Continuous Professional Development (CPD) of Faculty for Evidenced-Based Teaching Strategies in STEM

(10th-14th October, 2023)

DETAILED REPORT

Inter University Centre for Teacher Education

Banaras Hindu University
IUCTE Campus, Sundar Bagiya
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Chief Guests and Resource Persons

Foreword

The Inter University Centre for Teacher Education (IUCTE), Banaras Hindu University, Varanasi, is an autonomous institution established by the University Grants Commission (UGC) in 2014, with the vision of promoting excellence and innovation in teacher education. The IUCTE aims to provide a platform for collaboration, research, training, and advocacy among various stakeholders of teacher education, including universities, colleges, schools, teachers, students, and policy makers.

The IUCTE has been actively engaged in implementing the National Education Policy (NEP) 2020, which is a landmark document that envisages a holistic and multidisciplinary transformation of the Indian education system. The NEP 2020 emphasizes the importance of STEM (Science, Technology, Engineering, and Mathematics) education, as a key driver of innovation, creativity, and problem-solving in the 21st century. The NEP 2020 also advocates for experiential learning, coding, and mathematical thinking from the foundational stages of education, as well as the integration of digital and online learning to enhance access, quality, and equity in education.

The IUCTE has been conducting various programs and activities to support the implementation of NEP 2020, especially in the domain of STEM education. Some of the notable initiatives are IUCTE has organized a Faculty Development Program on the topic "NEP Implementation: Emerging Issues in Higher Education" and "Continuous Professional Development of Faculty for Evidenced-Based Teaching Strategies in STEM".

The IUCTE is committed to advancing the vision and mission of NEP 2020 together with its implementation, and to making STEM education a reality for all learners in India. We hope that this publication will serve as a useful resource and inspiration for all those who are interested in STEM education, and will contribute to the development of a vibrant and inclusive knowledge society.

I express my sincere thanks to the eminent Guests, experts and resources persons of these programs who have made their valuable contributions for guiding the participants and sharing their wisdom with all. I am thankful to all the faculty and staff members of IUCTE who have contributed towards the success of these events.

Prof. Prem Narayan Singh
Director, IUCTE

INDEX

About the Continuous Professional Development Program in STEM

The current educational system is undergoing significant change and improvement. This transformation includes teaching models and methodologies as well as changes to the curriculum, learning experiences, evaluation system, and syllabus. The higher education system is constantly looking for more efficient and meaningful teaching strategies that incorporate many disciplines and students with various learning preferences. One of these innovative teaching methods that integrates four disciplines is STEM (science, technology, engineering, and mathematics).

STEM in higher education encourages interdisciplinary teaching methods by fusing the fields of science, technology, engineering, and mathematics to impart subject matter. Higher education students can be inspired to use their problem-solving and critical thinking skills by participating in team-based, multidisciplinary assignments through the use of STEM teaching techniques. Traditional educational approaches can be academically restructured through STEM education.

Our ability to perform math, physics, chemistry, and other solo tasks is most certainly not put to the test when life challenges us. Instead, it evaluates how well we can manage the problem while using the lessons from these subjects—both their theoretical underpinnings and their real-world applications. For the population of the twenty-first century to successfully navigate modern life, STEM education must first get a solid foothold in the field of education.

STEM education, which stands for Science, Technology, Engineering, and Mathematics, is a new concept in education due to the market trends' quick shift and the nature of the talents that employers want in employees.

Objectives of the Program

Rapid advancements in science and technology are often related to challenging social problems. A lifelong continuous professional development (CPD) of lecturers in their local context is required to deal with these advances and to ensure sustainable quality of teaching and learning in STEM courses in higher education. The objectives of this project's activities are to develop technology-based teaching methods and incorporate technical, pedagogical, and content knowledge (TPACK) into the classroom in order to improve student learning.

The programme has specific objectives and strategies adopted accordingly to fulfill those objectives at the optimum level. Lectures by experts and resource persons, PPT presentations, panel discussions, interactions in workshop mode, sharing of experiences and individual and group-based practical activities would be the methods for imparting training. At the end of the CPD, each participant will be expected to develop a new module or transform a draft unit or module into the self-learning material format in the respective area of their expertise. Some of the important objectives of this programme are as follows:

1. To gain a complete understanding of the fields of science, technology, engineering, and mathematics.
2. To inculcate knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM.

3. To foster in pupils a culture of critical thinking, problem-solving, creativity, and technological awareness (AI) as mentioned in NEP 2020.
4. To Bridge the Gap between Secondary as well as Higher STEM Education and to reduce the gender disparity in STEM professions in higher education.
5. To identify the challenges associated with STEM teaching in higher education.
6. To satisfy the demands of the global labour market and prepare individuals for international industrial competition.

Major Themes of the Program

1. STEM Education: Roots in Bharat
2. Importance of STEM-oriented pedagogy, Formative assessment, and recent advances in STEM: in context of NEP 2020
3. Academic Leadership
4. STEM Education with a Multilingual Voice
5. Four Cs: The soft skills for STEM Learning
6. Resources for STEM Educators: OERs and Open Science Initiatives
7. New and Effective Pedagogical Strategies for STEM
8. Sustainability and Entrepreneurship
9. STEM Education and the New World Order
10. Technology Integration in STEM Education: TPACK Framework
11. STEM & AI: A Symbiotic Relationship for Higher Education
12. Bridging the Gender Disparity through STEM Education
13. STEM in Higher Education: Perspective of NEP-2020
14. Facilitating Thinking and Learning in the STEM Classrooms using research- based approaches
15. Entrepreneurship and Vocational Skill Development through STEM Education
16. Promoting Research in STEM Education
17. Approaches for enhancing student engagement in science classrooms of higher education institutions
18. STEM jobs and careers in India/Abroad
19. Building STEM readiness in students
20. Impact of STEM on Society

Key Data about the Program

1. **Total No. of Participants attended the programme: 20**
2. **Total number of State and UT representation: 09**
3. **Gender-wise participation:**

Gender of Participants	*Number*
Male	11
Female	09
TOTAL	**20**

4. **Total number of Resource Persons: 20**

Program Proceedings

Day 1: 10 October, 2023

Inaugural Session

Speakers:

- Prof. Avinash Chandra Pandey, Director, Inter University Accelerator Centre (IUAC), Delhi
- Prof. Bhartendu Kumar Singh, Director, PDPM-IIITDM, Jabalpur, MP
- Dr. Raj Singh, IUCTE, BHU
- Prof. Avinash Kumar Agarwal, Indian Institute of Technology, Kanpur

Brief

Inter University Centre for Teacher Education at Banaras Hindu University in Varanasi launched a five-day online program on "Continuous Professional Development (CPD) of Faculty for Evidence-Based Teaching Strategies in STEM" on Tuesday, October 10, 2023. Members of the CPD program came from numerous universities and from 9 different states. This CPD program's goal is to instill information, attitudes, and abilities so that participants can recognize questions and problems in real-world scenarios, explain how the natural and created world works, and reach judgments about STEM that are supported by facts. Prof. Bhartendu Kumar Singh, Director of the PDPM-IIITDM in Jabalpur, MP, served as the Guest of Honor in addition to Prof. Avinash Chandra Pandey, Director of the Inter University Accelerator Centre (IUAC), Delhi, as the Chief guest of the opening session. Director of IUCTE, BHU Prof. Prem Narayan Singh made the opening comments. In his welcome address, Prem Narayan Singh, emphasized the value of character development and the fact that how we teach is more crucial than what and to whom we teach. He remarked, "Ek shikshak gyan deta hai aur gyan ka sampreshan karta hai " but a real teacher 'A mentor' is someone who has a comprehension of how to communicate with students. In his words, "Shikshan seekhne ke liye upyukt paristhitiyon ka nirmaan hai," a teacher must put emphasis on pedagogy. A teacher is automatically satisfied if the students are.

Prof. Bhartendu Kumar Singh, discussed that female representation is now increasing. He

spoke about the Department of Science and Technology's (DST) Gender Advancement for Transforming Institutions (GATI) Pilot Project, which aims to advance gender parity in science and technology. He added that in order to address students' problems, a teacher must also modify the conventional pedagogical procedures.

Prof. Avinash Chandra Pandey, inspired the teachers to develop big ideas, which are the foundations of all new knowledge. In addition, he made the point that STEM teachers should tie their lessons to real-world experiences in order to make them more engaging. For higher cognitive abilities, he claimed that we must teach our children how different concepts relate to one another. The kids ought to develop a variety of talents, including teamwork, manipulative ability, and communication. 20 Participants from 9 different States/UTs attended the programme. There were a total 26 sessions in the FDP in which 20 subject experts gave the talks on various themes. Two Brainstorming sessions were also included during the CPD for which various activities were planned for the participants which includes:

Activity 1: Which innovative pedagogy do you follow while teaching in your institutions? Also mention about challenges faced by you?

Activity 2: a) What's your idea on promoting the female enrolment in STEM courses in India?

b) What's your opinion on promoting students' career in STEM and also promoting research in STEM?

Activity 3: A final quiz was conducted in the form of MCQs related to topics covered by experts and grades obtained by participants were mentioned on their certificates.

The program was being Coordinated by Dr. Kushagri Singh and Co-Coordinated by Dr. Deepty Gupta. Dr. Saurabh Singh Rathore gave a thank you speech.

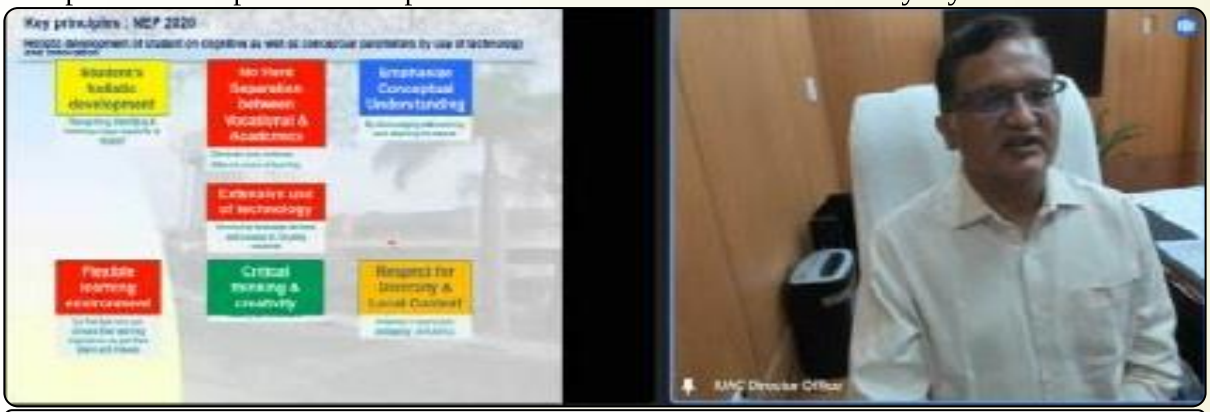
Session 2: STEM Education: Roots in Bharat: Prof. Avinash Chandra Pandey, Director, Inter University Accelerator Centre (IUAC), Delhi

During a recent talk, Professor AC Pandey, the Director of IUAC, began an enlightening exploration of the historical development of STEM (Science, Technology, Engineering, and Mathematics) in India. The speaker underscored the fact that the Indian subcontinent has served as a hub of scientific ingenuity and mathematical proficiency dating back to antiquity. The foundational principles in various scientific disciplines, including mathematics, medicine, and astronomy, have been significantly influenced by the groundbreaking contributions of early Indian intellectuals. An example of India's lasting STEM legacy may be observed through the influential contributions of Aryabhata in the 5th century AD, as well as the remarkable architectural achievements such as the stepwells found in Gujarat and Rajasthan. These notable instances serve as significant evidence of India's continuing scientific, technological, engineering, and mathematical heritage.

In addition, Professor Pandey emphasized the remarkable engineering capabilities of the Indus Valley Civilization, which continue to serve as significant milestones in the fields of urban planning and advanced engineering approaches throughout that time period. In order to have a more comprehensive understanding of the intricate knowledge systems prevalent throughout that era, it is advisable to consult esteemed religious texts such as the 'Vedas' and medicinal manuscripts like the 'Susruta Samhita'. These sources highlight the profound scientific and mathematical understanding achieved during that epoch.

According to Professor Pandey, STEM may be defined as an integrated educational methodology that combines theoretical academic concepts with practical applications in real-world contexts. The integrative methodology described promotes a culture that encourages problem-solving, discovery, and learner-driven creativity, beyond the limitations of isolated subject learning.

The professor emphasized the pervasive nature of STEM in our everyday lives. The essence



Prof. Avinash Chandra Pandey was Director, Institute of Interdisciplinary Studies, University of Allahabad since 2016 before joining IUAC. He was Vice Chancellor of Bundelkhand University from 2012 to 2015. He has earlier been Professor at University of Allahabad after obtaining Masters (Physics, Mathematics) and D.Phil. Degree from University of Allahabad. As a Principal Investigator he led to development of three new centres in Allahabad University. He is accredited with the development of the Nanotechnology Application Centre (NAC) besides setting up of High Fluence Ion Beam Facility: a state of art Ion Implanter facility in the premises of University of Allahabad and Innovation Center, Weather Station, Animal Research Facility at Bundelkhand University.

of STEM is evident in various aspects of modern society, such as the widespread use of cellphones, the development of technologies for clean drinking water, and developments in the automotive industry. The revolutionary potential of STEM is exemplified by pioneering medical interventions, including MRI scans, robotic-assisted operations, and telehealth, as well as agricultural advancements in high-yield crop growth.

In the context of post-colonial India, Professor Pandey emphasized the country's endeavor to establish a robust higher education system. The desire became more defined with the establishment of esteemed schools such as the Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), and All India Institute of Medical Sciences (AIIMS), all of which aimed to achieve high standards in education and groundbreaking research, notably in the fields of science, technology, engineering, and mathematics (STEM).

Over the course of several decades, the higher education landscape in India has experienced significant growth, with a notable increase in the number of universities over 1000, along with a wide array of colleges. This expansion has solidified India's position as one of the global leaders in terms of the scale and scope of its education system.

The professor commended India's remarkable transformation from facing challenges related to food scarcity to embracing agricultural plenty, highlighting the interconnectedness of science, technology, and societal advancement. This shift serves as a monument to India's ingenuity and innovative mindset.

Professor Pandey emphasized the crucial role that STEM (Science, Technology, Engineering, and Mathematics) plays in promoting sustainable development. The individual referenced emerging endeavors focused on the utilization of solar energy, advanced waste management techniques, and the preservation of water resources as exemplary illustrations of the contributions made by STEM disciplines towards achieving sustainability goals.

The educational framework promoting STEM in India is based on the principle of experiential learning. As per the professor's perspective, educational establishments place emphasis on experiential learning, leading to a transition in educational practices from conventional memorization-based methods to a more practical and application-oriented approach to acquiring knowledge. The dynamic learning philosophy not only engages learners but also provides them with the skills to effectively address complex challenges in the real world.

Professor Pandey proposed that the industrial resurgence of India, characterized by the worldwide supremacy of its IT sector in the latter part of the 20th century, as well as the remarkable growth patterns observed in the biotechnology, pharmaceutical, and automotive sectors, can be linked to the strong foundation in STEM (Science, Technology, Engineering, and Mathematics) disciplines inside the country.

India's pursuit of international recognition requires a skilled workforce proficient in the fields of science, technology, engineering, and mathematics (STEM). Acknowledging this, there is a coordinated effort from both the public and business sectors to enhance the quality and effectiveness of STEM education. Pioneering initiatives, such as the 'Atal Tinkering Labs', are carefully designed to foster the development of innovative and problem-solving skills among young individuals. Moreover, there is a wide array of scholarships and grants available that attract students to engage in STEM research and instruction.

The professor provided a detailed explanation of T-shaped education, highlighting its focus on acquiring a broad range of knowledge and skills. This approach effectively acknowledges and appreciates the value of possessing extensive expertise in particular fields, as well as a comprehensive interdisciplinary comprehension, aligning harmoniously with the principles and values of STEM.

Finally, Professor Pandey advocated for the incorporation of the STEAM paradigm, which involves the integration of the arts with STEM. This approach highlights the intersection of artistic creativity and technological expertise. The author asserts that this confluence highlights the fundamental nature of innovation, leading numerous Indian universities to integrate arts into their STEM framework.

In conclusion, the observations provided by Professor Pandey offer a comprehensive depiction of India's journey in the field of STEM, encompassing both its historical achievements and its present-day advancements. As India seeks to attain global leadership, it is evident that STEM education, supported by a T-shaped educational approach and the convergence of STEAM disciplines, will serve as a guiding principle. This approach will not only uphold India's esteemed historical achievements but also pave the way for a future characterized by innovation and brilliance.

Session 3: Importance of STEM-oriented pedagogy, Formative assessment, and recent advances in STEM: in context of NEP 2020: Dr. Raj Singh, IUCTE, BHU

Dr. Raj Singh, in his enlightening talk, delved into the nuances of our education system, tracing its evolution from ancient times to the modern era. Drawing inspiration from Professor Salujab of Delhi University, Dr. Singh began by elucidating the essence of 'Bhavana' and 'Prakash', signifying 'emotion' and 'light' respectively. These two terms can be perceived as a blend of emotion and knowledge, indicative of traditional education.

