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on

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88.	Prof. Dr. Kavita Bhadiriya	-	Govt. Girls College, Barwani (M.P.)
89.	Prof. Dr. Archana Vishith	-	Govt. Rajrishi College, Alwar (Rajasthan)
90.	Prof. Dr. Kalpana Parikh	-	S.S.G. Parikh P.G. College, Udaipur (Rajasthan)
91.	Prof. Dr. Gajendra Siroha	-	Pacific University, Udaipur (Rajasthan)
92.	Prof. Dr. Krishna Pensia	-	Harish Anjana College, Chhotisadri, Distt. Pratapgarh (Rajasthan)
93.	Prof. Dr. Pradeep Singh	-	Central University Haryana, Mahendragarh (Haryana)
94.	Prof. Dr. Smriti Agarwal	-	Research Consultant, New Delhi

Message's

इन्दर सिंह परमार
मंत्री
उच्च शिक्षा, तकनीकी शिक्षा एवं आयुष
मध्यप्रदेश शासन

जावक क्रमांक: २८४०/मंत्री/उ.शि.त.शि. एवं आ./२०२५
दिनांक: ०९-१०-२०२५
कार्तिक कृष्ण पक्ष तृतीया, वि.स. २०८२

//संदेश//

अत्यंत हर्ष का विषय है कि **शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल** द्वारा दिनांक **14** अक्टूबर 2025 को "रोज़गारपरक शिक्षा के विविध आयाम" विषय पर एक दिवसीय **राष्ट्रीय वेबिनार** का आयोजन किया जा रहा है।

वर्तमान समय में रोज़गारपरक शिक्षा की प्रासंगिकता और आवश्यकता सर्वविदित है। यह वेबिनार निःसंदेह विद्यार्थियों, शोधार्थियों, शिक्षकों, उद्योग जगत के विशेषज्ञों तथा नीति-निर्माताओं के लिए विचार-विमर्श का एक सशक्त मंच सिद्ध होगा।

मुझे विश्वास है कि इस आयोजन के माध्यम से व्यावसायिक एवं कौशल आधारित शिक्षा के विविध पहलुओं पर सार्थक संवाद स्थापित होगा, जो भावी पीढ़ी के लिए मार्गदर्शक सिद्ध होगा।

महाविद्यालय द्वारा आयोजित **राष्ट्रीय वेबिनार** के सफल आयोजन हेतु मेरी हार्दिक शुभकामनाएं।

(इन्दर सिंह परमार)

Message's

Vishvas Kailash Sarang
Minister
Cooperation
Sports and Youth Welfare
Government of Madhya Pradesh

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Link Road-1 Bhopal 462003 (M.P.)
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Ref No. : 1569

Bhopal, Date : 12/10/2025

Message

It is a matter great pleasure **Government Motilal Vigyan Mahavidhyalaya Bhopal, Madhya Pradesh**, is organizing One Day National Webinar on **"Various Dimension of Vocational Education"** रोजगार परक शिक्षा के विविध आयाम " 14 October 2025".

In present scenario the relevance of the topic is widely accepted. I am quite optimistic that during this Webinar, academicians, Faculty members, Research scholars, Industry orofessionals, Policymakers and students will discuss the recent issues related to Various Dimension of Vocational Education and their impact.

I extend my Best Wishes to the Government Motilal Vigyan Mahavidhyalaya Bhopal, for the success of the Webinar.

Vishvas kailash Sarang

Message's

भगवानदास सबनानी
विधायक
152-दक्षिण पश्चिम विधानसभा भोपाल म.प्र.
प्रदेश महामंत्री एवं कार्यालय प्रभारी भाजपा म.प्र.

कार्यालय / निवास
ई-45/45 बंगले
बाणगंगा चौराहा, भोपाल (म.प्र.) 462003
मो : 9425014600, 7771014600
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क्र.152/10/25 दिनांक : 13/10/25

संदेश

यह अत्यंत प्रसन्नता की बात है कि शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल, मध्य प्रदेश, "व्यावसायिक शिक्षा के विविध आयाम" विषय पर एक दिवसीय राष्ट्रीय वेबिनार का आयोजन कर रहा है। **"रोजगार परक शिक्षा के विविध आयाम** "14 अक्टूबर 2025"।

वर्तमान परिदृश्य में इस विषय की प्रासंगिकता सर्वमान्य है। मुझे पूर्ण विश्वास है कि इस वेबिनार के दौरान शिक्षाविद, संकाय सदस्य, शोधार्थी, उद्योग जगत के पेशेवर, नीति-निर्माता और छात्र व्यावसायिक शिक्षा के विविध आयामों से संबंधित नवीनतम मुद्दों और उनके प्रभावों पर चर्चा करेंगे।

मैं शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल को वेबिनार की सफलता के लिए अपनी शुभकामनाएँ देता हूँ।

आपका

(भगवानदास सबनानी)
विधायक

Message's

कार्यालय, क्षेत्रीय अतिरिक्त संचालक, उच्च शिक्षा

भोपाल – नर्मदापुरम संभाग, शा. मोतीलाल विज्ञान महाविद्यालय परिसर, भोपाल

:: शुभकामना संदेश ::

मुझे यह जानकर अत्यंत प्रसन्नता हो रही है कि शासकीय मोतीलाल विज्ञान महाविद्यालय भोपाल द्वारा दिनांक 14 अक्टूबर 2025 को **रोजगार परक शिक्षा के विविध आयाम** विषय पर एक दिवसीय राष्ट्रीय वेबीनार का आयोजन किया जा रहा है।

शिक्षा व्यक्ति की अंतर्निहित क्षमता तथा व्यक्तिगत विकास हेतु की जाने वाले सतत प्रक्रिया है शिक्षा में तकनीकि दक्षता, शिक्षण उत्तम चरित्र का निर्माण ओर विद्या का समावेश है, एक पीढी के द्वारा अपने ज्ञान का हस्तांतरण अगली पीढी को किया जाना ही शिक्षा है।

वर्तमान समय में राष्ट्रीय शिक्षा नीति का उद्देश्य युवाओ को रोजगारोन्मुख शिक्षा प्रदान करना है जिससे कि समय और परिस्थिति के अनुसार युवाओं को नये पाठयक्रम, प्रशिक्षण और तकनीकि ज्ञान के द्वारा शिक्षा को रोजगार परक बनाया जाये जिससे कि आज का युवा प्रधानमंत्री माननीय श्री नरेन्द्र मोदी जी के विकसित भारत 2047 के सपने को सच करने में सहायक सिद्व हो सके।

महाविद्यालय द्वारा आयोजित किये जा रहे वेबिनार हेतु अनेकानेक शुभकामनाएँ।

शुभेच्छ

(डॉ. मथुरा प्रसाद)
अतिरिक्त संचालक
उच्च शिक्षा, भोपाल नर्मदापुरम संभाग

Message's

शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल (म.प्र.)

