tablet/Mobile phones) - low code platform

3) Make it simpler so that any student / teacher, irrespective of their background and prior knowledge, can use it without any difficulty. For example, 5 days workshop "e-Teacher" initiated by us, approved by AICTE chairman and conducted at NITTTR Chandigarh was a great success. Using such platforms, we can enable the teaching fraternity to get on to the standard in digital education.

4) Bring a seamless transition from the traditional Teaching & Learning to Digital experience.

5) Make it a blended experience where traditional and digital approaches complement each other.

6) Structure the LMS well so that it can fit in well with the existing requirements of pedagogy.

- Basic elements – Class, Medium (Localization), Course, Instructor, Students. (English and Hindi should be the mandatory medium available in the whole platform. Major Regional language may be adopted based on the need- but it's on top of the primary platform).
- Types of content – Text, Tables, Audio files, Video files, Graphical materials, Images, Links to external sources, Files, etc.
- Types of Assessments – Quizzes, Classroom Polls, Subjective Assignments, Objective tests, Subjective tests, Surveys, etc.
- Plagiarism support to refrain students from copying.
- Rubrics support for evaluating the objective/subjective assessments - outcome based education may be achieved over a period of years.
- Forums to discuss academic related topics
- Administrative activities like Attendance Management, Schedule management, etc.- Govt may tie up the administrative aspect of the school /

college/ university - stating from admission to exit - where the system may be designed in a way where NBA / NAAC / AICTE / CBSE etc requisites may be recorded and monitored).

Additionally we can build analytics capabilities for teachers to focus on at-risk students, and for students to focus on their strengths and improve on weak areas. Moreover, we should have virtual classes from anywhere, video, audio, breakout groups, timers, chat, recording, annotations, dial to phone, scheduling meeting, screen sharing, whiteboard, polling etc. These should be accessible for everyone.

Digitalization and localization of content at every level

- Create and manage content – sites, channels, sections
- Authentication methods – Single sign on
- Content translation in major Indian languages to be reviewed by experts
- Access control on the contents
- Ensure security of the contents

Integration of available educational technology platforms for better outreach among teachers and students

- Connect Students – Parents – Teachers – School Administration – Government
- Enable access in all types of devices (Laptop/tablet/mobile phones)
- Mass communication – COPE (Create Once and Publish Everywhere – Email, Call, SMS, Institution website, Social media (facebook, whatsapp, twitter, etc.)
- Emergency messages, announcements, regular updates, class updates, to do tasks, reminders.
- Two-way communication between teachers, students & parents

Prof. Kannan Moudgalya, IIT Bombay

Mother tongue based education

We need many non-English speaking people as problem solvers. A strategy may be to bring up a lot more vernacular language learners through a mix of English and local languages - an example being Spoken Tutorials. The objective should be to quickly create a large set of problem solvers from a pool of people not fluent

in English. They will better understand the problems faced by their brethren. Unfortunately, however, most problem solvers do not come from these sections of the society. Those who studied in English medium schools do not necessarily understand the difficulties faced by those from a mother tongue medium.

At the college level, most education currently takes place in English. The quickest way to produce the above said problem solvers is to translate what is available in English to other languages. It is important to keep English as well, so as to retain employment opportunities. This will ensure that people from the mother tongue medium also reach high levels of the society, and that they have a say in decision making.

To achieve the above quickly, we should translate the English course content into our languages. The procedure to do this for video lectures is outlined first, because we do have a lot of content of this type for which intellectual property rights (IPR) may not be an issue. As a first step, translate the audio, but keep the English videos unchanged. As our languages are possibly verbose, this requires some effort. We outline one method to achieve the above for already available English videos:

1. Transcribe the audio of English video lectures.
2. Translate the audio into our languages, keeping the length of translated sentences the same duration. In many cases, this cannot be achieved in a straightforward manner. The following steps are proposed for this:
   a) Rewrite the English script obtained in 1 above to simpler sentences. Avoid difficult words. Such simplified sentences should not be longer than the original sentences. Ensure that the simplified sentences are short, and do not exceed a pre-fixed length. In the Spoken Tutorial project, this recommended length is 60 characters, and no sentence can exceed 80 characters. Any grammatical mistakes, or incomplete sentences, etc., should be corrected at this stage.
   b) Correctness/equivalence of the script obtained in a) above should be established.
   c) Short sentences and simple words will help ensure that the translated sentences are not longer than the original. Short sentences with simple words can be translated into sentences of equal or shorter length. Longer sentences sometimes have convoluted sentence structure, and may not

lend themselves to easy translation. While translating, it may be required to retain English words, especially technical words, where necessary.

d) Correctness/equivalence of the script obtained in c) above should be verified with the script obtained in a) above.