Dr. Singh reiterated the success of our ancient education system, emphasizing its skill-based nature as opposed to being strictly examination-centric. The most remarkable aspect was the community-driven funding of education; the society or students bore the expenses, ensuring access and inclusion for many. Dr. Singh also highlighted that this education model, focused on holistic development, remains relevant even in the 21st century.

Quoting Swami Vivekananda, Dr. Singh reminded the audience of the spiritual leader's perspective on education. Vivekananda described education as "the manifestation of perfection already in man." His belief in drawing out the inherent potential in every individual underscored the essence of true education. Vivekananda’s stress on character building, integrating moral values and ethics, and not just imparting knowledge, was emphasized by Dr. Singh, as a beacon for our education system to emulate.

Transitioning to the needs of 21st-century education, Dr. Singh referenced the significant work of UNESCO. In 1993, under the leadership of a French professor, UNESCO set up a commission to envision the future educational needs. The committee introduced the four pillars of learning: Learning to Know, Learning to Do, Learning to Be, and Learning to Live Together. These pillars capture the holistic essence of education, blending knowledge, skills, personality development, and collaborative coexistence.

Furthermore, the concept of 'Lifelong Learning' was proposed, emphasizing the continuous journey of acquiring knowledge and skills throughout one's life. Dr. Singh emphasized that learning should be adaptive and responsive to the ever-evolving global context, a sentiment echoed by Professor AC Pandey.

Addressing pedagogical methodologies, Dr. Singh emphasized three key components: Engaging pedagogy, Formative Assessment, and the incorporation of the latest knowledge.

Dr. Raj Singh currently serves as an Assistant Professor in the Physical Science Department at IUCTE, Banaras Hindu University, Varanasi, India. His academic and research journey reflects a blend of diverse experiences and profound expertise in the field of Physical Sciences. His research odyssey took him to CIMAP, GANIL in Caen, France from 2020 to 2023, where he was a CNRS Postdoctoral Fellow, working closely with Dr. Alicja DOMARACKA and Dr. Patrick Rousseau. Prior to this role, he delved into advanced studies at the Weizmann Institute of Science in Rehovot, Israel between 2017-2020, under the guidance of Prof. Daniel Zajfman and Dr. Oded Heber. Earlier, from 2014-2016, Dr. Singh was affiliated with the University of Gothenburg, Sweden, working alongside Prof. Raimund Feifel and Prof. J.H.D Eland as a Postdoctoral Fellow.

He stressed the need for active student engagement in higher education. The role of formative assessment, a continuous evaluation method to enhance student learning, was highlighted. Dr. Singh urged educators to stay updated and integrate recent global developments into their curriculum.

Dr. Singh concluded by highlighting the interdisciplinary nature of subjects like Physics. He described how it combines mathematical concepts with natural phenomena, leading to inventions and discoveries. Citing the example of the X-ray, invented by Roentgen in 1887, he noted its immediate application in hospitals, illustrating the profound impact of such interdisciplinary explorations.

In summation, Dr. Raj Singh's talk provided a comprehensive overview of the past, present, and future trajectories of our education system, urging educators and stakeholders to revisit traditional wisdom, integrate global perspectives, and adopt holistic pedagogical practices for a brighter future.

Session 4: Academic Leadership: Prof. Avinash Kumar Agarwal, Indian Institute of Technology, Kanpur

Academic leadership in STEM education in India is a topic that has gained importance in recent years, as the country strives to develop its scientific and technological capabilities and prepare its students for the challenges of the 21st century. STEM education refers to the integrated teaching and learning of science, technology, engineering and mathematics, with an emphasis on inquiry, problem-solving, creativity and innovation.

Some of the challenges and opportunities for academic leadership in STEM education in India are:

Quality of teachers: India needs a large number of well-trained and motivated teachers who can inspire and guide students in STEM subjects. According to a report by the White House, India will need a trained army of teachers to lead the next generation of students. The report suggests that creating a master teacher corps of around 10,000 STEM teachers might offer some guidelines for India's policy makers.

Access: India has a huge diversity of students from different socio-economic backgrounds, regions, languages and cultures. STEM education should be accessible and inclusive for all students, especially those from rural, remote and marginalized communities. Organizations like STEM India Foundation and STEM Learning are working to support teachers and students in the process of preparing students to ideate, innovate and create in the four domains of STEM. They are also establishing mini science centres in schools across the country to provide hands-on learning experiences for students.

Prof. Avinash Kumar Agarwal is an Indian mechanical engineer, tribologist and a professor at the Department of Mechanical Engineering of the Indian Institute of Technology, Kanpur. Sir obtained his BE in mechanical engineering from Malaviya Regional Engineering College, Jaipur (now Malaviya National Institute of Technology, Jaipur) in 1994, his MTech in energy studies from IIT Delhi in 1996, and his PhD in mechanical engineering from IIT Delhi in 1999. He did his postdoctoral work at the Engine Research Center of the University of Wisconsin-Madison from 1999 to 2001. He is known for his studies on internal combustion engines, emissions, alternative fuels and CNG engines, laser diagnostics, laser ignition of fuel-air mixtures, particle imaging velocimetry, phase doppler interferometry, lubricating oil tribology, micro-sensors, automotive emissions, particulates, secondary aerosols and toxicology, DOC, DPF and exhaust gas after treatment technology. He has published over 300 research papers in reputed journals.

Curriculum and pedagogy: India needs to update its curriculum and pedagogy to reflect the latest developments and trends in STEM fields. The curriculum should be relevant, engaging and aligned with the national and global standards. The pedagogy should be student-centered, inquiry-based and collaborative. A report by the Vivekananda International Foundation provides guidance on how the industry can contribute to science education and proposes some recommendations for improving STEM education in India.

Sir has given several examples of world leaders like Fidel Castro, Alexandar the great, Winston Churchill, Napolean Bonaparte, Adolf Hitler, Nelson Mandela, Julius Caeser, Mahatma Gandhi. He also described the traits of a good leader:

- Listen first
- Creative leadership
- Team Building

- Takes calculated risks
- See the big pictures
- Inspire
- Should lead from the front
- Transparency and honesty
- Motivation with speech
- Clear vision

He also defined leadership as a role, a position, an authority, a responsibility, a challenge. Role of a leader is to overcome the aspiration deficit. When followers lose faith in a leader then there is zero or negative time sense, no respect for others work, no achievable targets, abuse of position, taking of small benefits.

Execution of effective leadership in crisis is a skill that can help leaders to manage complex and uncertain situations, and to achieve positive outcomes for their organizations and stakeholders. According to some sources, effective leadership during a crisis requires the following behaviors:

Decide with speed over precision: Leaders need to act quickly and decisively, even with incomplete or conflicting information. They should avoid analysis paralysis and be willing to adjust their course of action as new data emerges.

Adapt boldly: Leaders need to embrace change and innovation, and to challenge the status quo. They should experiment with new solutions, learn from failures, and scale successes.

Reliably deliver: Leaders need to ensure that their actions are aligned with their words, and that they follow through on their commitments. They should also hold themselves and others accountable for results.

Engage for impact: Leaders need to communicate clearly and frequently, and to inspire trust and confidence. They should also solicit feedback, seek advice, and remain approachable. They should show empathy and compassion to their teams and stakeholders.

Manage the post-crisis "new normal": Leaders need to anticipate the long-term implications of the crisis, and to prepare for the opportunities and challenges that may arise. They should also foster a culture of learning and resilience, and celebrate the achievements and contributions of their teams.

These behaviors and mindsets can help leaders to navigate the coronavirus pandemic and future crises. They can also help them to create flexible plans, communicate effectively, lead with compassion, and demonstrate empathy. Sir described the importance of communication and interpersonal skills like assertiveness, non-verbal communication, listening skills, negotiation, verbal communication, problem solving, decision making.

Day 2: 11 October, 2023

Speakers:

- Prof. Minati Panda, Zakir Husain Centre for Educational Studies, JNU, Delhi
- Prof. Abha Sharma, Principal, SCERT, Delhi

- Prof. Gaurav Singh, Central University of Haryana, Mahendergarh, Haryana
- Prof. Meenakshi Singh, Faculty of Education, BHU, Varanasi
- Prof. Pradeep Kumar Mishra, Department of Chemical Engineering and Technology, IIT, BHU, Varanasi

Session 5: STEM Education with a Multilingual Voice: Prof. Minati Panda, Zakir Husain Centre for Educational Studies, JNU, Delhi

Prof. Minati Panda talked about the multilinguality in India, as in our country, every person speaks more than one language and combines different languages in daily life too. In a country like ours and also in several countries where multiple language speakers cohabit.

Prof. Minati Panda, is a professor of psychology and critical education at Jawaharlal Nehru University (JNU). She has a PhD in Social Psychology of Education (1996) from JNU and a Post Doc from University of California, San Diego, USA (2006-2007). She is the director of the Centre for Advanced Studies (CAS), ZHCES, JNU and the National Multilingual Education Resource Consortium (NMRC), JNU. She has been a visiting professor at the Centre for Mathematics Education, University of Manchester, UK (2009-2010) and at the International and Transcultural Studies, Department of Comparative Education, Teachers College, Columbia University, New York, USA (2019-2020).

Whenever we say language, we are assuming a kind of multilinguality, not that it is accepted across the board, because linguists work with a single language whenever they analyze linguistic structure and the nature of that, therefore, one language at a time. But when we talk about social phenomena or even the language used in a pedagogic space that is a classroom, we refer to mostly multilinguality, and whenever we talk about policy therefore multilingualism. She stated that there are hundreds of languages in India, and according to the eight schedules, it was mandated to communicate in 14 scheduled languages at first, and then it expanded to 22 languages.

These 22 languages are spoken by more than 10,000 people across the nation. In other words, this country speaks hundreds of languages and the constitution recognizes this. She focused on the three-language formula as per NEP 2020 which is a guiding principle for us, and it does at the outset recognize multilinguality of the society and mandates education to be multilingual. We definitely start with one language depending on the context, but in official spaces we stick to one language. She said that in education, most of the schools and colleges of our country are multilingual but when we talk about higher education, it's basically administ students from different regions, wherever it is located, it gets students from a larger catchment area and therefore it is fundamentally multilingual. She emphasized that the communication in our classrooms is more interesting, more meaningful and more engaging when it is a multilingual class. She elaborated that there was an MoU signed through which various complex scientific terms were translated into Hindi and other regional languages, which were included in eighth schedule to facilitate, kind of trans languaging or code switching or language mixing in the classroom of teachers who are teaching in regional languages.

So implicitly, there was an acceptance for multilingual, communication in higher education, including technical and STEM education, right from the beginning. Policy talks about multilingual children and the need to teach children's modern language in school as well as in higher education that includes technical skill education, adult education, wherever there is a literacy. Also, institutions of higher learning are instructed to translate all the reading materials like in technical Engineering sciences, basic sciences, medical sciences, and also idea Vedic and other kinds of, Unani and other kinds of sciences in at least 22 languages. She focused on the importance of language for the explanation of the concepts to a child and communicate some complex phenomena. She emphasized that in higher education institutions, if we want students to participate in the dialogue, in the classroom about any scientific phenomenon, the students on language their experiences, their identity, their emotions have to come on board. For more student participation in the classroom let the students bring their experiences and whatever language they can and then as a teacher decide how to use those experiences in the classroom to discuss about any scientific phenomena. She said that as a student and teacher of science, we have to understand the historical aspects of science to theorize and cognize the knowledge of science. A classroom where scientific discourse is carried out, science can be learnt in better way. In a diverse classroom we have to be multilingual and multi semnoitic for the knowledge creation. All the teachers should be multilingual, multsemnoitic, multiseminal for development of scientific knowledge. This will make our classroom more diverse and all the experiences will be based on equity and excellence for providing the knowledge of science. Multilingualism is a facilitating exercise. She cited various examples of scientific concepts which have to be discussed with appropriate mediums where a teacher shares a … She also suggested the teachers should not be stuck to one language during the evaluation. Various strategies like role play, storytelling can be introduced during the teaching. If we ignore multilinguality in the classroom then we cannot create a participatory and equitable pedagogy. She also cited an example of a project in Odisha where a translation of material is being done and a national repository is being made.

Session 6: Four Cs: The soft skills for STEM Learning: Prof. Abha Sharma, Principal, SCERT, Delhi

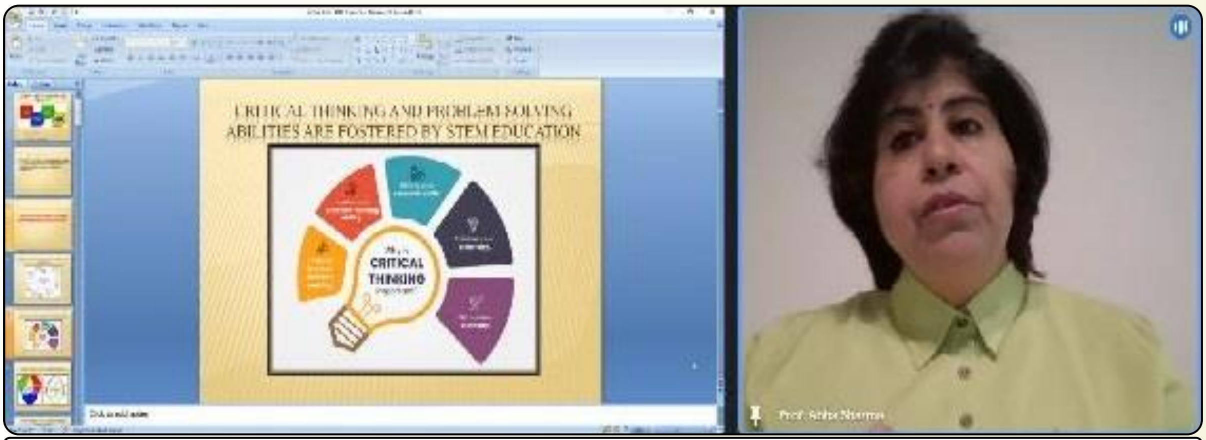
Professor Abha Sharma delivered an engaging lecture in the Continuous Professional Development Programme (CPDP) on 11/10/2023, organized by the Inter-University Centre for Teacher Education, BHU, Varanasi. The lecture revolved around the role of soft skills in STEM (Science, Technology, Engineering, and Mathematics) learning. It began with a profound quote, “Knowledge is a deep-seated treasure, and education helps in its manifestation as the perfection which is already within an individual," setting the stage for a discussion on the essence of knowledge and its integration with soft skills.

Professor Sharma initiated her talk by delving into the meaning of knowledge. She underscored the idea that knowledge isn't just information but a profound treasure waiting to be discovered and developed within each individual. Education, in this context, becomes the key catalyst in unlocking and refining this inherent knowledge. She then shared an ancient Shloka:

"विद्या वितर्को विज्ञानं स्मृतिः तत्परता क्रिया।

यस्यैते षड्गुणास्तस्य नासाध्य मति वर्तते॥"

This Shloka encompasses the six essential attributes of knowledge: Vidya (learning), Vitarka (reflection), Vijnana (science), Smriti (memory), Tattvaparata (dedication to truth), and Kriya (action). Professor Sharma emphasized how these attributes are interconnected and crucial for



Prof. Abha Sharma is Principal, B.Ed. at SCERT, New Delhi, India. Prior to this she was Professor and Assistant Dean at School of Education, GD Goenka University, Gurgaon, India. Professor Abha Sharma is an expert in the area of Teacher Education, Stress Management, Test and Measurement, Educational Technology and Science Education. She is gold medalist in both B.Ed. and M.Ed. and a recipient of National merit scholarship for doing M. Ed. She has more than 22 years of experience in academic and academic leadership roles in various Universities and Institutes in India. Abha holds a PhD in Education (Educational Psychology/ Educational Technology), M. Ed., M.Sc. (Organic Chemistry) and MBA (HR). She has more than 45 papers/ articles/ book chapters published in National and International Journals of repute. Abha has participated and presented papers in more than 45 National/ International workshops/ conferences etc.

the comprehensive understanding and application of knowledge.

Professor Sharma then shifted her focus to STEM education, highlighting its interdisciplinary nature. STEM, she argued, seamlessly integrates various domains of knowledge to create a holistic approach to learning. By bridging the gaps between different fields, STEM fosters creativity, innovation, and adaptability, which are vital qualities in today's ever-evolving world. One of the key takeaways from her lecture was the myriad benefits of a multidisciplinary STEM education. Such an approach equips students with a broader perspective, enabling them to tackle complex real-world problems more effectively. Furthermore, it prepares them for careers that require a combination of skills from different disciplines, fostering critical thinking and engagement with a diverse range of knowledge. Professor Sharma dedicated a significant portion of her lecture to the development of critical thinking and problem-solving abilities through STEM education. She stressed that STEM encourages students to think analytically, approach challenges methodically, and develop innovative solutions. The hands-on approach of STEM equips learners with the skills necessary to tackle complex, real-world issues. Central to her presentation were the "4 C's" of STEM learning: Collaboration, Creativity, Communication, and Critical Thinking. These four skills were identified as fundamental to success in STEM fields and beyond.