शुभकामना संदेश

अत्यंत हर्ष का विषय है कि शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल [redacted] अक्टूबर 2025 को **"रोजगार परक शिक्षा के विविध आयाम"** विषय पर एक दिवसीय राष्ट्रीय वेबिनार का आयोजन किया जा रहा है। यह वेबिनार निःसंदेह एक ऐसा मंच प्रदान करेगा जहाँ देशभर से विद्यार्थियों, शोधार्थियों, शिक्षाविदों, उद्योग विशेषज्ञों तथा नीति-निर्माताओं को समवेत होकर व्यावसायिक एवं रोजगारोन्मुखी शिक्षा के विविध पहलुओं पर विचार-विमर्श करने का अवसर प्राप्त होगा।

वर्तमान वैश्विक परिदृश्य में, शिक्षा को केवल शैक्षणिक ज्ञान तक सीमित न रखकर उसे रोजगारोन्मुख बनाना समय की आवश्यकता बन चुका है। इस वेबिनार के माध्यम से प्रतिभागी निश्चित रूप से शिक्षा के व्यावसायिक आयामों की गहन समझ प्राप्त करेंगे, जिससे उन्हें भविष्य के लिए बेहतर रूप से तैयार होने में सहायता मिलेगी।

मैं इस आयोजन हेतु आयोजन समिति की सभी सदस्यों को हार्दिक बधाई एवं शुभकामनाएँ प्रेषित करती हूँ और आशा करती हूँ कि यह वेबिनार सभी प्रतिभागियों के लिए ज्ञानवर्धक, प्रेरणादायक एवं दिशा-दर्शक सिद्ध होगा।

प्राचार्य
डॉ. गीता मोदी
शासकीय मोतीलाल विज्ञान महाविद्यालय, भोपाल

Naveen Shodh Sansar (An International Refereed / Peer Review Multidisciplinary Research Journal)
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Empowering Scientific and Industrial Skills through Vocational Chemistry Education

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Abstract: Vocational Chemistry Education (VCE) plays a vital role in bridging the gap between theoretical chemical knowledge and its practical applications in industry, laboratories, and research. With the rapid development of modern science and technology, industries require a workforce that is not only academically proficient but also technically competent and practically skilled. This review synthesizes key literature to highlight how vocational chemistry fosters laboratory proficiency, analytical reasoning, industrial safety, entrepreneurship, and sustainable practices. It explores the integration of advanced chemical techniques such as chromatography, spectroscopy, catalysis, and green chemistry into vocational training.

The discussion emphasizes how vocational chemistry education contributes to employability, innovation, and national economic progress. By analysing previous studies and international practices, the review underlines the necessity of aligning chemistry education with industry needs and preparing learners for twenty-first-century industrial and scientific challenges.

Keywords: Vocational Chemistry, Technical Education, Industrial Skills, Analytical Chemistry, Sustainable Development.

Introduction - Chemistry has long been regarded as the *central science* because of its vital function in bridging the natural sciences with engineering and technology disciplines. Its scope extends across a wide range of industrial and research sectors, including pharmaceuticals, petrochemicals, agriculture, polymer science, metallurgy, food technology, environmental monitoring, and materials innovation. Through these fields, chemistry not only supports economic progress but also contributes to sustainable development and technological modernization. Despite this significance, conventional classroom-based chemistry education has often been criticized for its predominantly theoretical orientation. Students frequently acquire conceptual understanding without sufficient exposure to real-world industrial applications, instrumentation, or process-oriented problem-solving. This gap has resulted in a growing call for educational reform that prioritizes experiential learning, technical competency, and industrial relevance alongside conceptual depth.

In this context, Vocational Chemistry Education (VCE) has emerged as a transformative and practice-driven pedagogical model. Unlike traditional instruction, VCE integrates theoretical principles with applied training through structured laboratory modules, industry collaborations, and project-based learning. It emphasizes mastery of experimental techniques such as titration, gravimetric and volumetric analysis, chromatography, electrochemistry, and spectroscopy, while also fostering analytical thinking, workplace safety, environmental consciousness, and entrepreneurial aptitude. By linking academic knowledge with industrial skills, VCE not only enhances students' employability but also strengthens national capacity for innovation, industrial productivity, and sustainable economic development.

Literature Review

A considerable body of research has examined the relevance of vocational and technical education to national development, particularly in the context of scientific and industrial progress. Okorie (2001) asserted that vocational education provides the *backbone of industrial advancement* by equipping learners with job-specific, technical, and operational skills essential for a productive workforce. Similarly, Eze and Okafor (2012) demonstrated that vocational education significantly reduces the persistent mismatch between educational outcomes and labor market demands, particularly in developing nations where skill gaps remain a critical barrier to economic growth. These findings indicate that vocational education not only enhances employability but also contributes directly to national productivity and industrial modernization.

In the realm of science education, Johnstone (1991) pointed out that students often struggle to relate abstract

chemical concepts-such as molecular orbital theory, thermodynamics, and reaction kinetics-to tangible, real-world applications. This cognitive gap frequently leads to a superficial understanding of chemistry as a subject confined to textbooks rather than as a dynamic discipline that underpins technological innovation. Johnstone proposed that integrating *vocational and experiential learning* strategies-through laboratory work, industrial training, and project-based problem solving-can bridge this conceptual divide and make chemistry more relevant, engaging, and applicable.

Within this framework, Vocational Chemistry Education (VCE) has emerged as an effective model for integrating theoretical knowledge with practical skill development. Adebayo (2018) emphasized that aligning chemistry curricula with industrial needs can substantially enhance workforce readiness, especially in high-demand sectors such as pharmaceuticals, petrochemicals, food technology, and environmental management. Oviawe et al. (2017) further observed that vocational and technical programs promote creativity, innovation, and problem-solving skills-competencies increasingly indispensable in modern industries that rely on automation, digitalization, and sustainable production technologies.

The principles of Green Chemistry, as proposed by Anastas and Warner (1998), have added another important dimension to vocational chemistry education. Their twelve principles—including atom economy, catalysis, renewable feedstocks, energy efficiency, and waste minimization—have been progressively incorporated into vocational curricula to cultivate environmentally responsible chemists and technicians. This integration not only strengthens the ecological and ethical dimensions of industrial chemistry but also prepares learners to address the pressing challenges of sustainability and circular economy models. The global significance of vocational and technical education is further emphasized by international studies and policy frameworks. According to the World Bank (2020), countries that prioritize technical and vocational training in science-related disciplines demonstrate higher productivity, lower unemployment rates, and stronger innovation indices. The OECD (2019) reports similarly highlight that nations such as Germany, Japan, and South Korea-renowned for their robust industrial sectors—have achieved remarkable success through dual education systems that integrate vocational training with academic learning. These systems ensure a seamless transition from school to work, maintaining a steady pipeline of technically skilled professionals for emerging industries.

Recent research has also highlighted the growing importance of incorporating advanced and interdisciplinary techniques into vocational chemistry programs. Shen and Yang (2020) recommend that training should include modern analytical and synthetic tools such as chromatography (HPLC, GC-MS), spectroscopy (UV-Vis, IR, NMR), polymer synthesis, nano-chemistry, computational chemistry, and materials characterization. Such exposure not only strengthens technical competence but also promotes innovation and adaptability-qualities essential in a rapidly evolving scientific and industrial landscape shaped by artificial intelligence, green technology, and digital chemistry.