3. Record the translated sentences obtained in b) above.
   a) Stitch the audio obtained in c) above with the original English video.
   b) Where the simplified English sentences in a) sound a lot better than the original English audio, dub the original English also.

Some projects have taken an easy way out by giving an audio file separately, as this will obviate the need to sync the translated audio with the original video. Unfortunately, this will make it difficult for the vernacular language based learners. It is likely that such audio files will not be seen by many people. As a result, it is even possible that the quality of the translation does not even get checked – in some cases, we have seen machine generated audio being given, although costing may have been done for manual translation and voice rendition.

Any dubbing done without worrying about the sync is a wasted effort. Modifying it at a later stage to provide the sync can become very expensive.

Giving mother tongue subtitles in a video lecture delivered in English is not at all useful. Should the reader be trying to read the contents of the video (for example, diagrams, derivations, etc.), or trying to read the subtitles? In this case, there is a lot of load on the video channel of the reader, with the audio channel not being used. Why should the vernacular language learner be made to do a lot more work than English language based learner? As a next step, slides used in the English videos can be changed into mother tongue, and the video can be re-edited. It seems doable, but we have not done it in the Spoken Tutorial project.

The above method is suggested also for school level software. Spoken Tutorials are already available for many school level software also. These have English videos with voice dubbing in our languages. Some of the topics covered in this section are used in colleges also. Some examples are C/C++, Java, Python, Scilab, and Moodle.

For other school level education, we already have a good tradition of vernacular medium teaching. This should be strengthened. Digital tools should be made available to help this community.

Prof. Vikas Dubey, IIT BHU

NETF is proposed as an autonomous body in NEP 2020. And it proposes to integrate technology at all levels of education. India has transformed itself as an information-intensive society. Entire globe sees India as an excellent country in IT and integrating technology in the educational sector to remove all barriers and give educational access to everyone. It is very useful in managing the enormous activities of education. The relationship between education and technology should be bidirectional, so we use technology to develop education and then use education to develop better technology. That's the way we should develop the relationship between technology and education. This pandemic situation has compelled us to use teaching/learning technology. That's the good thing that we have already started what NEP proposed us to do. We can use AI, AR & VR to develop very rich teaching resources. We are talking of virtual labs. This can help us in cost cutting of equipment and devices and address the resource crunch. We can have virtual labs for online teaching/learning processes. The Digital India campaign has already transformed us into a digitally intense society. Before India used educational technology, it moved to become a digital economy. We need to promote digital by default. Everyone should have the ability to use digital teaching/learning processes. Digitally competent has now become a necessity for modern life. Everyone should be digitally competent to implement this NEP. Given the implementation of online education, we need to have a suitable learning model, changing pedagogy, online assessment process, availability of digital platforms for everyone, and enabling our teaching/learning process with much more technology. We already have very successful digital learning mechanisms like MOOCs. Many of us are using some portals for teaching/learning. We don't have many teachers in rural areas who are digitally competent. So, we need to train rural teachers to become digitally competent. Online assessment has been a big challenge. When we are using online education, there is some kind of psychological impact on the smaller kids. We need to have a mechanism in the online learning system to assess the psychological impact of smaller kids. We should also ensure that the digital content should be available to everyone. There are certain limitations of delivering online education in some subjects like physical education. So we have to integrate technology like VR to develop course content that requires a different type of concept. We should have a deeper implementation plan. We need to customise architecture of digital education. We should have regular upgradation

and monitoring of education as to what digital material to be developed. We have to design MOOCs and training for teachers to become digitally competent. We need to implement and ensure digital content which is developed in urban areas should reach all nooks and corners of the country. We also need to integrate technology for the assessment and accreditation process.

Prof. Rajiv Prakash, IIT, BHU

Credit bank and inclusion of online lab teaching are critical for portability of education. There are very successful online classes, but to make those equally useful and effective is essential. Lab teaching especially for engineering and medical education should be simulated. At IIT BHU we have already started on this. Vey successfully we cover this during pandemic time – online teaching and others. Donation of computers to schools and other educational systems where the students are not having this facility, yes we are doing this at IIT BHU. We started only one year back. Because of the pandemic this year we will go for the second phase of computers and peripherals. We are facing challenges in demonstrating our laboratory classes, especially the engineering workshops where such learning is very much important. Pilots are taking training on simulators, software and facilities where students can feel how a CNC machine is working, and operate on a CNC machine. This type of solution can help us quite a lot.