1. Collaboration: Professor Sharma highlighted the importance of teamwork and collaboration in STEM. Many breakthroughs and innovations, she noted, are the result of collaborative efforts. Learning to work effectively in teams is crucial for solving complex problems and achieving scientific advancements.
2. Creativity: Creativity, she argued, is at the heart of STEM. It is the driving force behind innovation and the development of new technologies. STEM education encourages students to think creatively, explore new ideas, and come up with unique solutions to challenges.
3. Communication: Effective communication is essential for sharing ideas, presenting research, and collaborating with peers. STEM education helps students develop strong communication skills, ensuring that their findings and innovations can be understood and applied by others.
4. Critical Thinking: Critical thinking is the cornerstone of STEM education. It involves analyzing information, questioning assumptions, and making well-informed decisions. This skill is vital in both scientific research and everyday problem-solving.

To illustrate the importance of the "4 C's," Professor Sharma shared multiple examples from her institution. She showcased projects where students collaborated across disciplines to address complex problems, fostering creativity and innovation. These projects also required effective communication and critical thinking to present findings and develop practical solutions.

In her closing remarks, Professor Sharma emphasized the significance of integrating technology into the teaching-learning process. She stressed that technology is not merely a tool but an integral part of modern STEM education. It provides opportunities for interactive and immersive learning experiences, making complex concepts more accessible and engaging for students.

Session 7: Resources for STEM Educators: OERs and Open Science Initiatives: Prof. Gaurav Singh, Central University of Haryana, Mahendergarh, Haryana

Resources for STEM educators that are related to OERs and Open Science initiatives. Some of the examples are:

- Open educational resources - Open science - UNESCO: This is a resource from UNESCO that provides an e-course on OERs and how they are connected to Open Science. It covers the main topics and motivations behind OERs and how to create your own. It also provides a toolkit for implementing Open Science in your context.
- OER Commons: This is a public digital library of OERs that allows you to explore, create, and collaborate with educators around the world. You can find resources for various disciplines, levels, and standards, as well as use the Open Author tool to create

and remix your own OERs. You can also join or create groups to share and discuss resources with others in your network.

- Open educational resources in STEM - UBC Centre for Teaching, Learning …: This is a blog post from the UBC Centre for Teaching, Learning and Technology that highlights some examples of OERs in STEM fields. It also discusses some of the opportunities and challenges of using OERs in STEM education, such as quality, accessibility, sustainability, and pedagogy.
- OER in STEM: Opportunities & Challenges | Open UBC: This is a similar blog post from the UBC Open Education initiative that provides more details on the examples of OERs in STEM fields mentioned in the previous resource. It also offers some tips and suggestions for finding, evaluating, adapting, and creating OERs in STEM.
- Accelerating STEM education reform: linked communities of practice …: This is a research article from the International Journal of STEM Education that describes a collaborative approach to developing OERs that leverages linked communities of practice (CoPs). It presents a case study of how this approach was used to create OERs for introductory physics courses at three different institutions.

Prof. Singh has emphasized that OER and Open Science initiatives are important for several reasons. They can:

- Reduce the cost of education by providing free or low-cost access to high-quality learning materials.
- Enhance the pedagogical benefits of education by allowing instructors and learners to customize, adapt, and remix the materials to suit their needs and preferences.
- Promote the sharing and collaboration of knowledge and resources among educators, researchers, and students across different disciplines, institutions, and countries.
- Support the advancement of science and innovation by increasing the transparency, reproducibility, and accessibility of research outputs and data.

Some of the barriers to the adoption of OER and Open Science initiatives are:

- Lack of awareness and understanding of the concept, benefits, and practices of OER and Open Science among stakeholders.
- Insufficient incentives and recognition for the creation, use, and dissemination of OER and Open Science outputs.
- Technical and infrastructural challenges such as interoperability, quality assurance, accessibility, discoverability, and preservation of OER and Open Science materials.
- Legal and ethical issues such as intellectual property rights, licensing, attribution, privacy, and consent.

Sir has also elaborated that Open Science initiatives are efforts to make scientific research, data, and dissemination more accessible, transparent, and collaborative. They aim to foster the sharing and reuse of scientific knowledge and resources, as well as to increase the quality, impact, and social relevance of science.

Some of the Open Science initiatives in relation to STEM education in India are:

- I-STEM: This is a national portal launched by the Government of India in January 2022. It serves as a hub for various STEM-related initiatives, such as connecting researchers, educators, students, and industry partners; providing access to scientific equipment and facilities; facilitating online courses and workshops; and promoting innovation and entrepreneurship.
- Atal Tinkering Labs (ATL): These are innovation spaces set up by the Government of India in schools across the country. They provide students with access to tools, materials,

Prof. Gaurav Singh is working as Professor in the Department of Education, Central University of Haryana, Mahendragarh. He has vast experience of about 19 years in the field of teacher education. He started his career as a teacher in a traditional teacher education institute in 2003 and joined the School of Education, IGNOU, Delhi in November, 2011. Prof. Gaurav Singh has been an all-rounder and gold medalist during his M.Sc., M.Ed. He received his Ph.D in Teacher Education. His many research papers/articles have been published in various national and international journals. He has also contributed more than 33 chapters/units in ODL study material. He has recorded/developed 120 modules/lectures for MOOCs and has coordinated the development of various lectures for Swayam and Swayam Prabha. Prof. Gaurav Singh is the recipient of Commonwealth of Learning Fellowship-2018 by COL, Vancouver, Canada. He has been awarded the Silver Medal of Best Practices by the Asian Association of Open Universities, 2018 in Hanoi, Vietnam.

  and mentors to explore STEM concepts and develop their own projects and solutions. They also encourage students to participate in various challenges and competitions to showcase their creativity and problem-solving skills.
- STEM India Foundation: This is a non-profit organization that supports teachers and schools in implementing STEM education. It provides resources, training, curriculum, and assessment tools to help teachers integrate STEM subjects and activities into their classrooms. It also organizes events and programs to inspire students to pursue STEM careers and become innovators.

Session 8: New and Effective Pedagogical Strategies for STEM: Prof. Meenakshi Singh, Faculty of Education, BHU, Varanasi

In an era characterized by the amalgamation of technology and education, STEM, representing Science, Technology, Engineering, and Mathematics, emerges as a pivotal anchor around which modern educational paradigms revolve. Prof. Minakshi Singh, in a captivating discourse, delved into the heart of this transformative educational approach, elucidating on both its significance and the challenges that educators grapple within its integration into academic curricula.

STEM, as Prof. Singh highlighted, is not merely a contemporary educational buzzword. Its essence lies in the synthesis of disciplines that form the cornerstone of future advancements.

While the educational fraternity acknowledges the weight STEM carries, the challenges lie in translating this acknowledgment into practice, ensuring it seamlessly percolates into the very fabric of classroom instruction.

Setting the tone for her lecture, Prof. Singh unveiled her primary objective: illuminating the path to realizing this seamless integration by introducing six distinct pedagogies. These pedagogies serve as the conduits to imbue STEM concepts into educational settings:

1. Problem-Based Learning: Anchored in real-world complexities, this method nudges students to harness their critical and collaborative faculties to architect solutions.
2. Inquiry-Based Learning: A deeply student-driven approach, it places the reins of knowledge acquisition in the learners' hands, prompting them to question, probe, and derive insights.
3. Project-Based Learning: This pedagogy extends the academic canvas, prompting students to undertake expansive projects that traverse across multiple subjects, fostering an enriched, holistic learning journey.
4. Experiential Learning: By rooting learning in tangible experiences, it bridges the often wide chasm between abstract concepts and real-world applicability, enhancing both understanding and retention.
5. Flipped Classroom: A progressive reinterpretation of conventional pedagogical structures, this method optimizes classroom interactions, making them more dynamic and participatory.
6. Interdisciplinary Learning: By dissolving rigid academic boundaries, it encourages a more fluid, interconnected assimilation of knowledge across diverse disciplines.

Prof. Meenakshi Singh is Professor in the Faculty of Education, Banaras Hindu University, Varanasi. She has a Master's degree in Chemistry and a Ph.D. in Education. Her area of specialization includes ICT & Educational Technology, Teaching of Mathematics and Science, and Classroom Management. She has designed courses on Personal Development and Soft skills, Classroom Management and her current research focuses on innovative teaching practices in various disciplines like Chemistry, Biology, Mathematics, Commerce etc. She has publications in leading national and international journals of education and has co-authored four books and written several chapters for edited books.

A salient theme weaving through Prof. Singh's narrative was the paramountcy of grounding theoretical knowledge in the tangible realm of experience. Drawing on the illustration of a solar eclipse, she emphasized the profound difference between a passive, diagrammatic explanation and an immersive, technology-fueled experience. The latter, replete with sensory cues like the chirping of birds and the palpable disquiet of animals, not only amplifies the learning moment but engrains it indelibly in the student's cognitive framework.

However, Prof. Singh's vision wasn't insular. Recognizing the global momentum around STEM, she accentuated the imperative of ensuring our educational practices resonate with international benchmarks. With numerous nations having made strides in STEM education, any delay or deviation on our part might inadvertently place our students at a disadvantage in the global academic arena.

Adding another dimension to her talk was the introduction of Artificial Intelligence (AI) and its latent potential in redefining educational landscapes. Proposing institutes like IUCTE as torchbearers in this endeavor, Prof. Singh envisioned a future where AI doesn't merely supplement but significantly elevates the educational experience. This envisaged confluence of AI specialists and educators might well be the catalyst propelling education into a new era of innovation and engagement.

Concluding her enlightening exposition, Prof. Minakshi Singh's insights emerged as a clarion call to the academic community. It underscored the urgency to not only understand but actively incorporate STEM pedagogies and contemporaneous technologies, like AI, into our classrooms. Her vision is of an educational framework that is not only attuned to present exigencies but is also robustly equipped to navigate the intricate tapestry of future challenges. Through her discourse, Prof. Singh paints a picture of a dynamic, responsive, and forward-looking educational milieu, one that promises to shape the leaders and innovators of tomorrow.

Session 9: Sustainability and Entrepreneurship: Prof. Pradeep Kumar Mishra, Department of Chemical Engineering and Technology, IIT, BHU, Varanasi

Prof. Pradeep Kumar Mishra began his lecture on the topic of "Sustainability and Entrepreneurship" by addressing the pressing issues in our ecosystem and the need for understanding and action in these areas. His talk emphasized the importance of achieving sustainability while nurturing entrepreneurial endeavours that benefit both individuals and society. To illustrate the urgency of the environmental situation, Prof. Mishra referenced the 1984 film "The Road," which depicted a world grappling with global warming. He highlighted the film's portrayal of a father and son's journey south and east in search of a better ecological system, ultimately resulting in their tragic deaths. This science fiction tale raised the question of why, despite long-standing recognition of environmental problems, substantial progress has not been made in addressing them.

Prof. Mishra then delved into specific environmental issues, particularly those in Varanasi, a place close to his heart. He discussed the deteriorating condition of the Assi & Varuna Rivers, which were once mighty rivers but have now become little more than a drain due to encroachments and pollution. A similar situation was highlighted with the Ganga River as it flows through Varanasi. The unregulated release of untreated sewage, detergents, and industrial waste into the river has resulted in a severe environmental crisis, affecting not only the rivers but also contaminating the soil, air, and water bodies. Prof. Mishra pointed out that the three essentials for life—water, food, and air—are all currently contaminated, representing a grave concern. Various principles and policies have been proposed to address these issues, such as waste management and recycling, but more must be done to effectively tackle these environmental problems. Plastic pollution was identified as a significant concern, and Prof. Mishra acknowledged the role of scientists in creating various products. He emphasized the importance of the responsible use of these products, particularly the problems associated with single-use plastics. Innovative practices were highlighted, such as a school in West Bengal that incentivizes underprivileged children to exchange plastic for education, showcasing commendable initiatives that offer hope.

The lecture mentioned the success of the garbage clinic model implemented in Ambikapur, located close to Varanasi. Engineer Praveen Nayak, from Madhya Pradesh, was commended for his efforts to address solid waste problems in the National Capital Region. They have successfully reused a majority of waste products and converted biodegradable waste into manure, effectively dealing with waste-related challenges. The lecture highlighted the dire state of rivers like Alakananda and Bhagirathi in Devprayag, which merge to form the Ganga. Prof. Mishra explained that human intervention has disrupted the natural processes of these rivers, impacting their interaction with groundwater and causing depleted water levels during dry seasons. This underscored the need to preserve the riparian zones along riverbanks, which play a crucial role in recharging groundwater and maintaining water levels.

Nature was presented as a source of valuable lessons, emphasizing that natural reactors are large and slow, contrasting with the artificial reactors often used. Prof. Mishra suggested that merging engineering, chemistry, and biology could lead to the development of greener technologies that are both benign and environmentally friendly. He stressed the importance of shifting towards green chemistry and sustainable lifestyles. Prof. Mishra quoted Mahatma Gandhi's words, "The Earth provides enough to satisfy every man's need but not every man's

Prof. Pradeep Kumar Mishra is a senior professor of chemical engineering and technology at IIT BHU. He has served as Vice Chancellor at the Jharkhand University of Technology, Ranchi and Dr APJ Abdul Kalam Technical University, Lucknow. He has a Bachelor degree in Chemical Engineering from IIT Roorkee, a Master's degree from IIT Bombay and a PhD from IIT (BHU) Varanasi. He joined IIT BHU Varanasi as a faculty member in January 1997 and was placed to HAG scale in 2016 for his academic and R&D contributions. His areas of interest include Bio-energy, Biocompatible polymers, Wastewater Treatment and Membrane Separation. He has 6 patents in his name and has published many high-quality research articles, books and book chapters. Prof. Mishra is a keen researcher and has been involved as PI or Co PI in 17 projects from various funding agencies like DST, DBT, DRDO etc. He has received many national and international fellowships, awards and recognitions for his contributions in engineering and society.

greed," to highlight those current practices, including the overexploitation of water sources and wasteful energy consumption, are unsustainable. He stressed the need to modify our lifestyles and prioritize the well-being of the Earth for a sustainable future. He emphasized that by saving the Ganges, we are also protecting all other rivers essential for life on our planet, such as the Ganga, Krishna, and Kaveri. Prof. Mishra encouraged the audience to consider the impact of tree cover near water bodies, citing the shelter it provides for dragonflies, which in turn create a biopolymer layer that reduces water evaporation and helps maintain water levels in ponds. He called for the preservation of riparian zones and the adoption of slower, more sustainable processes to minimize resource consumption and environmental impact.

Prof. Mishra highlighted the need to integrate sustainability with entrepreneurship, suggesting the installation of biodigesters for domestic and organizational waste as a means to reduce pollution and create entrepreneurial opportunities. He also advocated for the utilization of solar and wind energy for sustainable entrepreneurship. Examples of eco-friendly detergents, clean vegetables, and biofuels were provided to demonstrate how sustainability and entrepreneurship can complement each other, creating job opportunities and contributing to societal well-being. In closing, Prof. P.K Mishra's lecture shed light on the potential of sustainable entrepreneurship and the critical importance of integrating sustainability into entrepreneurial initiatives. He emphasized the need for collaboration and the adoption of innovative practices to build a brighter and more sustainable future for individuals and the planet as a whole.

Day 3: 12 October, 2023

Speakers:

- Dr. Kaushal Bhagat, Indian Institute of Technology, Kharagpur
- Prof. Gaurav Singh, Central University of Haryana, Mahendergarh, Haryana
- Dr. Gyanendra Singh, IUCTE, Varanasi
- Dr. Poonam Mehta, School of Physical Sciences, JNU, Delhi
- Prof. Asheesh Srivastava, Professor & Dean, School of Education, Mahatma Gandhi Central University, Bihar

Session 10: STEM Education and the New World Order: Dr. Kaushal Bhagat, Indian Institute of Technology, Kharagpur

Dr. Bhagat described that the education should be meaningful, joyful, interactive and effective. He also stressed on the growth in technology and our dependence on it. India is the second largest user of technology in the world. He further stated that the role of emerging technologies in the 21st century mainly focusing on virtual and augmented reality. He described that augmented reality combines reality with a virtual world, interactive in real time and supports 3-D visualization.

Types of Augmented Reality:

Augmented reality (AR) is a technology that enhances the real world with digital elements, such as images, sounds, or text. There are different types of augmented reality, depending on how the digital content is triggered and displayed. Here are some of the main types of AR:

- Marker-based AR: This type of AR uses a specific physical image, such as a QR code or a logo, to activate the digital content. The camera of a device recognizes the marker and overlays the digital content on top of it. For example, you can scan a QR code on a product package and see additional information or a 3D model of the product on your screen.