Collectively, these studies reveal that Vocational Chemistry Education is not merely a pedagogical reform but a socio-economic imperative. It fosters innovation, entrepreneurship, and sustainable industrial development while bridging the gap between academic theory and professional practice. By producing a scientifically literate, technically proficient, and environmentally conscious workforce, vocational chemistry education plays a pivotal role in advancing national competitiveness, technological self-reliance, and global scientific collaboration

Thematic Review and Discussion: The role of vocational chemistry in laboratory skill development is particularly significant. Training in titration, gravimetric and volumetric analysis, chromatography, electrochemistry, and spectroscopy provides learners with the necessary competencies to conduct industrial processes such as drug quality testing, petrochemical analysis, polymer production, and environmental monitoring. Exposure to stoichiometric calculations and reaction kinetics ensures that learners can adapt to large-scale chemical manufacturing processes and optimize reaction yields.

Industrial applications of vocational chemistry extend beyond laboratory techniques. Training in chemical safety and hazard management, including the proper use of Material Safety Data Sheets (MSDS) and adherence to international safety standards, ensures that learners are prepared to handle risks associated with corrosive, flammable, and toxic substances. By learning safety measures within a vocational framework, students develop the confidence and responsibility necessary to maintain industrial efficiency and sustainability.

The role of vocational chemistry in entrepreneurship has also been widely acknowledged. Learners equipped with small-scale laboratory skills can establish enterprises in soap and detergent production, essential oil extraction, fertilizer formulation, agrochemicals, and polymer recycling. Such entrepreneurial ventures not only contribute to self-reliance but also strengthen local economies and reduce unemployment.

In addition, the integration of green chemistry principles into vocational training has made education more environmentally responsible. Learners are exposed to catalytic processes, energy-efficient reactions, and waste minimization practices. By adopting sustainable approaches, vocational chemistry contributes to both ecological preservation and industrial efficiency, aligning with global goals for sustainable development.

At a national level, vocational chemistry helps bridge

the education-industry gap by ensuring that students graduate with competencies relevant to current market needs. It enables countries to create a scientifically literate, technically skilled, and innovation-driven workforce capable of competing in the global economy.

Challenges in Implementing Vocational Chemistry: Despite its clear benefits, the implementation of vocational chemistry faces several challenges. Many educational institutions suffer from inadequate laboratory infrastructure and outdated equipment, making it difficult to provide high-quality hands-on training. Traditional curricula remain heavily focused on theoretical aspects, with limited integration of practical modules and industrial collaborations. In many countries, vocational education continues to carry a lower status compared to academic programs, discouraging students from pursuing it. Furthermore, insufficient funding, lack of policy emphasis, and inadequate training for educators in modern chemical techniques limit the effective delivery of vocational chemistry programs.

Future Directions: Addressing these challenges requires comprehensive educational reforms. Chemistry curricula must undergo restructuring to include practical training modules directly aligned with industrial practices. Stronger collaborations between academia and industry, including internships, apprenticeships, and research partnerships, are necessary to provide students with real-world exposure. Investments in modern laboratory infrastructure, digital learning tools, and simulation-based training can further enhance the effectiveness of vocational chemistry education. Finally, integrating sustainable practices such as green chemistry across all vocational modules will ensure that students contribute to environmentally responsible industrial growth.

Conclusion: This review underscores the central role of vocational chemistry education in promoting scientific and industrial skills. By integrating theoretical knowledge with laboratory training, safety practices, entrepreneurship, and green chemistry approaches, vocational chemistry produces a workforce that is both scientifically competent and industrially productive. Although challenges in infrastructure, policy, and perception persist, the global trend toward vocational training demonstrates that these obstacles can be overcome with systematic reforms and collaborative efforts. Ultimately, vocational chemistry education is not only a means of enhancing individual career prospects but also a strategy for national development, technological innovation, and sustainable progress in the global industrial arena.

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Guiding Workplace Learning in Vocational Education and Training : A Literature Review

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Abstract: Workplace learning in vocational education and training (VET) plays a pivotal role in bridging theoretical knowledge with practical skills. Effective guidance within workplace learning environments enhances students' skill acquisition, professional development, and employability. This literature review synthesizes empirical studies, policy analyses, and conceptual frameworks published between 2017 and 2025, focusing on guidance strategies, stakeholder roles, challenges, and best practices. Findings indicate that collaborative guidance, mentoring, and structured reflection significantly improve learning outcomes. The review highlights the need for integrated school–workplace cooperation and adaptive guidance approaches to support diverse learners.
Keywords: Vocational Education and Training, Workplace Learning, Guidance, Mentoring, Apprenticeship, Learning Outcomes.

Introduction - Vocational education and training (VET) has evolved to address the growing demands of skill-based economies. While classroom instruction provides theoretical foundations, workplace learning offers practical experience essential for developing competencies required in real-world occupations. Guidance in workplace learning involves structured support, mentoring, and supervision to facilitate student engagement, reflection, and skill mastery. Recent research emphasizes that the quality of guidance directly influences the effectiveness of workplace learning and overall learner satisfaction.

This review aims to synthesize recent literature on guiding workplace learning in VET, highlighting strategies, stakeholder involvement, and challenges. The review focuses on studies conducted between 2017 and 2025, providing a comprehensive understanding of current best practices and research gaps.

Literature Review:

1. Importance of Guidance in Workplace Learning: Guidance in workplace learning is critical for aligning educational objectives with practical experiences. Mikkonen et al. (2017) emphasized that effective guidance helps learners navigate workplace challenges, fosters self-regulation, and enhances competence development. Similarly, Spring-er (2024) highlighted the role of supportive work environments in reducing dropouts and improving engagement among apprentices. Structured guidance, including mentoring and feedback, ensures that students can translate theoretical knowledge into practical skills efficiently.

2. Types of Guidance Strategies: Studies categorize guidance strategies into formal and informal methods:

Formal guidance: Includes scheduled mentoring sessions, structured orientation, and competency assessments (Ramli et al., 2024).

Informal guidance: Occurs through daily interactions, peer support, and on-the-job coaching (Pylväs et al., 2025).

Both strategies complement each other, with formal guidance providing structure and informal guidance fostering adaptability and problem-solving skills.

3. Role of Stakeholders: Effective workplace learning guidance requires collaboration among multiple stakeholders:

Teachers / Trainers: Bridge theory and practice, plan workplace activities, and monitor progress.

Industry Supervisors: Provide hands-on mentoring and real-world context.

Peers: Offer collaborative support and knowledge sharing.

The integration of these stakeholders enhances learning outcomes and ensures comprehensive skill development (Stöckl & Struck, 2025; Muhwezi, 2025).

4. Challenges in Guiding Workplace Learning: Despite the benefits, several challenges affect effective guidance: Mismatch between school curricula and workplace requirements leads to confusion and underutilization of workplace opportunities.

Limited supervisor training reduces the quality of mentoring.

Time constraints and high student-to-supervisor ratios affect individualized support (MDPI, 2025).

Addressing these challenges requires policy-level interventions, structured collaboration, and professional development for workplace mentors.

5. Best Practices and Innovative Approaches: Recent literature identifies best practices in guiding workplace learning:

Integration of reflective journals and structured feedback loops (Mikkonen et al., 2017).

Use of digital platforms for communication between students, schools, and workplaces (Spring-er, 2024).

Collaborative planning between schools and industry to align learning objectives with real-world tasks (MDPI, 2025).

These approaches enhance learner engagement, ensure continuous skill development, and prepare students for future workplace challenges.