Credit bank is a wonderful initiative. With credit banks, students can get a lot of benefits, a lot of freedom, and enable them to take any course of their choice. But we should be very careful. Students are very young to decide what courses they have to take. So, there should be a system that determines how much freedom there should be to opt for such courses. But sure one or two elective courses can be taken by students not very much related to their core course. At IIT BHU, we are offering open elective courses to students to pick some courses from other branches. And this I think can be a trans-disciplinary approach.

Prof. Y. N. Singh, IIT Kanpur

We have to put all things in perspective else it will not be successful. Purpose of education should be real skill in solving problems. Technology cannot solve the issues of why students are not asking questions. Students should be curious, and they must be encouraged to ask questions. There is no way to make observations

by students. Genius cannot come from certificates and degrees. Skill sets are to be acquired by PhD students. Skills are to be learned automatically. Technology is only solving the issues of space/distance. Learners should know about what's right and what's wrong. That should be the objective of education. Next 4-5 years will be very dynamic, and NETF has to play a very important role.

We can use protocols to distribute data in a seamless manner. We have to create the system now. AI has become a very big hype. We need lateral thinking R&D. AI can't do that. Human intelligence is more powerful than AI.

Prof. D. P. Goyal, IIM Shillong

Implementation is key to the success of any policy. Open Source systems can play an important role in online education. Technology should be an important part of education. R&D is also important for higher education. Adoption of technology should be much easier. A blended system can be more powerful than stand-alone systems. We need to capture the emotion and experience of students through technology. NETF should emphasize on the training of teachers. Case discussion is very important in classroom teaching. Content can be digitised but we have to think about the pedagogy, which can be done through technology.

Prof. Madhav Govind, JNU

Continuous evolution in technology has helped us address the challenges of education. We are now living in a technology society. Every aspect of life is guided by technology. Technology should be used for minimising discrepancy. Technology can bring transparency in assessment and objective evaluation. Knowledge transmission is very important. Explicit & implicit knowledge should be codified. Passive knowledge should be translated to dynamic form. Use of technology should be decided based on the output desired.

Prof. Sreepad Karmalkar, IIT Madras

Student engagement through various means is important. Monitoring of students during online learning is critical. There must be a mechanism to measure engagement of students. Q/A session should be there every 7-10 minutes. Assessment through online mode is critical. Exams should be conducted in face-to-face mode. Question paper should not be made public.

Subodh Sachan, Director, STPI

Startup ecosystem has been a vehicle for frugal innovation. Startups require guidance and mentorship. 300+ startups are there in our STPI's startup ecosystem with a great set of mentors. We need to create immersive educational content. Need of immersive technology is important for delivering quality content. It's important to engage with the startup ecosystem for building innovations. Use of AR & VR for immersive experience in engineering education is important. NETF should create a platform for enablement. Higher educational institutes should be linked to startups.

Amit Bansal, Director, STPI

NETF can build an ecosystem for collaboration with various stakeholders to empower the implementation of NEP in a seamless manner. Technology as the mainstay of NEP in ensuring accessibility and affordability can bring in a paradigm shift in the learning process. Focus on digitisation, virtual enablement, and multidisciplinary education will transform the entire education system and ignite the students to be more creative, innovative, responsive, and professional.

Prof. Nageshwar Rao, Vice Chancellor, IGNOU

Summary

The online discussions on NETF captured the deliberations by 9 speakers in the 1st session and 8 speakers in the 2nd session. The discussions touched upon various dimensions including the massive learners in India touching 33 crore, the affordability & assessment of education in a technology-enabled ecosystem, pedagogy, content creation & delivery, skilling of teachers, credit banks, compliance, governance, and infrastructure development. Despite having a robust content delivery platform like SWAYAM, students till date were not eager to leverage; however, pandemic has accelerated this process. COVID has enhanced the pace of using technology. Robust open source systems are important for affordability. Cloud resources sharing is also critical for affordability. Translation of educational material in vernacular languages through open source systems can be done in an easy and affordable way. Multidisciplinary education is important. SWAYAM can address multidisciplinary learning and enable learners to get certified. Regulations should be light and

tight. The base of learning and disciplines must be expanded. Online revolution has been looming. Capacity building is essential. Motivation and encouragement are required. Online evaluation should be strengthened for mass learning. India should have a robust system to evaluate 33 crore learners. The objective & subjective evaluation of learning through technology must be deliberated. Continuous and subjective evaluation of learners through technology is also paramount.