- Marker less AR: This type of AR does not require any image recognition to produce the digital content. Instead, it uses the location, orientation, and movement of the device to determine where to display the digital content. For example, you can use a navigation app that shows you directions and landmarks on your screen as you move around.
- Projection-based AR: This type of AR projects light onto a surface to create 3D imagery. It can also detect human interaction with the projected image by using sensors or cameras. For example, you can see a hologram of a person or an object that you can touch and interact with.

Dr. Kaushal Bhagat is an assistant professor in the Advanced Technology Development Centre at the Indian Institute of Technology, Kharagpur. He received his PhD from the National Taiwan Normal University in September 2016. His research areas include virtual reality, augmented reality, online learning, flipped classroom, formative assessment, and technology-enhanced learning. He is a member of several professional bodies, such as the Association for Educational Communications and Technology (AECT), the Asia-Pacific Society for Computers in Education (APSCE), and the IEEE Computer Society. He is also an editor or reviewer for several journals, such as Educational Technology Research and Development, Educational Technology and Society, British Journal of Educational Technology, and Computers & Education. He has received many awards and honors for his research contributions, such as the Excellence in Distance Education Award (EDEA) by the Commonwealth of Learning (COL), Canada in 2022, the APSCE Early Career Researcher Award 2020, and the IEEE TCLT Early Career Researcher Award 2018.

- Superimposition-based AR: This type of AR replaces the original view of an object with an enhanced or modified version of it. It can also provide multiple perspectives of the same object by changing the angle or position of the camera. For example, you can see how a piece of furniture would look like in your room by replacing the existing furniture with the virtual one.

These are some of the different types of augmented reality that are used for various purposes and applications.

Augmented reality (AR) is a technology that enhances the real world with digital elements, such as images, sounds, or text. There are many applications of AR in various fields and domains, such as gaming, education, healthcare, retail, tourism, and more. Here are some examples of how AR is used in different ways:

- Gaming: AR games allow players to interact with virtual characters and objects in their real environment. For example, Pokemon Go is a popular AR game that lets players catch and battle Pokemon in their surroundings.

- Education: AR can enhance learning by providing interactive and immersive experiences for students. For example, Google Expeditions is an app that allows teachers to take students on virtual field trips to different places and times.
- Healthcare: AR can assist medical professionals in diagnosis, training, surgery, and rehabilitation. For example, AccuVein is a device that uses AR to project the veins of a patient on their skin, making it easier to locate them for injections or blood draws.
- Retail: AR can help customers visualize products before they buy them, or provide additional information and features. For example, IKEA Place is an app that allows users to see how furniture would look like in their homes by using their smartphone camera.
- Tourism: AR can enhance the travel experience by providing information and guidance for tourists. For example, Wikitude is an app that allows users to scan their surroundings and get information about landmarks, attractions, restaurants, and more. Some of the applications of AR are in medical, entertainment, education, military, designing and evaluating AR softwares.

Sir has also explained about the traditional mode of teaching, flipped classroom and beyond flipped classroom teaching mode. He mentioned a software ARchi used for chemical structure and visualization of 3D structure. Using this software one can create a custom chiral compound and save it to the database. There is another software called CodAR, an augmented reality game to teach programming. He described formative assessment can also be interactive, therefore assessment and learning both can be interactive through informative feedback and immediate feedback.

Game-based learning is a teaching method that uses the power of games to define and support learning outcomes. A game-based learning environment achieves this through educational games that have elements such as engagement, immediate rewards and healthy competition. All so that while students play, they stay motivated to learn.

Some of the benefits of game-based learning are:

- It can increase student engagement and motivation by making learning fun and interactive.
- It can enhance student learning outcomes by providing immediate feedback, adaptive challenges, and personalized learning paths.
- It can foster 21st century skills such as creativity, collaboration, problem-solving, and critical thinking.
- It can support diverse learners by accommodating different learning styles, preferences, and needs.

Some of the challenges of game-based learning are:

- It can be difficult to find or design games that align with the curriculum and learning objectives.
- It can be costly and time-consuming to implement and maintain game-based learning environments.
- It can be hard to assess student learning and performance in game-based learning contexts.

- It can raise ethical and social issues such as addiction, violence, privacy, and equity.

Some of the strategies for using game-based learning are:

- Identify the learning goals and outcomes that you want to achieve with game-based learning.
- Choose or create games that are relevant, engaging, and appropriate for your learners and context.
- Integrate game-based learning with other instructional methods and activities to create a balanced and effective learning experience.
- Provide guidance and support for your learners before, during, and after playing the games.
- Evaluate the impact of game-based learning on your learners' knowledge, skills, attitudes, and behaviors.

Session 11: Technology Integration in STEM Education: TPACK Framework: Prof. Gaurav Singh, Central University of Haryana, Mahendergarh, Haryana

Prof. Gaurav Singh has discussed about Technological Pedagogical Content Knowledge (TPACK) Framework. He introduced the history of framework and how Punya Mishra and Matthew J. Koehler's in 2006 developed this framework. He said that as teachers we have a challenge to integrate technology and to identify which technology is appropriate for learning. He suggested that technology must communicate the content and support the pedagogy to enhance the students' learning experience. This model basically talks about three types of pedagogical knowledge, technological knowledge and content knowledge and it tries to gel all the three components. We need to think a lot about where we use the technology, how to use the technology and which technology we need to use. These are some key questions which we need to answer. The three major components are pedagogical knowledge and content knowledge and technological knowledge and their intersection. The Shulman's PCK Model was the foundation on which this whole model was later developed. He focussed that the importance of this model exists in the dotted line representing the context of particular university, institution, classroom where this model has to be used. He said that a teacher has to think in which pedagogy, technology could be integrated, but whether that technology is available with us, if it is available with us, whether to communicate with that, or whether the institutional infrastructure is supporting that. So what is good technology is a good thing, but the available technology is more important.

He cited various examples where the challenges faced to use technology were overcome by adapting new technologies by a teacher. He focussed that many technologies used during COVID were not meant to be used in education but the educators have adopted them as per their requirements. All teachers know what pedagogy is but it includes the priorities, the classroom management, the assessment techniques and how to cater the diverse learning needs and for this technology is very good facilitator, to facilitate the needs of diverse learners. For example, YouTube videos are good for slow learners because they can learn at their pace even for hard of hearing students, because Facebook Video has an option that you can see the Closed Caption option. He suggested that as the subject matter we should have a deep understanding of the topics, which we are teaching. Content and pedagogy should go hand in hand. It enhances our explanation power and the ground knowledge and it also gives us a lot of confidence. He differentiated between the textbooks and reading materials which a teacher should understand while delivering a lecture. A teacher should be more comprehensive, more explanatory and should give a lot of examples.

Teachers should have a different base to represent, and should not repeat the same example, the same sentence, the same definition, the same line, which is in the textbook. He elaborated that Technological pedagogical knowledge (TPK) describes relationships and interactions between technological tools and specific pedagogical practices, while pedagogical content knowledge (PCK) describes the same between pedagogical practices and specific learning objectives; finally, technological content knowledge (TCK) describes relationships and intersections among technologies and learning objectives.

He further elaborated that at the center of all these intersections epic lies where all three knowledge moments are conversing and which considers the relationships among all three areas and acknowledges that educators are acting within this complex space. So a teacher has to identify the content, then need to identify, which pedagogical techniques is appropriate, for that content which technology could be integrated in that pedagogy. This model will not only provide the training in technology integration and pedological strategies, but it also helps to bridge the gaps in our own knowledge. Also get a good understanding of curriculum designing because to know which technology should be placed in which content. He motivated the participants to design a lot of activities and the lesson plan. He suggested that a lot of digital resources and collaborative tools, multiple tools are there to involve in the lessons. Technique is a holistic approach, so it bridges holistic approaches as it talks about

technology pedagogy and content together. He concluded that whenever we are thinking about technology, whenever we are thinking about pedagogy or whenever we are thinking about content, who should be in the center, it should be the learner. He also showcased how TPACK framework can be utilised for different purposes like collaboration, professional development, experimentation, feedback and reflection etc. along with the benefits of this framework.

Session 12: STEM & AI: A Symbiotic Relationship for Higher Education: Dr. Gyanendra Singh, IUCTE, Varanasi

In a thought-provoking presentation, Dr. Gyanendra Singh shed light on the intertwined relationship between STEM and AI, emphasizing their transformative role in shaping India's higher education landscape. Initiating the discourse, Dr. Singh described STEM as an interdisciplinary approach that seamlessly amalgamates Science, Technology, Engineering, and Mathematics. Rather than treating these as isolated silos, STEM emphasizes their interconnectivity, fostering a holistic educational experience that nurtures critical thinking, innovation, and problem-solving capabilities. Moving on, Dr. Singh introduced the audience to the revolutionary world of Artificial Intelligence (AI). He defined AI as the endeavour to mimic human intelligence using machines, driven by intricate algorithms and sophisticated computational models. Its vast potential, he stated, lies in its capacity to process colossal data, make precise predictions, automate multifaceted tasks, and drive innovation across myriad sectors. Dr. Singh highlighted that AI is poised to be a game-changer for higher education in India. Its potential extends to personalizing learning trajectories, streamlining administrative intricacies, and acting as a catalyst in academic research endeavours. Reflecting on India's educational heritage, Dr. Singh underscored the country's profound legacy in science and

Dr. Gyanendra Singh is an Assistant Professor at BHU's Inter University Centre for Teacher Education (IUCTE). He's held this post since December 2022. Dr. Singh began his academic career as an Assistant Professor (Ad-hoc) in the Physics Department at Keshav Mahavidyalaya, University of Delhi, in 2015. He then traveled abroad for post-doctoral studies at two top universities, driven by his thirst for knowledge. The individual initially provided great contributions to the academic community at the University of Fukui in Fukui, Japan, from December 2015 to May 2016. The researcher then studied at Tel Aviv University in Israel from September 2016 to February 2021. He became an Assistant Professor in Biomedical Engineering at Thapar Institute of Engineering & Technology, Patiala, after arriving in India. He held this position until December 2022, when he joined BHU.

mathematics. From the pioneering contributions of luminaries like Aryabhata to the contemporary academic bastions like the IITs, India's commitment to STEM has been unwavering and monumental. As Dr. Singh noted, the 21st century ushered in an AI renaissance. Globally, industries—from healthcare to finance—underwent radical transformations. AI's footprint became evident in enhanced productivity, novel problem-solving paradigms, and propelling economic growth. India, with its formidable IT prowess, embraced AI's potential with enthusiasm. Dr. Singh highlighted the proliferation of AI-centric startups, investments by tech behemoths, and the academic community's burgeoning interest in AI research and applications.

Delving into the current educational milieu, Dr. Singh emphasized STEM's revered stature in India. He pointed out the government's initiatives, institutional commitments, and the collective societal push to embed STEM principles in educational curricula and practices.

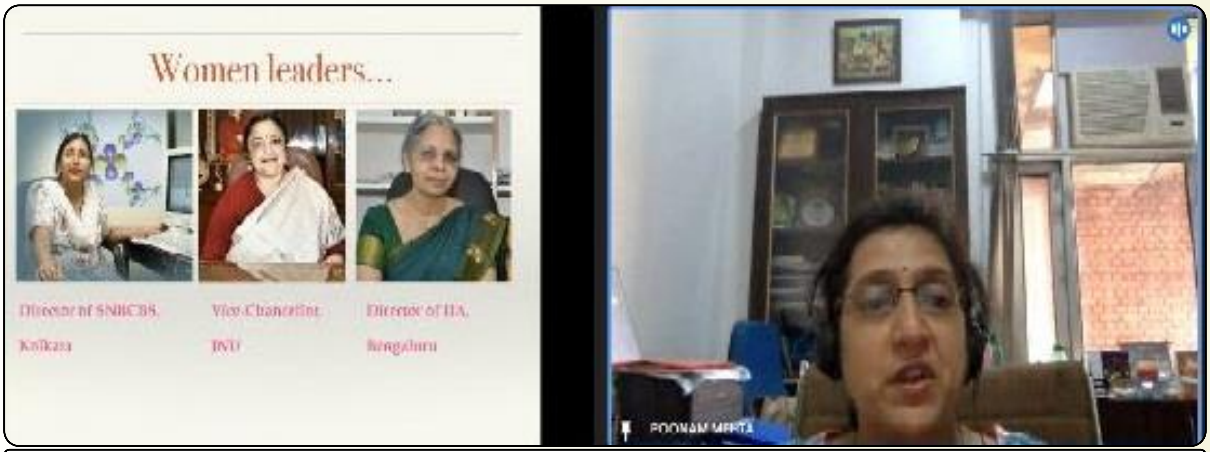
On a global scale, Dr. Singh delineated the transformative AI trends in higher education—adaptive learning platforms, virtual laboratories, research augmentation, and data-driven administrative solutions. In the Indian context, Dr. Singh proudly spotlighted the integration of AI in pedagogical strategies, research methodologies, and institutional management, highlighting India's stride towards global alignment in harnessing AI for educational excellence. The crux of Dr. Singh's discourse was the symbiotic relationship between STEM and AI. He elucidated how AI acts as an enabler for STEM education, fostering a dynamic, responsive, and innovative educational ecosystem. Emphasizing R&D's cardinal role, Dr. Singh highlighted the collaborative ventures between academic institutions and industries, underscoring the importance of research acceleration in STEM and AI for shaping a globally competitive higher education landscape in India. From virtual labs to predictive analytics for student performance, Dr. Singh enumerated the myriad applications of AI in enhancing and refining STEM education, making it more engaging, efficient, and effective. In the professional arena, Dr. Singh stressed the escalating demand for STEM and AI expertise, citing the burgeoning job opportunities, competitive remunerations, and the premium placed on interdisciplinary skills. Proudly reflecting on India's progress, Dr. Singh showcased the state-of-the-art facilities, innovation hubs, and research centres dedicated to STEM and AI, underscoring India's commitment to academic and research excellence. However, the path isn't devoid of challenges. Dr. Singh candidly discussed the hurdles— the digital divide, resistance to change, the need for faculty upskilling, and the imperative of continuous curriculum updates. Concluding his enlightening discourse, Dr. Singh presented a vision of an India where STEM and AI, in harmonious synergy, drive an education system that's dynamic, inclusive, innovative, and globally revered. He envisioned India not just as a knowledge consumer but as a global knowledge beacon, courtesy of the potent STEM-AI amalgamation. In essence, Dr. Gyanendra Singh's presentation was a clarion call, emphasizing STEM and AI's cardinal role in shaping India's higher education future, inspiring stakeholders to embrace, invest, and innovate.

Session 13: Bridging the Gender Disparity through STEM Education: Dr. Poonam Mehta, School of Physical Sciences, JNU, Delhi

Prof. Poonam Mehta started her lecture by mentioning about the AISHE (All India Survey on Higher Education) report is an annual web-based survey conducted by the Ministry of Education to portray the status of higher education in the country. The latest report for the year 2020-21 was released on January 29, 2023. It covers various parameters such as teachers, student enrolment, programmes, examination results, education finance, infrastructure, and indicators of educational development. The female enrolment has reached the 2-crore mark, an increase of 13 lakh from 2019-20. The gender parity index (GPI) has improved from 1.01 in 2019-20 to 1.03 in 2020-21.

She also described about women in pure sciences as women who pursue careers or research in the fields of mathematics, physics, chemistry, biology, and other natural sciences. Women have made significant contributions to these fields throughout history, but they have also faced many challenges and barriers due to gender discrimination and bias. Some of the women who have overcome these obstacles and achieved excellence in pure sciences are:

- Hypatia (c. 350-415 CE), a Greek mathematician, astronomer, and philosopher who taught at the Neoplatonic school in Alexandria. She is considered the first woman to make a substantial impact on the development of mathematics.
- Marie Curie (1867-1934), a Polish-French physicist and chemist who discovered radioactivity and two new elements, polonium and radium. She was the first woman to win a Nobel Prize, the first person to win two Nobel Prizes, and the only person to win Nobel Prizes in two different sciences.
- Rosalind Franklin (1920-1958), a British biophysicist and X-ray crystallographer who played a crucial role in revealing the structure of DNA. Her work was used by James Watson and Francis Crick to propose the double helix model of DNA, but she did not receive due credit or recognition during her lifetime.
- Anna Mani (1918-2001), an Indian physicist and meteorologist who worked with C.V.



Dr. Poonam Mehta is an assistant professor of physics at Jawaharlal Nehru University (JNU) in New Delhi, India. She is a theoretical high energy physicist who works on neutrino physics, new physics scenarios, and foundational and geometric aspects of quantum mechanics. She has a Ph.D in physics from Delhi University and has done post-doctoral research at various institutes in India, Israel, USA, and Europe. She is also a collaboration member of the Deep Underground Neutrino Experiment (DUNE) in the USA and the India-based Neutrino Observatory (INO) in India. She has received several awards and honors, such as Fulbright-Nehru Academic Excellence Award, Commonwealth Academic Staff Fellowship, Fulbright Senior Research Fellowship, and Bharat Vikas Award. She has published more than 15 papers in reputed journals and conferences.

Raman and made important contributions to atmospheric physics and instrumentation. She was the Deputy Director General of Observatories in the India Meteorological Department and one of the pioneers of solar radiation measurement in India.