Discussion: Guidance in workplace learning is not merely supervisory; it is a collaborative, interactive process involving reflection, feedback, and adaptation. Studies indicate that students receiving structured mentoring and frequent feedback demonstrate higher skill acquisition and professional readiness. Furthermore, integrating digital tools and structured reflection enhances learning outcomes by providing real-time feedback and encouraging self-directed learning.The reviewed literature also highlights the critical need for policy support, supervisor training, and alignment between educational curricula and industry requirements. Countries implementing dual systems (e.g., Germany) showcase the positive outcomes of structured school–industry collaboration (MDPI, 2025). In contrast, gaps in guidance lead to inconsistent learning experiences and reduced employability.

Conclusion: Guiding workplace learning in VET is essential for developing competent, employable graduates. Effective guidance encompasses formal mentoring, informal support, stakeholder collaboration, and reflective practices. While recent research demonstrates promising strategies, challenges such as curriculum–industry mismatch, supervisor training, and resource constraints persist. Policymakers, educators, and industry stakeholders must collaborate to implement adaptive guidance frameworks, ensuring meaningful workplace learning experiences that foster both technical skills and professional growth.

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Skill Convergence and Institutional Strategy: Aligning Indian Higher Education with NEP 2020 through an Expanded Industry Interface

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Abstract: The National Education Policy (NEP) 2020 necessitates a fundamental re-orientation of Indian Higher Education Institutions (HEIs) to develop technology-fluent human capital and address the critical national skill gap. This paper analyzes the comprehensive findings of the Academia-Industry Research Interface 2.0, conducted by the A+ accredited Institute for Excellence in Higher Education (IEHE), Bhopal, to generate an evidence-based framework for strategic alignment. The study identified pressing skill requirements across four interconnected, high-growth industrial clusters: Artificial Intelligence in Agriculture, Fintech/Banking, Electronics & Fabrication, and Renewable Energy Systems. Results demonstrate that effective implementation of NEP 2020's tenets, specifically Multidisciplinary Education, Vocational Integration, and robust Academia Industry Collaboration (AIC) is essential. This study offers empirically grounded policy recommendations (IDP) for HEIs to transform into responsive knowledge and innovation ecosystems, thus fulfilling the national agenda for *Viksit Bharat*.

Introduction: The Imperative for Institutional Transformation: The Indian Higher Education System (HES) is currently navigating a period of profound, policy-driven transformation, mandated by the National Education Policy (NEP) 2020. This policy is not merely an academic reform; it is a strategic national initiative aimed at repositioning India as a global knowledge and skill hub, capable of supporting the vision of *Viksit Bharat* (Developed India) by 2047 (Goa Legislative Assembly, 2023; Indira Gandhi National Open University [IGNOU], 2024). Historically, a persistent structural gap has existed between the theoretical output of HEIs and the dynamic, application-oriented requirements of the modern industrial sector, leading to endemic skill shortages and concerns about graduate employability (Jagat Guru Nanak Dev Punjab State Open University, n.d.). The NEP 2020 directly addresses this by demanding a fundamental shift in institutional governance and pedagogy**,**moving away from a rigid, content-based model toward one that champions critical thinking, interdisciplinary expertise, and entrepreneurial capacity (Association of Indian Universities [AIU], 2020).

Successful HEIs, particularly those with high accreditation grades like IEHE, Bhopal (A+), must operationalize this policy by creating a seamless interface with the industry. This institutional agility is crucial because technological advancements, such as the proliferation of Artificial Intelligence (AI), the success of the Unified Payments Interface (UPI) in finance, and the rapid expansion of the Green Energy sector, are constantly rendering traditional skill sets obsolete (Sharma & Jain, 2025; Kohli et al., 2025; EY & DLAI, 2025).

This paper examines the comprehensive, multi-sectoral findings of the Academia-Industry Research Interface 2.0 initiative (IEHE, 2025) as a case study for strategic institutional development. By consulting experts across four critical growth clusters, Agri-Tech, Fintech, Electronics & Fabrication, and Renewable Energy, the study provides granular, evidence-based data on market demand. The analysis translates these demands into specific, actionable recommendations for HEIs' Institutional Development Plans (IDPs), ensuring their alignment with the NEP 2020's core pillars of Multidisciplinarity, Vocationalization, and Academia Industry Collaboration (AIC).

The study's objectives are to:

1. Identify and categorize the high-priority, future-ready skill gaps across all consulted sectors.
2. Assess the on-ground barriers to technology adoption and skill transfer within the regional economic context.
3. Propose a strategic, NEP 2020-compliant roadmap for HEIs to enhance their research and vocational interface (AIU, 2020).

Literature Review and Policy Context

The NEP 2020 Framework for Alignment: The NEP 2020 outlines three strategic pillars for institutional transformation:

1. **Multidisciplinary and Holistic Education:** Requires HEIs to break down disciplinary silos, introducing flexible, credit-based courses and Multiple Entry and Exit (MEE) options to cater to diverse learner pathways and reduce academic rigidity (Goa Legislative Assembly, 2023; AIU, 2020).
2. **Vocationalization and Employability:** Aims to eliminate the academic-vocational divide, embedding National Skills Qualification Framework (NSQF)-aligned practical skills to cultivate "job creators/entrepreneurs" (IGNOU, n.d.; Jagat Guru Nanak Dev Punjab State Open University, n.d.). This is essential for elevating the societal value and career pathways associated with vocational training.
3. **Academia Industry Collaboration (AIC):** Mandated as the primary vehicle for curriculum co-design, facilitating mandatory student internships, and driving translational research that is socially relevant and directly contributes to economic output (Directorate of Internal Quality Assurance, 2025).

Sectoral Skill Disruption: Literature confirms that techno -logical disruption is driving skill change across all clusters:

1. **AI in Agriculture:** The move to precision farming requires expertise in AI and IoT (Rajendra et al., 2025; Kohli et al., 2025), but its success is critically dependent on addressing grassroots barriers like digital literacy (Ali & Khan, 2021; Sharma & Joshi, 2025).
2. **Fintech:** Driven by the **Digital Public Infrastructure (DPI)** like UPI, this sector demands new roles centered on digital risk management, cybersecurity, and RegTech (Sharma & Jain, 2025; EY & DLAI, 2025; NISM, 2025).
3. **Electronics & Energy:** The push for indigenous manufacturing and the green economy requires expertise in specialized areas like fire-retardant insulation (DI Kay Insulation) and materials (BHANWAR DEEP COPPER STRIPS) within a broader systems context (IEHE, 2025).

Methodology: The Academia-Industry Research Interface 2.0: The Institute for Excellence in Higher Education (IEHE) in Bhopal, established in 1995 by the Government of Madhya Pradesh, has solidified its reputation as a leading autonomous institution within the state. The campus is beautifully situated in a serene valley near the Kaliyasot Dam on Kolar Road, offering an optimal green and peaceful setting for academic pursuits. Operating with full autonomy over its academic, administrative, and financial affairs, IEHE acts as a key driver of progressive change in higher education, empowering it to innovate, establish new benchmarks, and influence the broader educational landscape of Madhya Pradesh. The institute provides a comprehensive range of undergraduate and postgraduate programs across Arts, Science, and Commerce, complemented by vocational and certificate courses. Its curriculum is deliberately designed to harmonize traditional knowledge with contemporary relevance, emphasizing industry integration and global viewpoints. IEHE is strongly dedicated to the holistic development of its students, focusing on character and values alongside intellectual growth. This commitment is supported by a modern campus equipped with advanced laboratories, a digital library, and ICT-enabled facilities, creating an environment that fully supports and inspires its diverse student population. The Academia–Industry Interface serves as a vital bridge, fostering a rich synergy between aspiring students and seasoned professionals by illuminating the critical intersection of academic theory and industrial demand, allowing students to gain deep insights and forge essential cross-disciplinary connections. This dynamic platform empowers learners to embark on a transformative journey across various fields, focusing on practical, solution-oriented engagement to spark innovation and unlock the potential of the next generation.

The Academia–Industry Interface 2.0 marked a significant evolution of the program, taking the form of a structured consultation process held in February 2025 at the IEHE, Bhopal. This updated initiative successfully brought together over 20 industry leaders and experts for focused discussions. The consultations were strategically organized around four main clusters: Agri-Tech, Fintech/ Banking, Electronics & Fabrication, and Renewable Energy Systems. This targeted approach allowed the interface to move beyond general discussions to delve into sector-specific demands, ensuring the academic curriculum remains highly relevant and responsive to the needs of these critical, modern industries.

Data Gathering and Policy Outcomes: Data was collected via focused group discussions (FGDs) on observable skill deficiencies, specific industrial standards, and the feasibility of AIC. Key outcomes included the formal signing of an MoU by ISED Services & ITSC Tech Pvt. Ltd. and collaboration commitments from Heliosvento Power Infra, EVONE Industry Pvt. Ltd., and others for technical training and student entrepreneurship (IEHE, 2025).

Results and Institutional Strategy by Cluster

Agri-Tech and AI: Operationalizing Technology Transfer: The consultation confirmed that AI-driven tools (e.g., GenAI advisory) are underutilized due to a gap in operational competence at the field level. The imperative is to produce graduates who can not only use but also contextualize technology, validating the need for multidisciplinary curricula that combine Computer Science, field ecology, and local economic knowledge.

Fintech and Banking: The Demand for Digital Risk Management: Traditional financial degrees are deemed insufficient for the digital economy. The primary skill demand is shifting from accounting to digital assurance and governance.

1. Required Skills: Expertise in Cybersecurity, Data Privacy, and Regulatory Technology (RegTech).

2. Action: Institutional strategy must include specialized, industry-accredited FinTech certification pathways in partnership with sectoral bodies (NISM, 2025; BFSI Sector Skill Council of India, n.d.).

Electronics and Fabrication: Precision and Supply Chain Resilience: Consultants like Mr. Ashish Bafna (BHANWAR DEEP COPPER STRIPS) and Mr. Vashu Bhojvani (FAB & ELECTRO ENGINEERING PVT. LTD.) emphasized the need for precision manufacturing skills and expertise in specialized materials. The focus is on:

1. Quality Control: Stringent adherence to national and international material and fabrication standards.
2. Innovation: Applied research into materials science and supply chain optimization, directly tied to India's self-reliance missions.

Renewable Energy Systems: Integration and Green Skills: Experts from Heliosvento Power Infra (Solar), EVONE Industry (EVs), and DI Kay Insulation (Specialized Insulation) highlighted the need for cross-disciplinary integration. The key demand is for engineers who possess:

1. Systems Thinking: The ability to manage complex installations, from component materials (e.g., fire-retardant insulation) to software/grid integration.
2. Green Skills: Specialized knowledge in Battery Management Systems (BMS), solar panel efficiency, and sustainable engineering practices.

Conclusion and Policy Recommendations: The Academia-Industry Research Interface 2.0 provides empirical justification for HEIs to aggressively execute their NEP 2020 mandates. The findings necessitate a shift in institutional priorities to ensure direct market relevance across all sectors.

Strategic Policy Recommendations for IDP Execution:

1. Strengthen AIC and Translational Research: Fully activate all AIC partnerships (MoUs) to secure consistent industry mentorship and co-designed technical modules. The institution must ensure a minimum of 25% of student research projects are sponsored by or co-developed with an industry partner (Directorate of Internal Quality Assurance, 2025).

2. Modular and Vocationalized Learning: Institutionalize the Multiple Entry and Exit (MEE) system, immediately launching NSQF-aligned certificate and diploma vocational programs in the four high-demand clusters (Agri-Tech, FinTech, Green Skills, and Precision Fabrication).

3. Faculty and Infrastructure Modernization: Institute mandatory, incentivized Faculty Development Programs (FDPs) focusing on the practical application of emerging technologies (AI/ML, DPI, Renewable Energy systems) and allocate capital for upgrading labs with industry-grade testing and simulation equipment to maintain pedagogical quality (IGNOU, 2024).

By executing these evidence-based strategies, IEHE will successfully translate the vision of NEP 2020 into tangible student outcomes, thus fulfilling its critical role in the development of *Viksit Bharat*.

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The Role of Chemistry Education in Skill Development and Economic Empowerment

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Abstract: Chemistry, as a foundational science, serves as a vital link between scientific understanding and practical application in various industrial, research, and technological domains. In the twenty-first century, where employability and entrepreneurship increasingly depend on applied knowledge and skills, chemistry education holds the potential to become a significant driver of economic empowerment. This paper investigates how chemistry education contributes to skill development and earning potential, particularly within the Indian context while referencing global trends. The research adopts a mixed-method approach that combines literature review and simulated survey data from students, educators, and professionals. Findings reveal that chemistry graduates acquire a broad set of employable competencies, including laboratory proficiency, analytical reasoning, problem-solving, and entrepreneurship-related skills. However, there exists a notable gap between theoretical instruction and practical exposure, highlighting the need for curriculum reforms emphasizing experiential learning, industry collaboration, and innovation. The study concludes that strengthening chemistry education through skill-oriented approaches can enhance career readiness and promote socio-economic growth.

Introduction: Chemistry is often regarded as the 'central science' because it connects physical sciences with life sciences, engineering, and technology. Its relevance extends far beyond laboratories and academic institutions, influencing everyday life and economic progress through industries such as pharmaceuticals, energy, agriculture, cosmetics, polymers, and environmental management. In a rapidly evolving global economy, education systems are shifting focus from mere content acquisition to the development of practical, transferable, and entrepreneurial skills that foster employability and sustainable livelihoods. Within this paradigm, chemistry education plays an indispensable role.

India's National Education Policy (NEP) 2020 and the Skill India Mission both emphasize competency-based learning and interdisciplinary education. The integration of chemistry with applied sciences, technology, and innovation can generate skilled professionals capable of addressing industrial challenges while creating self-employment opportunities. However, traditional chemistry curricula at many institutions remain heavily theory-oriented, offering limited avenues for real-world problem-solving or entrepreneurship training.

Review of Literature

Chemistry education has long been recognized for developing analytical thinking, experimental accuracy, and systematic reasoning—skills that are widely transferable across professions. Holme and Murphy (2012) note that chemistry nurtures both cognitive and psychomotor skills, enabling students to interpret data, design experiments, and apply theoretical knowledge to practical contexts.

Studies by the Royal Society of Chemistry (2021) highlight that professionals trained in chemistry are highly valued across interdisciplinary sectors including biotechnology, nanotechnology, renewable energy, and forensic science. Entrepreneurial ventures such as analytical laboratories and eco-friendly product manufacturing demonstrate chemistry's potential as a tool for economic self-reliance.

Internationally, chemistry education reform has focused on integrating laboratory-based learning, digital technologies, and interdisciplinary projects. In India, many undergraduate chemistry programs emphasize rote learning over inquiry and experimentation, resulting in graduates who are theoretically competent but lack workplace readiness.