- Kamal Ranadive (1917-2001), an Indian biochemist and cell biologist who established the first tissue culture laboratory in India at the Indian Cancer Research Centre. She conducted groundbreaking research on leprosy, cancer, and immunology, and was awarded the Padma Bhushan for her services to science.

These are just a few examples of the many women who have excelled in pure sciences.

Gender gap in physics is a term that refers to the underrepresentation of women in the field of physics, both in education and in research. It is a persistent and global problem that has many causes and consequences. According to a recent analysis of more than 36 million authors of academic papers, physics has one of the largest gender gaps in science, technology, engineering, mathematics and medicine (STEMM). The study found that only 13% of last authors in physics were women, and that it would take 258 years to achieve gender parity at the current rate of progress. Some of the factors that contribute to the gender gap in physics are:

- Stereotypes and biases that associate physics with masculinity and discourage girls from pursuing the subject.
- Lack of female role models and mentors who can inspire and support girls and women in physics.
- Social and cultural norms that influence girls' and women's choices and expectations regarding education and career.
- Structural and institutional barriers that limit girls' and women's access and opportunities in physics education and research.

The gender gap in physics has negative impacts on both individuals and society. It deprives girls and women of their potential and aspirations, and it deprives physics of diverse perspectives and talents. It also hinders the advancement of science and innovation, which depend on the participation and contribution of all people. Therefore, it is important to address the gender gap in physics and promote gender equality and inclusion in the field. Some of the possible solutions are:

- Challenging and changing the stereotypes and biases that affect girls' and women's interest and confidence in physics.
- Increasing the visibility and recognition of female physicists and their achievements, especially in leadership positions.
- Providing more opportunities and resources for girls and women to learn and engage with physics, such as scholarships, internships, outreach programs, etc.
- Creating a more supportive and inclusive environment for girls and women in physics, such as mentoring networks, peer groups, family-friendly policies, etc.

Women in science are women who have pursued careers or research in the fields of science, technology, engineering, mathematics, and medicine (STEMM). Women have made significant contributions to these fields throughout history, but they have also faced many challenges and barriers due to gender discrimination and bias.

Women in science (WiS) have received many honors and awards for their achievements and contributions to various fields of science, technology, engineering, mathematics, and medicine (STEMM). Some of the honors that women in science have got are:

- The Nobel Prize, the most prestigious award in science, has been awarded to 23 women in physics, chemistry, and medicine since 1901. Some of the female Nobel Laureates are Marie Curie, Rosalind Franklin, Dorothy Hodgkin, Rita Levi-Montalcini, and Tu Youyou.

- The L’Oréal-UNESCO For Women in Science Awards, established in 1998, recognize outstanding women researchers who have contributed to scientific progress. The awards are given annually to five laureates, one from each continent. Some of the laureates are Ada Yonath, Elizabeth Blackburn, Jennifer Doudna, and Emmanuelle Charpentier.
- The Association for Women in Mathematics (AWM) and the Association for Women in Science (AWIS) are two organizations that promote and support women in STEMM fields. They offer various awards and scholarships to women at different stages of their careers, such as the Alice T. Schafer Prize, the Noether Lecture, the Leadership Award, and the Kirsten R. Lorentzen Award.
- The Iota Sigma Pi is an honorary society for women in chemistry that was founded in 1902. It grants several awards to women chemists who have demonstrated excellence in research, teaching, or service. Some of the awards are the Agnes Fay Morgan Research Award, the Anna Louise Hoffman Award for Outstanding Achievement in Graduate Research, and the Violet Diller Professional Excellence Award.
- The Society of Women Engineers (SWE) is a professional organization that advocates for women engineers and engineering students. It bestows several honors and awards to women who have made significant contributions to engineering or SWE. Some of the awards are the Achievement Award, the Distinguished Engineering Educator Award, and the Emerging Leader Award.

Science academies are organizations that promote and support scientific research and education in various fields and disciplines. They also provide advice and guidance to policymakers and the public on scientific issues and challenges. Some of the initiatives of science academies are:

- Climate Crossroads: This is a new initiative launched by the National Academies of Sciences, Engineering, and Medicine in the United States to help the nation meet the challenges of climate change by harnessing the full complement of expertise and skills across the Academies and catalyzing actions among a more diverse range of stakeholders and decision-makers.
- India Science, Technology & Innovation Portal: This is a web-based platform developed by the Ministry of Education in India in collaboration with several national science academies, such as the Indian National Science Academy, the Indian Academy of Sciences, and the National Academy of Sciences, India. It provides information and resources on various aspects of science, technology, and innovation in India, such as fellowships, scholarships, funding, startup opportunities, etc.
- Women in Science Panel: This is a panel established by the Indian Academy of Sciences to address the issues and challenges faced by women scientists in India. It organizes various activities and programs to encourage and empower women to pursue careers in science, such as workshops, lectures, mentoring schemes, etc.
- Science Education Programmes: These are programmes conducted by various science academies to promote and enhance science education among students and teachers. For example, the Indian Academy of Sciences organizes summer research fellowships, refresher courses, lecture workshops, etc., for students and teachers from different

institutions across the country. The National Academy of Sciences, India organizes science communication workshops, science exhibitions, science quizzes, etc., for school students.

Session 14: STEM in Higher Education: Perspective of NEP-2020: Prof. Asheesh Srivastava, School of Education, Mahatma Gandhi Central University, Bihar

The National Education Policy 2020 (NEP 2020) is a comprehensive framework for transforming India's education system. It aims to provide quality education to all students, regardless of their background, location, or socio-economic status. One of the key aspects of the NEP 2020 is the promotion of STEM (Science, Technology, Engineering, and

Prof. Asheesh Srivastava, Professor & Dean, School of Education, Mahatma Gandhi Central University, Bihar. He is Professor & Dean, School of Education, Mahatma Gandhi Central University, Bihar. He has a Ph.D. in Education & M.Sc. (Mathematics) from University of Lucknow. He has worked with various organizations including Visva-Bharati, West Bengal. He has been acting in various roles like Chairman in Board of Studies and Member in various councils and committees. He was awarded the Maya Gold Foundation Award for 'Excellence & Service as a Young Academic Leader' on September 05, 2020 by 'The Maya Gold Foundation' New Paltz, New York, United States of America. He has guided many Ph.D. and M.Phil. scholars. He has delivered many lectures at national and internal level.

Mathematics) education, which is essential for developing a scientific temper, innovation, and problem-solving skills among the learners.

STEM education in NEP 2020 has several features, such as:

- Integrating STEM learning and approach in the updated curricula, with an emphasis on experiential learning, hands-on learning, and inquiry-based learning.
- Providing flexibility and choice to the students to pursue their interests and talents in STEM fields, without any rigid separation between arts and sciences, curricular and extracurricular activities, or vocational and academic streams.
- Introducing subjects such as Artificial Intelligence (AI), Design Thinking, Machine Learning (ML), Data Science, and Coding at an early stage of education.

- Enhancing the skills and competencies of the teachers and faculty in STEM fields through continuous professional development and training.
- Establishing specialized STEM labs and centers of excellence in educational institutions to foster research and innovation.
- Encouraging collaboration and partnership among various stakeholders, such as industry, academia, government, and civil society, to support STEM education.

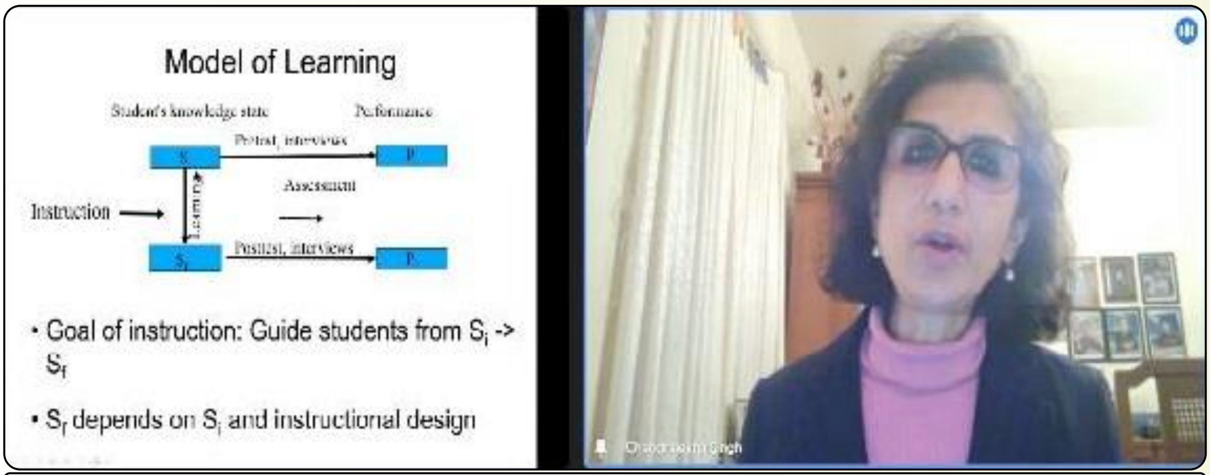
The NEP 2020 envisions a holistic and multidisciplinary education that will prepare the students for the challenges and opportunities of the 21st century. STEM education will play a vital role in this vision, by developing the cognitive, creative, and critical thinking abilities of the learners. By promoting STEM education, the NEP 2020 hopes to create a culture of scientific inquiry and innovation in India.

Day 4: 13 October, 2023

Speakers

- Prof. Chandralekha Singh, University of Pittsburgh, Pennsylvania, United States
- Prof. Nishith Dubey, National Institute of Technical Teachers Training and Research (NITTTR), Bhopal
- Prof. C. B. Sharma and Prof. Arbind Kumar Jha, School of Education, IGNOU, Delhi
- Dr. Saurabh Singh Rathore, IUCTE, Varanasi
- Prof. Rajesh Tiwari, Senior Scientist, Secure Navigation at QinetiQ, Nottinghamshire, England, UK

Session 15: Facilitating Thinking and Learning in the STEM Classrooms using research- based approaches: Prof. Chandralekha Singh, University of Pittsburgh, Pennsylvania, United States



Prof. Chandralekha Singh has a Ph.D. in physics from the University of Pittsburgh and has done post-doctoral research at various institutes in India, Israel, USA, and Europe. She is the founding director of the Discipline-based Science Education Research Center (dB-SERC) at the University of Pittsburgh, which aims to improve science education through research and innovation. She is also the president of the American Association of Physics Teachers (AAPT), which is a professional organization for physics educators. Her research interests include identifying and addressing student difficulties in learning physics, both at the introductory and advanced levels, and designing, implementing, and assessing curricula and pedagogies that may enhance physics learning and problem solving. She has published more than 100 papers in reputed journals and conferences, and has received several awards and honors.

In the realm of modern pedagogy, few topics are as pertinent as understanding how students learn and, more importantly, how to teach effectively. Prof. Chandralekha Singh's enlightening discourse on the Cognitive Approach to Instructional Design delved deep into these concerns, providing a roadmap for educators worldwide. At the heart of her discussion was the understanding that any educational endeavor should commence with a clear determination of the course goals. These goals, along with their sub-goals or performance criteria, provide a vision for what the learning journey should accomplish. But understanding the destination is only half the challenge; it's equally essential to gauge where the learners currently stand. Prof. Singh stressed the significance of assessing the initial knowledge students possess, a vital step often overlooked, which can be the determining factor between a student's success and failure. By juxtaposing this initial state of knowledge with the course's end goals, educators can craft a tailored pathway that bridges the gap, focusing on specific learning processes that resonate with the students' current understanding. The essence of effective teaching, as Prof. Singh described, lies in the details. Determining the granularity or 'grain-size' of instruction allows educators to break down complex ideas into digestible segments, ensuring that students aren't overwhelmed. Moreover, the environment in which learning occurs plays a crucial role. A classroom that fosters active engagement, nurtures curiosity, and provides a motivating backdrop is more likely to witness enthusiastic participation and comprehension. Transparent communication, where course designs and goals are explicitly shared with students, further augments the learning experience, making students active stakeholders in their educational journey. Highlighting a seminal concept by Schwartz titled "A Time for Telling", Prof. Singh elucidated how students, when exposed to an idea or concept beforehand and given the chance to grapple with it, can be 'primed' for deeper learning. In this digital age, where student responses can be collated online even before a class session, tailoring instruction based on these responses makes the teaching feel personalized. This nuance makes students feel valued and heard, consequently motivating them to invest more deeply in the learning process.

One of the standout segments of Prof. Singh's talk was her emphasis on Collaborative Learning. In a world increasingly defined by collaboration, understanding that learning is embedded in a social context is paramount. Knowledge isn't just an isolated entity; it's encoded in our memories intertwined with the context in which it was learned. This social fabric of learning facilitates easier retrieval of information and offers opportunities to clarify doubts, especially in a setting where diverse opinions are present. Prof. Singh's assertion that discussions amongst peers, where students articulate concepts and explain their reasoning, doesn't just challenge them but also makes the learning process enjoyable. Through collaboration, students co-construct knowledge, thereby strengthening their grasp on concepts.

However, learning without a mechanism to evaluate its effectiveness is incomplete. This brought Prof. Singh to the realm of Assessment of Learning. Aligning assessments with course goals is foundational. More than just a measure of retention, assessments should encourage students to think, reason, and apply. In a poignant critique, Prof. Singh highlighted the pitfalls of rote-driven exams, which can drastically reduce the incentive for profound understanding. Instead, she championed assessments that probe various levels of cognitive complexity, pushing students beyond mere recall.

In the concluding segment, Prof. Singh explored the world of Formative Assessment. These are continuous, ongoing assessments that provide immediate feedback to both students and educators, allowing course corrections in real-time. From minute papers, which are quick reflections, to interactive demonstrations and problem-based learning, these methods foster a deeper engagement with the subject matter. The innovative 'think-pair-share' technique and 'clicker questions' make lectures interactive, while group tests and peer reviews provide a collaborative angle to assessments. Techniques like POGIL (process-oriented guided inquiry learning) and invention activities make students active participants in the learning journey, rather than passive recipients of knowledge.

To sum up, Prof. Chandralekha Singh's exploration into the cognitive approach to instructional design wasn't just a theoretical exposition but a clarion call for educators to introspect, innovate, and inspire. By understanding the cognitive underpinnings of learning, educators can transform classrooms into hubs of curiosity, collaboration, and comprehension.

Session 16: Entrepreneurship and Vocational Skill Development through STEM Education: Prof. Nishith Dubey, National Institute of Technical Teachers Training and Research (NITTTR), Bhopal

Prof. Nishith Dubey gave a brief introduction about NITTTR at the start of the session. He initiated the talk with the participants to answer, 'If you yourself want to start an enterprise? So, what could it be? He concluded that if anybody wants to start an enterprise, basically, there could be three kinds of units: Manufacturing, Trading and Service sector. He explained in detail about each sector and told the differences between all the sectors. He gave examples of various sectors along with the pros and cons of each. He also elaborated about the differences in investment in various sectors. He focused that the best sector for STEM is the service sector like designers, surveys, architect, etc. and in this sector risk and investment both are less. He also discussed that for first generation entrepreneurship, the service sector is advisable for better understanding the market and customers at initial level. He demonstrated a video and later asked everyone, 'How would you use this video in your classroom?'.

The video was on waste management of discarded shoes and how the young students had created a startup 'Greensouls' which provided footwear to millions of people who are dying due to diseases, contracted through unprotected feet, refurbishes discarded shoes to comfortable footwear and provides them to the people in need. As a teacher we can showcase the video for motivating the students towards entrepreneurship, as at young age students need direction. He elaborated that for becoming an entrepreneur we have to have a problem related to society, commercial etc. but the solution should be innovative. It should not be a compulsion of having a new product every time, there can be some traditional product also with some new innovative way. The video also shows social entrepreneurship and he said that in our infrastructure we have Section 8 companies, they work like companies and the other companies like ordinary companies. So, they can sell their products and they can earn money too. Also, they can have a profit but the only point is that whatever they earn has to be reutilized for social causes. He said that in such companies everybody gets a salary and benefits. Many companies invest and become a Corporate Social Responsibility (CSR) partner also. He elaborated on some actionable points which are required for STEM skill entrepreneurs like Determination, adaptability, and flexibility. He focused on the key skills which have to be developed in our students through STEM for becoming an entrepreneur like Independent Thinking, Problem Solving, Initiative, creativity, communication, critical analysis, digital literacy and teamwork. Teachers should have a responsibility to inculcate the ability to take initiative among our students and we should give the opportunity to our students. We also ask our students to be involved in product selling as a part-time job or maybe their internship.