Objectives of the Study:

1. To identify the core skills developed through chemistry education that contribute to employability and entrepreneurship.
2. To analyze the relationship between chemistry education and economic empowerment in the Indian context.
3. To assess perceptions of students, educators, and professionals regarding the skill-oriented value of

chemistry.

4. To propose strategies for enhancing the skill-development component within chemistry curricula.

Methodology: A mixed-method approach was adopted, combining literature review and simulated empirical data. The sample included 120 participants—students, teachers, and professionals in chemistry-related sectors. Data were analyzed through thematic and descriptive interpretation, focusing on skill acquisition, employability, and entrepreneurial outcomes.

Results and Discussion

Perceptions of Chemistry as a Career-Enabling Subject : Respondents viewed chemistry as a discipline that enhances logical thinking and scientific curiosity. However, many felt that the current curriculum does not adequately prepare students for industrial or entrepreneurial roles. Educators emphasized revising laboratory work to include modern instrumentation and applied problem-solving.

Skills Acquired through Chemistry Education: Modern chemistry education serves as a bridge between scientific knowledge and vocational competence. It equips learners with technological proficiency, analytical expertise, and entrepreneurial mindset, transforming the laboratory into a platform for livelihood creation. Among the most vocationally relevant and advanced competencies are:

1. High-Performance Liquid Chromatography (HPLC) and Gas Chromatography–Mass Spectrometry (GC–MS): essential for roles in quality control laboratories and pharmaceutical analysis.
2. Nuclear Magnetic Resonance (NMR) and X-ray Diffraction (XRD): vital for research and materials characterization services.
3. Raman, FTIR, Mössbauer, and ESR/EPR Spectroscopy: widely used in environmental and forensic testing.
4. Nanomaterial Synthesis and Characterization (SEM, TEM, AFM): foundational for startups in nanocosmetics and sensors.
5. Green Chemistry and Sustainable Synthesis: crucial for biofertilizer, detergent, and biodegradable polymer production.
6. Computational Chemistry and Cheminformatics: applicable to virtual R&D and data-driven chemical design.

These competencies align with vocational frameworks that emphasize hands-on expertise and marketable service development. Exposure to automation, safety management, and digital laboratory systems enhances employability across sectors.

Chemistry and Economic Empowerment: The vocational relevance of chemistry extends beyond employment to self-sustaining entrepreneurship. Graduates trained in modern analytical and spectroscopic techniques can establish income-generating ventures, such as analytical laboratories, green product startups, and vocational training consultancies. They can also engage in freelance chemical data services, sustainable product formulation, and public–private environmental projects. Thus, chemistry functions as both an academic and vocationally rich profession that enables economic self-reliance.

Conclusion and Recommendations: Chemistry education has immense potential to foster skill development and economic empowerment. Strengthening practical exposure, industry collaboration, and innovation-based pedagogy can transform chemistry into a dynamic field of employability and entrepreneurship.

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Green Chemistry - Building a Sustainable Future

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Introduction - Chemistry has enhanced our quality of life and made countless products possible. However, this progress has come at a cost: our overall health and the environment are at risk. Many synthetic industrial chemicals have contaminated our bodies, with numerous substances recognized as toxic or carcinogenic, while others remain unassessed for their health impacts. They enter our bodies through unlabelled products, food that has been polluted by chemicals, air, water, and dust, and the developing foetus's direct exposure to chemicals in the womb. Chemicals used in the tropics are frequently discovered in the Arctic, and flame retardants used in electronics and furniture are now frequently detected in marine mammals. These chemicals go throughout the world and work their way up the food chain.

However, as the number of cancer cases rises and there is more proof that some chemicals are linked to birth deformities and learning disabilities[1], our regulatory system has not been able to force chemical manufacturers to offer comprehensive testing data or advocate for safer chemicals. Even while there are initiatives underway to reform chemicals regulation, most notably the recent enactment of the European Union's new REACH chemicals legislation, the emphasis must also be on reforming the way chemicals are created from the ground up. The goal of Green Chemistry is to achieve this.

What is Green Chemistry?

Green chemistry is an approach to the design, manufacture and use of chemical products to intentionally reduce or eliminate chemical hazards.[1a]The goal of green chemistry is to create better, safer chemicals while choosing the safest, most efficient ways to synthesize them and to reduce wastes.

How is green chemistry different?

Usually, when chemicals are developed, the idea is that any potential risks may be handled or regulated in some way by setting "safe" concentrations and exposure limits. Green chemistry seeks to remove risks at the very beginning of the design process. Through the design, production, use/reuse, and disposal processes, the practice of removing dangers from the start of the chemical design process improves the environment and human health. [1b]To show how chemical production may be both effective and profitable while also respecting human health and the environment, two US chemists, Drs. Paul Anastas and John Warner, outlined the Twelve Principles of Green Chemistry in 1998. [1c]

The use of petroleum is one instance of how traditional chemistry and green chemistry differ from one another. Nowadays, non-renewable petroleum is practically the only source of raw materials used in the chemical industry. Usually highly energy-intensive, inefficient, and poisonous, this kind of chemical synthesis uses a lot of energy and produces dangerousThis kind of chemical synthesis usually uses a lot of energy, is poisonous, and inefficient, which leads to the production of hazardous waste and high energy consumption. Prioritising the use of renewable and alternative resources, such as biomass, agricultural waste, and non-food bioproducts, is one of the tenets of green chemistry. Chemical reactions involving these substances are often far less dangerous than those involving petroleum products. Other tenets centre on waste reduction, fewer hazardous chemical syntheses, and the development of safer chemicals, such as safer solvent vents. Others concentrate on the efficiency and simplicity of chemical processes as well as the design of chemical products that can safely decompose in the environment.

The benefits of green chemistry reduce risks all along the life cycle of chemical production and use.Green chemists also take a life cycle approach to reduce the potential risks throughout the production process. They work to ensure that a product will pose minimal threats to human health or the environment during production, use, and at the end of its useful life when it will be recycled, or disposed of. A green chemistry approach is one of "continual improvement, discovery, and innovation"6 that will bring us ever closer to processes and products that are safe within natural ecosystems. Ultimately a product should safely degrade as a biological nutrient or it should be safely recycled

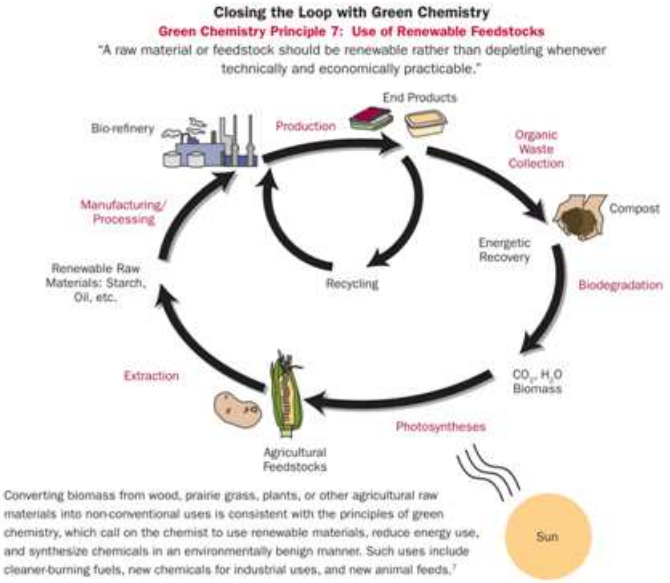

Table 1. Examples of implementation of green chemistry principles into practise

Nr	Principle	Examples:
1	Prevention	Use of solvent-less sample preparation techniques [2]
2	Atom Economy	Hydrogenation of carboxylic acid to aldehydes using solid catalysts
3	Less Hazardous Chemical Syntheses	Adipic acid synthesis by oxidation of cyclohexene using hydrogen peroxide [3]
4	Designing Safer Chemicals	New, less hazardous pesticide (e.g. Spinosad) [4]
5	Safer Solvents and Auxiliaries	Supercritical fluid extraction, synthesis in ionic liquids [5]
6	Design for Energy Efficiency	Polyolefins – polimer alternative to PWC (polimerization may be carried with lower energy consumption) [6]
7	Use of Renewable Feedstocks	Production of surfactants [7]
8	Reduce Derivatives	On-fiber derivatization vs derivatization in solution in sample preparation [8]
9	Catalysis	Efficient Au(III)-catalyzed synthesis of b-enaminones from 1,3-dicarbonyl compds. and amines [9]
10	Design for Degradation	Synthesis of biodegradable polymers [10]
11	Real-time analysis for Pollution Prevention	Use of in-line analyzers for wastewater monitoring
12	Inherently Safer Chemistry for Accident Prevention	Di-Me carbonate (DMC) is an environmentally friendly substitute for di-Me sulfate and Me halides in methylation reactions [11].

Examples of Implementation of Green : Chemistry Principles into Practise In some industrial chemical processes, not only waste products but also the reagents used for the production, may cause a threat to the environment. The risk of exposure to hazardous chemical compounds is limited in daily work by protective equipment such as goggles, breathing apparatus, face-guard masks, etc. According to the principles of green chemistry, a threat can be eliminated in a simpler way, by applying safe raw materials for production process. Large amounts of adipic acid [HOOC(CH2)4 COOH] are used each year for the production of nylon, polyurethanes, lubricants and plasticizers. Benzene — a compound with convinced carcinogenic properties — is a standard substrate for the production of this acid. Chemists from State University of Michigan developed green synthesis of adipic acid using a less toxic substrate. Furthermore, the natural source of this raw material — glucose — is almost inexhaustible. The glucose can be converted into adipic acid by an enzyme discovered in genetically modified bacteria [12]. Such a manner of production of this acid guards the workers and the environment from exposure to hazardous chemical compounds.

Green chemistry tries, when possible, to utilize renewable feedstocks as raw materials. From the point view of green chemistry, combustion of fuels obtained from renewable feedstocks is more preferable than combustion of fossil fuels from depleting finite sources. For example, many vehicles around the world are fuelled with diesel oil, and the production of biodiesel oil is a promising possibility. As the name indicates, biodiesel oil is produced from cultivated plants oil, e.g. from soya beans. It is synthesized from fats embedded in plant oils by removing the glycerine molecule- a valuable raw material for soap production

The great threats to the environment are organic sol vents applied in many syntheses. They are released into the environment by a volatilization process, especially in the case of volatile organic compounds (VOCs) and as a result of leakage. The emission of such compounds is significant because in many syntheses their amounts exceeds the quantity of reagents. The new solutions for practical synthesis aim at complete elimination of sol vents or to substitute the compounds belonging to VOCs by cheap technological media, harmless for humans and the environment. The use of supercritical fluids (SCFs) in chemical processes is becoming more and more prevalent [13- 17]. The term “supercritical fluids” comprises the liquids and gases at temperatures and pressures higher than their critical temperatures and pressures.

Above the critical point the liquid-vapour phase boundary disappears while the formed phase exhibits properties between those of gas and liquid. High compressibility of supercritical fluids in the vicinity of the critical point makes it easy to adjust density and solution ability by a small change of temperature or pressure. Due to this, the supercritical fluids are able to dissolve many compounds with different polarity and molecular mass. Among many possible supercritical fluids, fulfilling the green chemistry demands as the reaction media are carbon dioxide ($scCO_2$) and water (scH_2O)Carbon dioxide as a supercritical fluid is most frequently used as medium for reactions. It is inflammable, easily available (from natural sources, from power engineering) and cheap. Its application gives considerable energy savings because the critical point is easy to reach due to a low evaporation heat of CO2. Carbon dioxide as a supercritical fluid dissolves non-polar compounds and some polar (e. g. methanol, acetone) like fluorocarbon solvents. Discovery of a new surfactant with high surface activity in super critical carbon dioxide opened a way to new processes in textile and metal industries and for dry cleaning of clothes. Micelle Technologies Company offers technology for removal of stains using liquid carbon dioxide instead of the perchloroethylene more commonly applied.[18]

The extraction of pesticides from soil samples using

accelerated solvent extraction is a good example of an analytical procedure fulfilling the rules of green chemistry. [19]

Teaching of Green Chemistry.

The main rule: Teaching must be in harmony with practice. The question of how to educate the future generation of chemists possessing the skill and knowledge to practice environmentally friendly chemistry lies in the centre of educational materials related to green chemistry [20]. Education is especially important in the popularization of green chemistry. It is realized both at the level of academia and on the level of pro-environmental education for broad circles of society. Different international institutions, i.e. the American Chemical Society (ACS) and Polish Chemical Society (PTChem), are active in publishing materials that promote the rules and achievements of green chemistry. The green chemistry program should lead to sustainability by designing and using the methods in which natural raw materials will be economically processed, rational usage of energy sources, elimination of hazardous gaseous, liquid and solid wastes and by introduction of safety products for man. The popularization of green chemistry in schools, among the workers at plants of chemical industry and distributors of chemical products is also very important. The broad usage of green chemistry achievements will enable us to balance eco-development profitable for society, economy and the environment. The numerous educational materials, available currently on market [21] and on the Internet, are very useful in everyday teaching of green chemistry principles, e.g.:

GreenChemistryResources,ACShomepage: www.acs.org/education/greenchem
GreenChemistryInstitute:chemistry.org/greenchemistry institute
EPAGreen Chemistry Program: www.epa.gov/green chemistry Green Chemistry,
A journal of the Royal Society of Chemistry: www.rsc.org/is/journals/current/green/greenpub.htm
Green Chemistry Network: chemsoc.org/networks/gcn
Chemical Education Foundation: www.chemed.org
Chemical Industry Education Centre: www.york.ac.uk/org/ciec Conclusion

Conclusions : Green chemistry is not a new branch of science. It is a new philosophical approach that through application and extension of the principles of green chemistry can contribute to sustainable development. Presently it is easy to find in the literature many interesting examples of the use of green chemistry rules. They are applied not only in synthesis, processing and using of chemical compounds. Many new analytical methodologies are also described which are realized according to green chemistry rules. They are useful in conducting chemical processes and in evaluation of their effects on the environment. The application of proper sample preparation techniques, (e.g. SPME, SPE, ASE) allows us to obtain precise and accurate results of analysis.[21]

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Impact of Vocational Education on Indian Economy

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Abstract: The biggest resource on this living planet is human, when a particular country that is India is so rich in terms of resources is still facing crisis in happiness, well-being and development. We lack all types of international index namely HDI, GHI, MPI etc. which measures the progress in terms of socio-economic development. Why so? The possible reason is mismanagement of human resources due to that we failed to derive the demographic dividend. Or the social structure of our contrary which historically prohibits the majority of resources to remain dumped. Yes, India has both possible reason to remain as regressive state. In this paper we will be going to study each factor and how vocational education will help especially when we have tariff trouble and left with sole option of Atmanirbhar to sustain our economy.