Our students can also go for business consulting in various sectors such as technical business consulting enterprise or in Persons Coach for the persons who are already in business for example E- platforms, data literacy and epay payment etc. He also discussed that the Government of India is spending a lot of funds for the infrastructural development of STEM Education. A teacher has the responsibility to uncover the syllabus for STEM areas as rate of change is very fast and we have to be an independent learner or self-directed learner. Entrepreneurship and skill development go hand in hand. We have to focus on experiential learning and allow students to uncover their knowledge themselves like repairing any

Prof. Nishith Dubey is an eminent professor and head of the Department of Vocational Education and Entrepreneurship Development at National Institute of Technical Teachers Training and Research (NITTTR), Bhopal. He has a Bachelor degree in Mechanical Engineering, a Master's degree in Business Administration and a PhD in Entrepreneurship Development. He has more than 20 years of experience in teaching, research and consultancy in the field of entrepreneurship development, intrapreneurship, corporate entrepreneurship and skill development. He has published several papers, books and book chapters on various aspects of entrepreneurship and vocational education. He has also received many awards and honors for his academic and professional achievements, such as the Best Teacher Award by NITTTR Bhopal, the Best Research Paper Award by ISTE.

laboratory device, coding, etc. Along with this a teacher has to include diversity in the classroom by making groups of rural urbans, economic, etc. NEP 2020 also talks about multidisciplinarity and promoting innovation. He said that innovation is not easy but we have to admire our students at every step to develop the culture of innovation where it becomes a part of the classroom. A teacher has to handhold our students after he leaves the organization too. He posed the example of many companies who are the startup icons in our country and lastly, he motivated all the participants to become an incubator to become an entrepreneur. He also informed the participants about the manufacturing and service sector enterprises like Micro, Small and medium enterprises in India. He also showed a video where the issue of waste disposal and recycling was identified and an innovative solution was undertaken. The session was very interactive and informative.

Session 17: Promoting Research in STEM Education: Prof. C. B. Sharma and Prof. Arbind Kumar Jha, School of Education, IGNOU, Delhi

Prof. Sharma and Prof. Jha emphasized that promoting research in STEM education in India is a vital and timely topic, as India faces the challenges of developing a skilled and innovative workforce for the 21st century. STEM education refers to the integrated teaching and learning

Prof. C.B. Sharma is currently the director of school of education, IGNOU. He is a professor of education at the Indira Gandhi National Open University (IGNOU), New Delhi. He has a PhD in Education from the University of Hull, UK. His research interests include teacher education, language teaching, ICT in teaching and training, and educational research. He has published several papers and books on these topics, such as Teaching Foreign Literature through Multimedia, Globalising Education in an Unequal World, and Research in Language Teaching through Television.

Prof. Arbind K Jha enjoys the distinction of having his Bachelor's, Master's, M.Phil. and Ph.D. — all degrees in Education from University of Delhi. More than thirty fellows at masters' level, twenty fellows at M. Phil. level and seven fellows at Ph.D. level have written their dissertations and thesis in education under his supervision and guidance. Presently there are eight Ph.D. scholars conducting their research work.

of science, technology, engineering, and mathematics, with an emphasis on creativity, problem-solving, and inquiry. STEM education can help India achieve its goals of economic growth, social development, and global competitiveness.

Some of the initiatives taken by the Indian government and other stakeholders to promote research in STEM education are:

- The National Education Policy (NEP) 2020, which aims to transform the Indian education system by making it more holistic, multidisciplinary, and flexible. The NEP 2020 envisages a STEM culture in schools and higher education institutions, with a focus on experiential learning, digital literacy, and innovation.
- The Atal Innovation Mission (AIM), which is a flagship initiative of the NITI Aayog to foster a culture of innovation and entrepreneurship in India. AIM supports various programs such as Atal Tinkering Labs, Atal Incubation Centers, Atal New India Challenges, and Atal Community Innovation Centers, which provide opportunities for students, researchers, and entrepreneurs to develop and showcase their STEM-based solutions.
- The Inspire Program, which is a scheme of the Department of Science and Technology (DST) to attract and nurture talent in science and research. Inspire offers various awards,

fellowships, internships, and mentorship programs for students from class 6 to PhD level, to inspire them to pursue careers in STEM fields.

- The STEM India Foundation, which is a non-profit organization that provides educators with resources and training to implement STEM-based teaching and learning pedagogy in Indian schools. The foundation also organizes events such as STEM Festivals, STEM Olympiads, and STEM Competitions to promote awareness and interest in STEM among students.

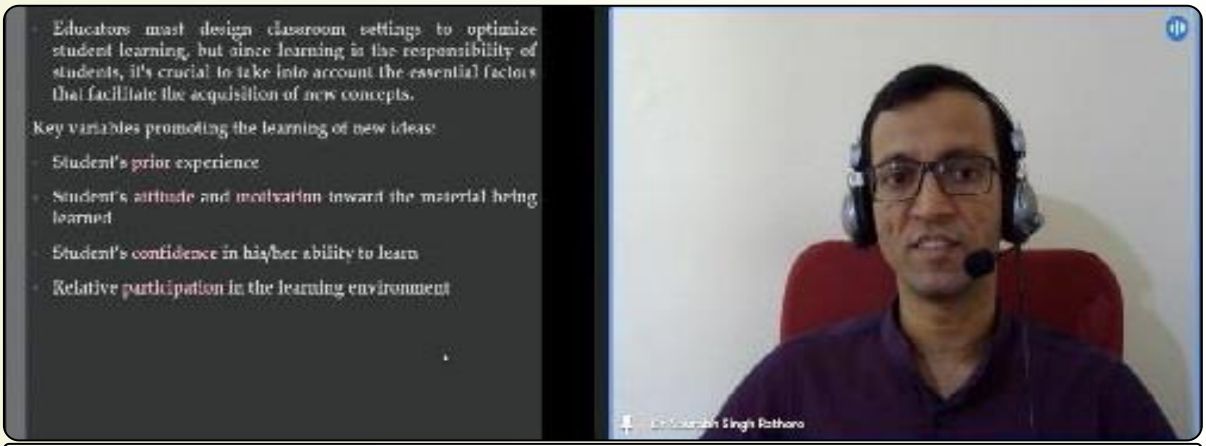
These are some of the examples of how research in STEM education is being promoted in India. However, there are still many challenges and gaps that need to be addressed, such as:

- The lack of adequate infrastructure, equipment, and funding for STEM education and research in many schools and colleges.
- The shortage of qualified and trained teachers and mentors for STEM subjects.
- The low enrolment and retention of girls and marginalized groups in STEM fields.
- The weak linkages between academia, industry, and society for collaborative research and innovation.

To overcome these challenges, India needs to adopt a holistic and inclusive approach to STEM education and research, involving all the stakeholders such as government, educators, researchers, industry, civil society, media, and parents. India also needs to benchmark its STEM policies and practices with the best global standards and learn from the experiences of other countries such as the USA, China, UK, Canada, and Australia. By doing so, India can harness the potential of its young population and become a leader in STEM innovation.

Session 18: Approaches for enhancing student engagement in science classrooms of higher education institutions: Dr. Saurabh Singh Rathore, IUCTE, Varanasi

Dr. Saurabh Singh Rathore's insightful presentation on promoting equitable participation and



Dr. Saurabh Singh Rathore is currently working as an Assistant Professor (life sciences) at IUCTE, BHU. Before joining IUCTE BHU, He has served as a faculty at the Department of Biotechnology Mahatma Gandhi Central University Bihar for more than 6 years. He obtained his PhD from the Department of Medical Genetics, Sanjay Gandhi Post Graduate Institute of Medical Sciences Lucknow. Dr. Rathore has done his M.Sc. Biotechnology and B.Sc. (Hons) from the School of Biotechnology Madurai Kamaraj University Tamil Nadu and Banaras Hindu University respectively. His area of expertise is pharmacogenomics and translational research. He has published 13 SCOPUS indexed research articles and 8 book chapters. His current research involves identifying and evolving effective life science topic-based pedagogies in higher education.

collaboration in science classes provided a comprehensive framework for transforming the traditional dynamics of the classroom into a more inclusive and engaging environment. The core principle emphasized throughout the presentation was the pivotal role of encouraging students to compare and refine their ideas, thereby fostering an atmosphere of cooperative learning, rather than competition, which was particularly significant in the realm of science education. One of the central strategies proposed by Dr. Rathore was the implementation of the 'think-pair-share' activity. This approach ensured that students had an opportunity to reflect and process their thoughts before delving into new subject matter. Not only did this activity grant students the necessary neural processing time, but it also encouraged them to actively participate in discussions. Moreover, during the peer discussions that followed, students often uncovered areas of confusion or points of disagreement, which, in turn, drove their curiosity and deepened their understanding of the subject matter.

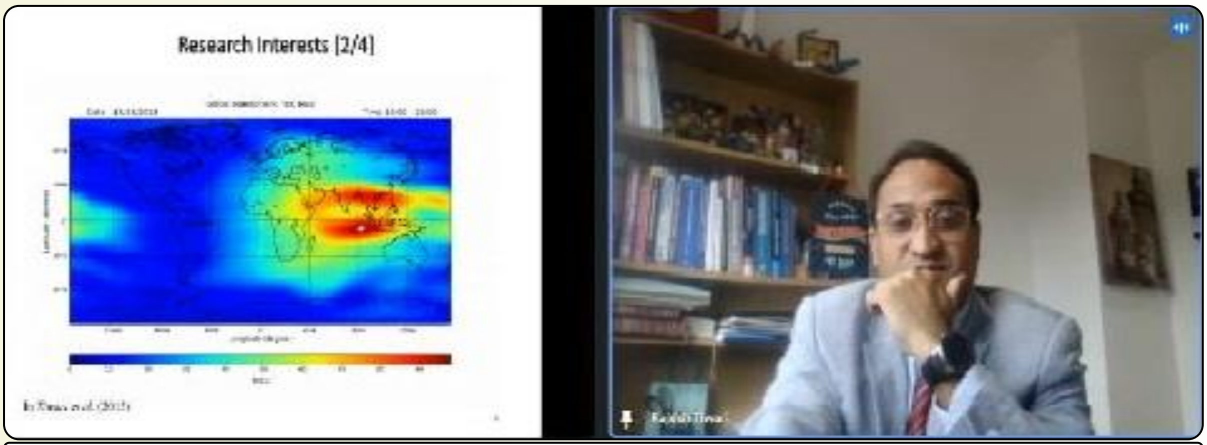
A significant point raised in the presentation was the need to diversify the methods of managing questions in the classroom. The conventional practice of relying on a single student to respond to questions was discouraged, as it could inadvertently exclude quieter or less confident students. Dr. Rathore suggested alternative approaches, such as 'hand raising' and 'multiple hands and multiple voices,' which aimed to ensure that all students had an equal opportunity to share their thoughts and engage actively in the learning process. To make the classroom environment more equitable, Dr. Rathore advised educators to structure active learning outside the classroom. This could be achieved through homework assignments that went beyond the typical textbook readings and delved deeper into the subject matter. Case study assignments were also recommended to stimulate critical thinking and provide a more profound grasp of complex scientific concepts. The presentation further addressed the issue of unequal participation frequently observed in undergraduate science classes. Dr. Rathore proposed various strategies to rectify this imbalance. These strategies included 'random calling,' a method that promoted widespread student participation while minimizing bias in student selection, and 'assigning reporters' within small groups. This ensured that even students who may not naturally volunteer were given an opportunity to contribute their insights to the discussion. In summary, Dr. Saurabh Singh Rathore's presentation offered a holistic and practical approach to creating a classroom environment that is equitable and inclusive. By implementing these strategies, educators could ensure that every student felt valued and actively participated in the learning process. This ultimately led to a more enriching and engaging educational experience, particularly in the field of science.

Session 19: STEM jobs and careers in India/Abroad: Prof. Rajesh Tiwari, Senior Scientist, Secure Navigation at QinetiQ, Nottinghamshire, England, UK

STEM stands for Science, Technology, Engineering, and Mathematics. These are the fields that offer many exciting and rewarding career opportunities in India and abroad. STEM careers are in high demand because they contribute to innovation, economic growth, and social development. STEM careers also require skills such as creativity, problem-solving, critical thinking, and collaboration, which are essential for the 21st century.

Some of the examples of STEM careers are:

- Physician Assistant: A physician assistant is a healthcare professional who works under the supervision of a doctor. They can diagnose illnesses, prescribe medications, perform procedures, and provide patient care. To become a physician assistant, you need a bachelor’s degree in a science or healthcare field, and a master’s degree in an accredited physician assistant program.



Dr. Rajesh Tiwari, PhD is Senior Scientist, and Honorary Fellow at the University of Nottingham, UK. He is Fellow of Higher Education Academy, Member of RIN, ION and Society of Automotive Engines (SAE). Dr Tiwari has been a technical lead for various space-based and territorial navigation systems projects, he led safety and integrity of PNT projects required for autonomous vehicles. His research interest includes, GNSS software receiver designing, multi-system, multi-sensors data fusion for PNT application and Autonomous vehicle. He has received the prestigious International Young Scientist award from International Union of Radio Science, best presentation award from ION, USA. Dr Tiwari has published more than 50 research articles, supervised 5 PhD and 52 MSc.

- Software Developer: A software developer is a person who creates computer programs and applications for various purposes. They use programming languages, tools, and frameworks to design, develop, test, and maintain software. To become a software developer, you need a bachelor’s degree in computer science or a related field.
- Nurse Practitioner: A nurse practitioner is an advanced practice registered nurse who can provide primary and specialty care to patients. They can perform physical exams, order tests, diagnose conditions, prescribe treatments, and educate patients. To become a nurse practitioner, you need a bachelor’s degree in nursing, a master’s degree or a doctorate in nursing practice, and a state license.
- Data Scientist: A data scientist is a person who analyzes large amounts of data to find patterns, insights, and solutions. They use statistical methods, machine learning algorithms, and visualization tools to collect, process, and present data. To become a data scientist, you need a bachelor’s degree or a master’s degree in mathematics, statistics, computer science, or a related field.
- Biomedical Engineer: A biomedical engineer is a person who applies engineering principles and techniques to solve problems in medicine and biology. They can design and develop devices, systems, and software for diagnosis, treatment, and research. To become a biomedical engineer, you need a bachelor’s degree or a master’s degree in biomedical engineering or a related field.
- Environmental Scientist: An environmental scientist is a person who studies the natural environment and its interactions with human activities. They can conduct research,

monitor conditions, assess risks, and propose solutions for environmental issues such as pollution, climate change, and biodiversity loss. To become an environmental scientist, you need a bachelor's degree or a master's degree in environmental science or a related field.

- Astronomer: An astronomer is a person who studies the universe and its celestial objects such as stars, planets, galaxies, and black holes. They use telescopes, satellites, and mathematical models to observe and explain astronomical phenomena. To become an astronomer, you need a bachelor's degree in physics or astronomy, and a doctorate in astronomy or astrophysics.
- Mechanical Engineer: A mechanical engineer is a person who designs and builds machines and mechanical systems for various industries such as aerospace, automotive, manufacturing, and energy. They use physics principles, engineering tools, and computer software to create and test prototypes, improve performance, and ensure safety. To become a mechanical engineer, you need a bachelor's degree or a master's degree in mechanical engineering or a related field.
- Chemist: A chemist is a person who studies the structure, composition, and properties of matter and its interactions with other substances. They can conduct experiments, synthesize compounds, and analyze materials for various purposes such as pharmaceuticals, cosmetics, food, and materials. To become a chemist, you need a bachelor's degree or a master's degree in chemistry or a related field.
- Mathematician: A mathematician is a person who uses logic, reasoning, and calculations to explore abstract concepts and solve problems in mathematics and its applications. They can work in fields such as education, research, finance, and cryptography. To become a mathematician, you need a bachelor's degree or a master's degree in mathematics or a related field.

These were just some of the examples of STEM careers that one can pursue in India or abroad described by Dr. Tiwari.

Day 5: 14 October, 2023

Speakers:

- Dr. Kalpana Maski, Regional Institute of Education, NCERT, Bhopal
- Prof. Prerna Shelat, Director, Centre for Education, The Indian Institute of Teacher Education (IITE), Gujarat
- Prof. S.C. Lakhotia (Retd.), Department of Zoology, BHU, Varanasi
- Prof. A.S. Raghubanshi, Director, IESD, BHU, Varanasi

Session 20: Building STEM readiness in students: Dr. Kalpana Maski, Regional Institute of Education, NCERT, Bhopal

Dr. Kalpana Maski introduced the topic 'STEM readiness among students' by highlighting the examples of STEM like solar cell, development of cars, measurements etc. She said what will happen if we do not have aeronautical engineers, civil engineers, Computer engineers, software engineers and many more in our society. So, STEM is a blessing and we have been using it from very ancient times. A person is dreaming of innovations and trying to achieve it. She focused that Technological innovation is essential for human development. Technology is not inherently good or bad, the outcome depends on how it is used. She focused on the approaches of STEM like problem solving, design, inquiry, games, amusement, music and

Dr. Kalpana Maski is an assistant professor of physics at the Regional Institute of Education (RIE), Bhopal. She is a faculty member of the Department of Education in Science and Mathematics (DESM). She has a M.Sc. (Physics), M.Ed., and Ph.D. (Electronics) as her educational qualifications. She joined the NCERT on October 11, 2013. She has 2 years of teaching experience at school level and 16 years of teaching experience at UG level. She has 12 years of research experience and has published 18 research papers. She has completed 9 research projects and has presented 36 papers in national/international seminars/conferences. She has conducted 11 training programmes and has developed modules on various concepts of science, physics, physical science, and educational pedagogy. She has received the BESTM fellowship from Homi Bhabha Center for Science Education, TIFR Mumbai.

dance, recreational facilities, etc. The innovative equipment has been developed and we are doing innovative things day by day like Technical Theater, Drama, etc. We must know the difference between technology and Engineering and change in ideas nowadays and what will be in future. She elaborated the phase of transformation which arrived in 1874 and the revolution came during the invention of the transistor which leads to mobile phones. If we talk about the history of our culture, it also had STEM in many aspects like crossing the river, starting fire, etc. When we are talking about pedagogical approach it means we need to use STEM in our classroom in such a way that a student can get the opportunity to explore and experience. If we will provide experience to our learners, in a way, they can have a good conceptual understanding and learning environment among themselves. She showed a video and asked the participants to interpret the video in terms of education. After compiling the responses of participants, she said that the video showed teamwork among all characters, problem diagnosing and solving, and motivation. The teacher has to design the strategy for peer support, take all the learners together and to support slow learners and help him/her to move ahead along with all the learners.

We can say STEM is an approach to learning and development that integrates all the four areas and through it we can develop key skills, communication, collaboration, critical thinking and problem-solving, creativity and innovation, imagination, team work, independent thinking, initiative, persistence and reciliation. STEM education fosters curiosity in students, encouraging them to explore experiments and solve problems. STEM education encourages students to identify problems, analyze data, generate hypotheses, test solutions, and evaluate outcomes. By engaging in hands-on, inquiry-based, and collaborative learning, students learn how to apply scientific and mathematical concepts to real-world scenarios and create innovative solutions. STEM Education, a curriculum centered on these disciplines, has grown in popularity due to its innovative solutions to global problems. This teaching methodology is not confined to the study of theoretical subjects alone. In fact, it teaches the child about the application of techniques (taught under these subjects) in the real-world context. She has discussed the collaboration with Curtin university, Australia, and Crevit, South Korea in STEM and designed some activities with them for their students. She briefly discussed about the TPACK Framework also and how to integrate it for identifying the learning goals, analyze the curriculum, assess the existing knowledge and skills of the learner, choose pedagogical strategies, select appropriate technologies, combined Content, pedological pedagogical and technological knowledge, collaborate with other teachers development, develop lesson plans, Evaluate the effectiveness of the plans and reflect on learning outcomes, those who are working on STEM.

She suggested to teachers that there is a need to provide opportunities to students to learn and grow together. To provide them the opportunity to actively participate, in the classroom and involve, in some activities. We need to provide experiences which are centered on design, innovation, engineering and technology which helps them to increase creativity, inventiveness, ingenuity and imagination capabilities. She elaborated about Design thinking is a problem-solving approach that helps people to understand and address problems and come up with innovative solutions. It is a mindset and process allowing creativity, empathy and experimentation. By using the design thinking process, children can learn to approach problems in a structured and creative way and develop critical thinking and problem-solving skills. She has demonstrated the simple models through which STEM can be initiated in the classroom like a simple electric motor, a torch, small circuit, sensor the obstacle, Magnetic Levitations etc. She has also demonstrated a software ‘Netlogo’ which can be used for showing the behavior of gases. Tinker cad is also one of the softwares for demonstrating physics experiments for diodes. She also told the role of Atal tinkering labs and marker space which has provided the facilities in Demonstration school at RIE, Bhopal. She discussed about the initiatives by the Government of India to strengthen a STEM education like in October 2020, The Department of Science & Technology (Ministry of Science and Technology, Government of India) collaboration with IBM to improve STEM opportunities for girls and recently in Sep’2022, a Public Notice was uploaded on the Ministry’s website for candidates interested in Early Academy Fellowship offered by UK universities (The British Council scholarships). At last, she motivated the participants that there are a number of ways to promote STEM education in India if we want to compete at a global level. If we want to give them experiential learning, we need to use contextual strategies, which help them to relate it with real life experiences. We have to look at the curriculum in a flexible way rather than looking at it in a rigid way. As a teacher we have to design the activities for learners so that he/she will be able to discover.

Session 21: Impact of STEM on Society: Prof. Prerna Shelat, Director, Centre for Education, The Indian Institute of Teacher Education (IITE), Gujarat

The lecture shed light on the profound impact of STEM (Science, Technology, Engineering, and Mathematics) on society, providing valuable insights into its philosophy, approach, pedagogy, and its transformative potential. Professor Prerna Shelat opened her lecture by introducing STEM as much more than a mere collection of academic subjects. She characterized STEM as a comprehensive philosophy and an innovative approach to education. Her emphasis was on the idea that STEM signifies a transformation from conventional knowledge delivery systems to a mode that encourages the creation of knowledge. In the context of India, she highlighted a significant report by UNCTAD in 2018, which indicated that a noteworthy 29.2% of Indian students had graduated in STEM subjects. This statistic underscored the growing significance of STEM in the educational landscape.

Professor Shelat then ventured into the core principles of STEM, underscoring the importance of what she referred to as the "4 Cs": Collaboration, Communication, Critical Thinking, and Creativity. These four pillars constitute the bedrock upon which STEM education is constructed, promoting an interactive and problem-solving approach that equips students with the skills necessary to tackle the complexities of the real world. One of the highlights of Professor Shelat's lecture was her comprehensive discussion on the applications of Artificial Intelligence (AI) in education. She elucidated how AI is revolutionizing the educational landscape by enabling proctoring, personalizing learning experiences, accumulating and analyzing data, and creating smart content. The integration of AI holds the promise of customizing education to individual needs, creating a more engaging and effective learning environment. Professor Shelat extended her discussion on AI to its applications in a multitude of sectors. This included healthcare, finance, the automobile industry, surveillance, social media, education, gaming, robotics, agriculture, and more. The integration of AI is

Prof. Prerna Shelat is a professor and head of the research programme at the Centre of Education, Indian Institute of Teacher Education (IITE) in Gandhinagar, Gujarat. She has a Ph.D. in education from The Maharaja Sayajirao University of Baroda, where she also obtained her M.Sc. in electronics and radio physics, B.Ed. and M.Ed. degrees. She has more than 20 years of experience in teaching and research in the field of science education, teacher education and educational administration. She has published 14 papers in journals, books and conference proceedings, and has guided two doctoral thesis. She is also a member of various professional bodies such as Indian Science Congress Association, Indian Association of Physics Teachers, Indian Association of Teacher Educators, etc. She is currently the director of the Centre of Education at IITE, which is a state public university established by the Government of Gujarat.

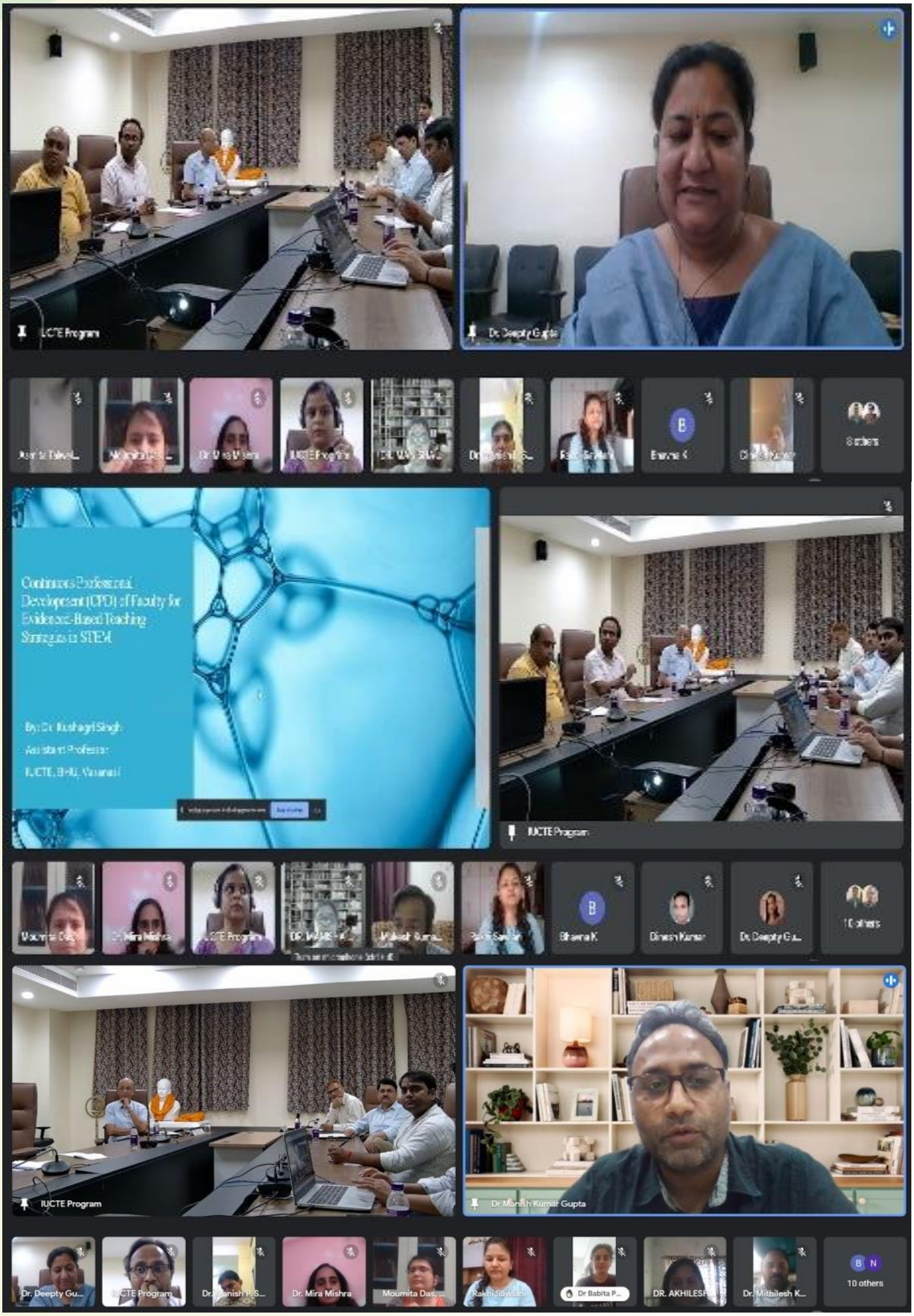
shaping the future in these areas, making processes more efficient, enhancing decision-making, and improving the overall quality of life. STEM advocates, according to Professor Shelat, play a pivotal role in promoting the adoption and integration of STEM in educational institutions and the broader community. These advocates serve as ambassadors for the STEM philosophy, working diligently to ensure its implementation in a manner that benefits society as a whole. They are instrumental in guiding educational institutions and policymakers to recognize the significance of STEM and its potential to transform education and, by extension, society.

A substantial part of the lecture was devoted to spotlighting national initiatives and campaigns that align with STEM principles. Make in India, Atma Nirbhar Bharat, Skill India, and the introduction of 10 Bagless Days were discussed in depth. These initiatives are driving innovation, self-reliance, and skill development, in alignment with STEM's transformative potential. These initiatives are designed not only to encourage the adoption of STEM but also to provide a framework for practical implementation, enabling students to witness the tangible benefits of STEM education. Professor Shelat offered insights into the STEM Tinkering Experience Centre established at IISER Pune. These centers serve as fertile ground for hands-on STEM experiences, encouraging students to experiment, innovate, and develop critical problem-solving skills. The IISER Pune center is a shining example of the practical application of STEM principles in education, illustrating how theory and practice can seamlessly intertwine to produce an enriched learning experience. The lecture drew to a conclusion with a discussion on the shift from structural to functional change brought about by STEM. This transformation in learning represents a fundamental paradigm shift, with STEM's influence extending beyond the classroom and into everyday life. STEM is not just about acquiring knowledge; it's about harnessing it for practical applications that benefit society. It's about moving from a system that imparts knowledge to one that empowers individuals to create, innovate, and address real-world challenges.

Valedictory Session:

The Inter-University Teacher Education Centre in BHU, Varanasi organized a Continuous Professional Development program on “Evidence-Based Teaching Strategies in STEM” from October 10th to 14th, 2023. On the final day, Dr. Kalpana Maski from the NCERT Bhopal campus spoke about the evolution and benefits of STEM education. He underscored the need for teachers to explore motivational techniques for their students, highlighting the increasing recognition and adoption of STEM at the school level.

Prof. Prerna Shelat, Director of IITE Gujarat, who participated remotely from Gandhinagar, emphasized the integral role of STEM in our daily lives. She further accentuated the foundational pillars of STEM – the 4Cs: Critical Thinking, Creativity, Collaboration, and Communication. The discussions during the program delved deep into enhancing students' learning outcomes, with a particular focus on key technologies in STEM and their effective implementation. An overarching theme was the importance of holistic assessment to improve learning outcomes, thereby reducing exam-related stress, and adapting teaching methodologies based on classroom feedback. Prof. Prem Narayan Singh, Director of IUCTE, articulated the pivotal role of educators in ensuring the holistic development of students. He stressed that knowledge shouldn't be forced upon students; instead, teaching methods should be compelling enough to facilitate spontaneous knowledge transfer. Throughout the five-day event, distinguished scholars both from India and abroad shared their insights, including Prof. Avinash Chandra Pandey of IUAC, Prof. Bhartendu Kumar Singh of IIIT-DM. Jabalpur, Dr. Chandralekha Singh from Pittsburgh University, USA, and many others. Prof. S.C. Lakhotia



graced the concluding session as the chief guest, with Prof. A.S. Raghuvanshi as the guest of honour. The program saw participation from nine different states, with the proceedings led by

Centre Director Prof. Prem Narayan Singh and coordinated by Dr. Kushagri Singh and co-coordinated by Dr. Deepty Gupta.

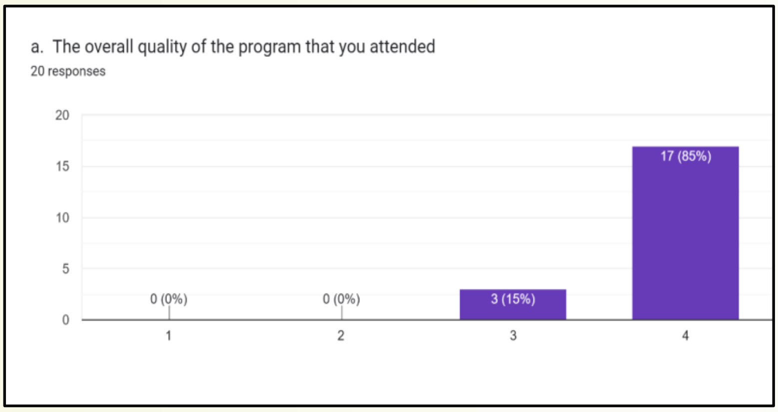
Programme Outcome

1. Improved STEM education in schools and universities by giving instructors access to current materials, pedagogy, and evaluation techniques.
2. Introducing students to practical, enjoyable, hands-on activities that encourage creativity, problem-solving, and innovation in order to increase their interest and engagement in STEM areas.
3. Creating a pool of bright and competent STEM workers who can support the nation's social and economic advancement by giving them chances to take part in national and international contests, research initiatives, and industry partnerships in India/Abroad.
4. Fostering a culture of STEM literacy and awareness in the broader community by establishing forums for discussion, information sharing, and support of STEM education and its advantages.
5. Acquisition of knowledge about various AI Tools and their integration in class.

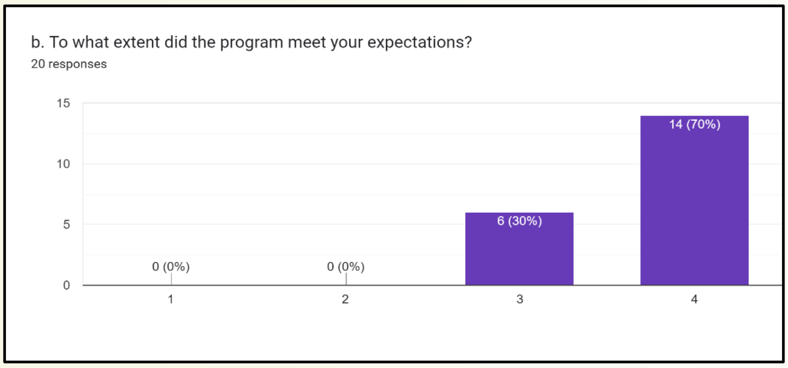
Annexure 1: Participants Feedback

Feedback was taken from the participants regarding the quality of the CPDP. Along with that the requirements of participants were also asked for the future programmes. The detailed analysis is discussed below.

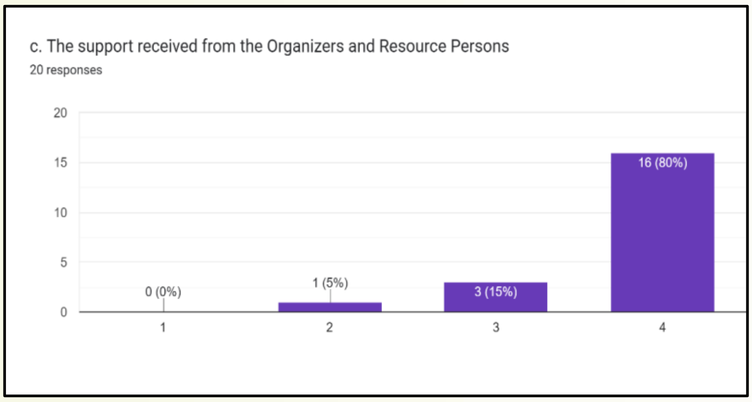
1. **Regarding the Overall quality of the program, maximum participants have praised the program.**



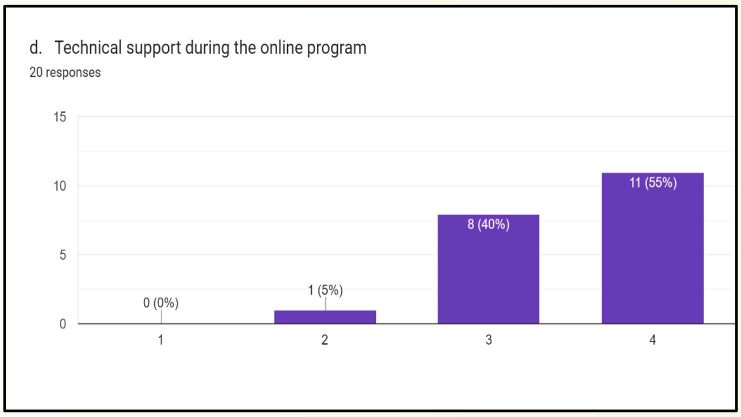
2. **It was also asked whether the expectations of the participants have been achieved or not through this FDP and maximum participants have rated that it was achieved.**



3. **The support from the Organizers and Resource persons was provided during the program and maximum participants have appreciated the support received from the organizers and Resource Persons**



4. **Feedback regarding the technical support feedback was also received from the participants and almost all have appreciated the arrangements provided during the program.**



5. **Participants were also asked to tell the topics which they think would have been covered in greater details. Following sessions were told:**

- Research and Innovation
- How to integrate STEM
- Multidisciplinarity and stem education
- STEM in NEP 2020
- Research and OER aspects

6. **Opinion of participants regarding the brainstorming and interactive sessions for which All the participants appreciated the sessions and some testimonials were:**

- Good.
- Excellent.
- Engaging.
- Amazing.
- Informative.
- Outstanding.
- Excellent.
- Very good.
- Wonderful experience.
- Although I participated in all the sessions, that were conducted pretty well, I wish the organizers made sure that ALL participants actually participated in the sessions.
- The brainstorming and interactive sessions were interesting and engaging.
- More interaction needed.

7. **Few Suggestions received from the participants for improving the program in future were:**

- Conduction in offline mode.
- Include more experts from other Science branches as Health sciences.
- Less assignments.
- No.
- Qualitative research in stem education.

- Well done.
- Would be helpful if recorded sessions are also shared.
- Please keep conducting such programs, they are so valuable and informative for us.
- The program was very well organized.
- Should increase hands on and creative sessions.
- Avoid bilingualism.
- It should be in physical mode.
- It was well organized.
- Overall it was very nice but you may consider about length of schedule of a day. In my opinion it should not be more than 5 hrs. in a day.
- Duration of my everyday schedule was lengthy. It should be a maximum of five hours.
- More Such programs should be organized in offline mode and focusing on higher education
- Teachers were taught how to teach, but did all the speakers actually follow the rules they were 'teaching'? Some of them really did, they interacted with the participants during their talk, and took measures to make their presentation/talk really interesting. Not all can be good Moderators, but we can certainly TRY to do what we preach.
- The program could have been better by timely providing the link for quizzes, assignments, etc. There was a bit of confusion there.
- None.
- Change is required.

8. According to participants the outcome of this CPDP:

- It opened new avenues for research in STEM and Pedagogy.
- Will be implementing a few in my University at my TLC centres.
- Refreshed and navigated.
- enhanced validated knowledge and various skills, came to know about views and opinions of experts in the field.
- Extremely Good.
- Enhanced STEM learning in INDIA.
- Teaching teachers, how to teach.
- To enhance knowledge and understanding in various dimensions.
- Awareness towards STEM.
- We incorporate STEM in my career.
- Acquisition of knowledge about various AI Tools and their integration in class.
- Greater learning.
- It was very interesting and informative. I have learnt many new things which I will definitely use in my class, course. It will also enhance my teaching skills.
- I have learned many new ideas, concepts and can enhance my teaching skills.
- I believe that it will surely help all of us to use the approach in our teaching and research.
- Participants learnt that they need to change their mindset and adopt the student centric, application-oriented teaching methodology so that students develop critical thinking and

problem-solving abilities. We also got to learn about various free resources available to help us teach. Last but not the least, got to know about various Govt programs that could help us bring in the change.

- Making people aware about STEM courses Introducing Innovative Pedagogical Learning Techniques in STEM courses.
- Gone through aspects of NEP and STEM.
- Positive.

9. Feedback from participants regarding on which topics/areas/themes they want future training/workshops to be organised at IUCTE:

- Teacher Education and STEM.
- Academic leadership.
- Case studies of STEM practices in classrooms.
- Artificial intelligence.
- Multidisciplinary nature of stem education, practical aspects of stem, AR and VR, mixed reality, craft-based pedagogy in stem, gamification.
- All streams.
- Stem in Biology.
- Tools/apps/softwares used for teaching.
- Mathematics Education, FOSS, OER.
- Hands on practice of module designing of MOOCs.
- Active learning methodology and building thinking classrooms in higher education.
- Digital literacy in education.
- Student friendly techniques.
- Absorbance of STEM graduates and Ph.D. students other than academics.
- STEM Research, Opportunities after STEM.
- Role of Artificial Intelligence/Use of OER for higher education research.
- Workshops should be conducted to provide hands-on training to the teachers, how to make their class more STEM oriented, instead of the traditional teaching techniques. We teachers need to bring the change in the mind-set, and for this, we ourselves need proper guidance to let go of the old (techniques) and adopt the new (concept of student centric, application-oriented teaching).
- Assessment of Skills under Innovative Pedagogical Learning Techniques in STEM courses.
- STEM Technology.
- Problem solving.

Annexure 2: List of Dignitaries and Resource Persons

List of Dignitaries

Name of the Participant	Affiliation
Prof. Avinash Chandra Pandey	Director, Inter University Accelerator Centre (IUAC), Delhi
Prof. Bhartendu Kumar Singh	Director, PDPM-IIITDM, Jabalpur, MP
Prof. S.C. Lakhotia	(Retd.), Department of Zoology, BHU, Varanasi
Prof. A.S. Raghubanshi	Director, IESD, BHU, Varanasi

List of Resource Persons

S.No	Name of RPs	Affiliation
1	Prof. Avinash Chandra Pandey	Director, Inter University Accelerator Centre (IUAC), Delhi
2	Prof. Minati Panda	Zakir Husain Centre for Educational Studies, JNU, Delhi
3	Prof. Asheesh Srivastava	Professor & Dean, School of Education, Mahatma Gandhi Central University, Bihar
4	Dr. Abha Sharma	Principal, SCERT, Delhi
5	Prof. Gaurav Singh	Central University of Haryana, Mahendergarh,Haryana
6	Prof. Meenakshi Singh	Faculty of Education, BHU, Varanasi
7	Prof. Kaushal Bhagat	Indian Institute of Technology, Kharagpur
8	Dr. Nishith Dubey	National Institute of Technical Teachers Training and Research (NITTTR), Bhopal
9	Dr. Kalpana Maski	Regional Institute of Education, NCERT, Bhopal
10	Prof. Prerna Shelat	Director, Centre for Education, The Indian Institute of Teacher Education (IITE), Gujarat
11	Prof. C.B. Sharma	School of Education, IGNOU, Delhi
12	Prof. Arbind Kumar Jha	School of Education, IGNOU, Delhi
13	Dr. Poonam Mehta	School of Physical Sciences, JNU, Delhi
14	Prof. Chandralekha Singh	University of Pittsburgh, Pennsylvania, United States
15	Prof. Rajesh Tiwari	Senior Scientist, Secure Navigation at QinetiQ, Nottinghamshire, England, UK

16	Prof. P.K.Mishra	Department of Chemical Engineering and Technology, IIT, BHU,Varanasi
17	Prof. Avinash Kumar Agarwal	Indian Institute of Technology, Kanpur
18	Dr. Raj Singh	IUCTE, BHU, Varanasi
19	Dr. Gyanendra Singh	IUCTE, BHU, Varanasi
20	Dr. Saurabh Singh Rathore	IUCTE, BHU, Varanasi

Annexure 3: List of Participants

S.No	Prefix	Name	Name of the Institute/Organization/University
1	Dr.	Akhilesh Mishra	Central University of Karnataka
2	Mr.	Amardeo Singh	Banaras Hindu University, UP
3	Dr.	Babita Parashar	Manav Rachna University, Haryana
4	Dr.	Bhavna	Dehradun Institute of Technology University, Dehradun
5	Dr.	Dinesh Kumar	Mahatma Gandhi Kashi Vidyapith, Varanasi, UP
6	Mr.	Eswaran V	Sri Ramakrishna Mission Vidyalaya College of Education, Tamil Nadu Teachers Education University
7	Dr.	Manish Kumar Gupta	Veer Bahadur Singh Purvanchal University, Jaunpur, UP
8	Dr.	Manish Pratap Singh	Veer Bahadur Singh Purvanchal University, Jaunpur, UP
9	Dr.	Manisha Bajpai Gupta	Sam College, Barkatullah University, Bhopal
10	Dr.	Mira Mishra	Manav Rachna University, Haryana
11	Dr.	Mithilesh Kumar Pandey	Veer Bahadur Singh Purvanchal University, Jaunpur, UP
12	Dr.	Moumita Das	Mahila Mahavidyalaya, BHU, UP
13	Prof.	Mukesh Kumar	Motilal Nehru National Institute of Technology (MNNIT), Prayagraj
14	Prof.	Nidhi Goel	Aditi Mahavidyalaya, University of Delhi
15	Dr.	Prashant Ankur Jain	Jacob Institute of Biotechnology and Bio-Engineering (JIBB), SHUATS, Prayagraj, UP
16	Mr.	Priyam Nath	Dhakuakhana College, Dibrugarh University
17	Dr.	Raj Kumar	Veer Bahadur Singh Purvanchal University, Jaunpur, UP
18	Dr.	Rakhi Sawlani	Pillai College of Education and Research, Mumbai University
19	Dr.	Ruchi L. Khatri	Central Institute of Educational Technology (CIET), NCERT
20	Mrs.	Asmita S. Talwelkar	P. P. Savani University, Surat

Annexure 5: Advisory Committee

1. Prof. Meenakshi Singh, BHU, Varanasi
2. Prof. Sunil Kumar Singh, BHU, Varanasi
3. Prof. Prerana Shelat, IITE, Gujarat
4. Prof. Gaurav Singh, CUH, Haryana
5. Prof. Minati Panda, JNU, Delhi
6. Prof. D.P. Singh, TISS, Mumbai

Annexure 5: Organising Team

Patron: Prof. Prem Narayan Singh, Director, IUCTE, BHU, Varanasi

Programme Convener: Dr. Kushagri Singh, Assistant Professor
Programme Co-Convener: Dr. Deepty Gupta, Assistant Professor

Academic Team:

1. Dr. Saurabh Singh Rathore, Assistant Professor
2. Dr. Gyanendra Singh, Assistant Professor
3. Dr. Raj Singh, Assistant Professor
4. Dr. Raja Pathak, Assistant Professor
5. Dr. Sunil Kumar Tripathi, Assistant Professor
6. Mr. Chakradhar Rana, Assistant Librarian

Technical Team

1. Mr. Rana Pratap Rao, Hardware Engineer
2. Mr. Kuldeep Pandey, System Analyst
3. Mr. Vikas Janu, Webmaster
4. Mr. Anand Jaiswal, Server Engineer
5. Mr. Sushil Kumar Rai, Electrician

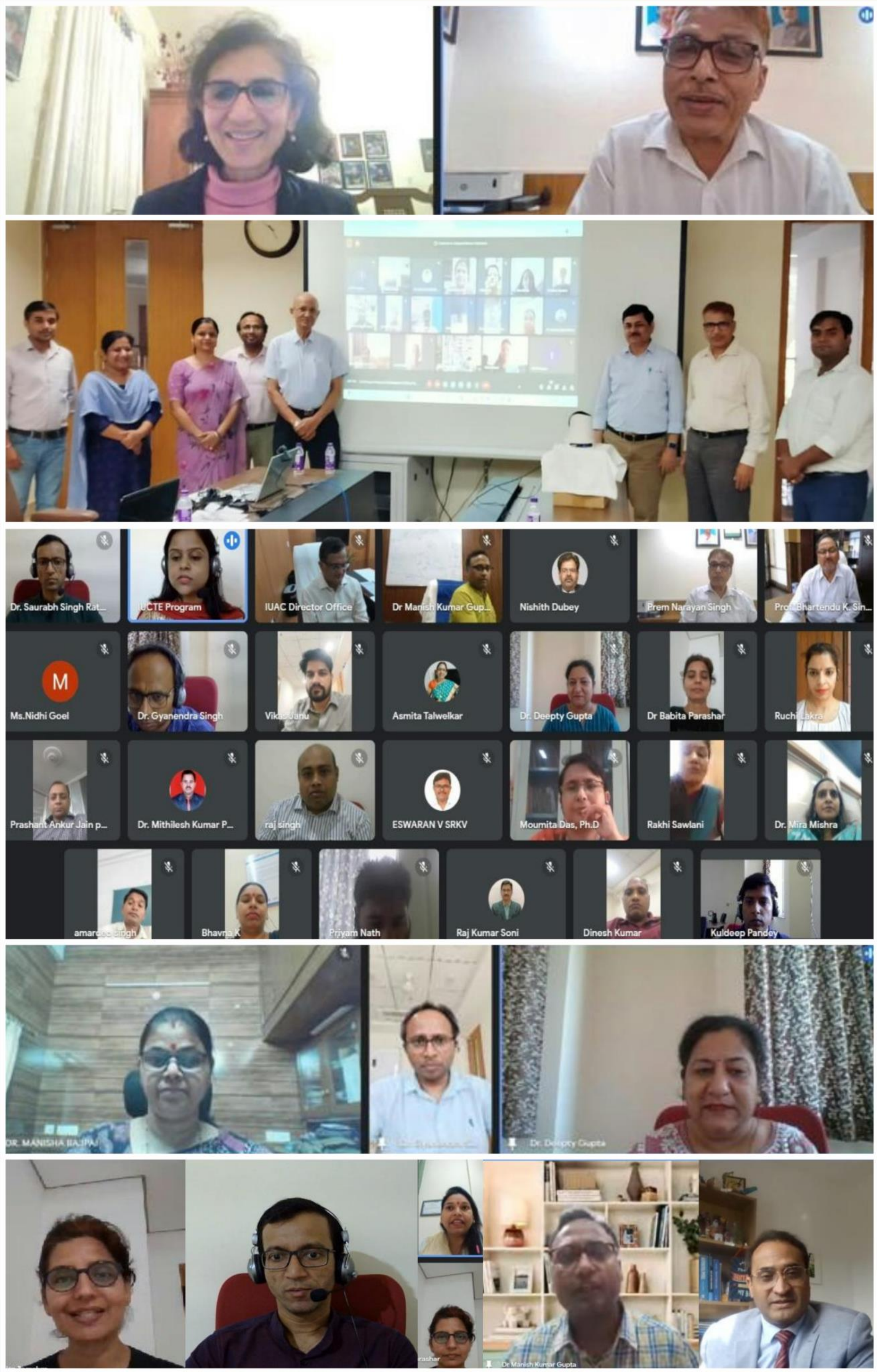
Administrative Team

1. Mr. Akash Chauhan, Administrative Officer
2. Mr. K. Ajay Kumar, Personal Secretary to Director
3. Mr. Anil Kumar Singh, SO (Admin)
4. Mr. Brijendra Sarkar, Assistant
5. Mr. Vijay Kumar Rai, Assistant
6. Ms. Purnima Singh, UDC
7. Mr. Anand Kumar Yadav, LDC
8. Mr. Ajit Kumar Singh, Driver
9. Mr. Mantu Kumar, MTS
10. Mr. Praveen Kumar Yadav, MTS
11. Mr. Ram Pravesh Pathak, MTS
12. Mr. Vineet Kumar Upadhyay, MTS
13. Mr. Vikash Kumar, MTS
14. Mr. Virendra Patel, MTS

Accounts Section

1. Mr. M.R. Ramasubramaniam, Administrative Officer (Finance)
2. Ms. Pooja Singh, LDC
3. Ms. Neha Patel, LDC

Annexure 6: Glimpses of the program



Inter University Centre for Teacher Education

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Uttar Pradesh

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