Keywords: GHI, HDI, MPI, VET, ICT.

Introduction - The terms *vocation* and *career* are often used interchangeably. Vocational education primarily focuses on teaching procedural knowledge—that is, practical skills and techniques—unlike declarative knowledge, which emphasizes theoretical and conceptual understanding typical of broader academic or scientific fields in tertiary education.Vocational education may be offered at both the secondary and post-secondary levels, often integrated with apprenticeship systems. Increasingly, it is being recognized through mechanisms such as recognition of prior learning and academic credit transfers toward higher education programs. However, vocational education itself is still not generally classified as part of the traditional higher education framework.

Historically, until the late twentieth century, vocational training was oriented toward specific trades—such as automotive repair or welding—and was often associated with lower social status, leading to a degree of stigma. It evolved from the long-standing apprenticeship model of skill learning.Today, as economies grow more specialized and demand advanced technical expertise, both governments and industries are investing heavily in vocational training. This includes publicly funded training institutions and subsidized apprenticeship or traineeship programs for businesses. At the post-secondary level, vocational education is commonly delivered through institutes of technology or community colleges (AICTE, 2025).

India, with an average age of 28.7 years, is among the youngest nations in the world. This demographic advantage presents an opportunity for the country to position itself as the “Skill Capital of the World,” as envisioned by the Prime Minister, by equipping its youth with appropriate skills and converting this potential into a productive dividend. However, the higher education system in India continues to face persistent challenges related to access, equity, infrastructure, and employability. Studies indicate that only 10–15% of graduates possess employable skills (Chakrabarti & Prakash, 2016). This highlights the urgent need to strengthen the skill base of the workforce through high-quality vocational education and training (VET).

In this context, training institutes play a crucial role in harnessing the country’s demographic dividend. As trends, technologies, and work methodologies evolve rapidly, India’s working-age population must be continuously skilled, reskilled, and upskilled to remain relevant. Building a robust and scalable skilling infrastructure—considering the vast size, sectoral diversity, and geographic spread of the population and economic activities—is therefore essential. As India transitions toward accelerated economic growth, ensuring a skilled workforce will be critical to sustaining this momentum.The evolution of vocational education and training (VET) in India shows that it has been a subject of active debate for over a century. Various committees and commissions, both before and after Independence, have recommended comprehensive reforms to strengthen the VET framework. The establishment of Industrial Training Institutes (ITIs) in the 1950s marked a major milestone in India’s vocational education system. These institutes operate under the regulation of the National Council for Vocational Training (NCVT), which was constituted in 1956 as the first national-level regulator for the VET ecosystem.ITIs were established with the objective of

ensuring a steady supply of skilled manpower for both the public and private sectors while reducing unemployment among educated youth through skill-oriented education and disciplined training. They offer one- or two-year courses under the Craftsman Training Scheme (CTS), organized in a semester pattern and covering a wide range of economic sectors. These programs aim to equip trainees with fundamental trade skills and technical knowledge, preparing them for employment as semi-skilled or skilled workers, or for self-employment, thereby fostering lifelong career opportunities(Aayog, 2023).

Index Analysis: Measurement of progress of Indian economy is measured by the global competitiveness in terms of our human capability and capacity so that the gap between actual and potential will be bridged.

Index	Key Dimensions	Common Elements
Multidimensional Poverty Index(MPI)	- Health (nutrition, child mortality) - Education (years of schooling, school attendance) - Living standards (sanitation, electricity, housing, assets)	Health, Education, Living standards
Global Hunger Index (GHI)	Undernourishment - Child wasting and stunting - Child mortality	Health and Nutri tion
Human Develop-ment Index (HDI)	Health (life expectancy) - Education (mean & expected years of schooling) - Income (GNI per capita)	Health and Educa tion
Gross Happiness Index (GNH)	Psychological well-being - Health - Education - Living standards - Good governance - Cultural&ecological diversity	Health, Education, Living standards

The most common element is the human health and education. According to World Health Organisation (WHO),*"A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"*(WHO, 1948).

Education is the basis of both income and health by which we can assure our human dignity. Therefore to make human resources a more productive we need to invest in her education, especially the education which equip her to bring return that is practical and scientific for which government of India have many skill and vocational educational programme.

Role of ICT: Imparting vocational education across the region, geographies and with demographics with cost effective manner is only possible through the Information Communications Technologies. Technologies will enable the people to acquire skills which have been directly related to their lives and livelihoods. For that there are few pre-requisites are sine-qua-non namely digital infrastructure which provide meaningful universal internet coverage, digital literacy plus minimum secondary school education. Without these minimum essential requirement, it is difficult to rollout vocational education to all so that no one left without skills which makes them employable or industry ready labour work force.

Digital connectivity means being able to access and use the internet through devices like computers, tablets, or mobile phones. The main goal is to make these devices and applications easy, safe, and affordable, so that people can use them to create economic and social value.In developing countries, 84% of people aged 15+ own a mobile phone, while 64% have used the internet in the past three months. Among these internet users, 80% use social media.Looking at India, 66% of people own a mobile phone, and 46% have used the internet. Among these internet users, 71% are active on social media.This shows a clear gap across developing economies. Among five neighboring countries—Bangladesh, Nepal, India, Pakistan, and Sri Lanka—India ranks: (i) 4th in mobile ownership (66%), (ii) 2nd in internet use (46%), and (iii) 5th in social media use (71%).According to Indian Council for Research on International Economic Relations (ICRIER) that every 10% growth in internet penetration can rise 3.2% increased rate of growth in State per capita GDP, which in turn helps in reducing poverty.

Possible solutions and Conclusion: It is evident from the above that India faces a serious challenge in capitalising its human resources. To transform human resources into human capital, we must invest in their health and education, and empower them with modern ICT tools and technologies so that they can meaningfully contribute to the national economy.

Education yields long-term benefits not only for individuals but also for society as a whole. However, a growing concern today is the perception that education no longer guarantees employment. Many families question the purpose of education when skilled and educated individuals still remain unemployed. This mindset itself has become a major obstacle to progress.Furthermore, it is impossible to exaggerate the critical role that teachers play in providing students with access to ICT resources and advancing their educational paths, underscoring the significance ofteacher preparation programs and continuous professional development activities. Vocational education may adapt to the changing needs of the workforce in the twenty-first century by tackling these issues and seizing the chances provided by ICT integration, guaranteeing that students

have the abilities and proficiencies required for professional success

Two decades ago, a similar narrative was used against women — "Why educate girls when they are destined to stay at home and raise children?" Yet, many parents challenged this stereotype and educated their daughters. The results are visible: women's participation in the organised sector has risen from less than 1% to around 8–10%. Though this is progress, it is still far from enough, as over 40% of women remain outside the sphere of economic activity — a challenge that affects men as well, though to a lesser degree.

One truth must be recognised — education is the foundation of life. Its value goes far beyond employment; it shapes awareness, health, and social well-being. An educated person knows what is right or wrong for their life and community.

Therefore, the path forward rests on three pillars:

I. Education – the base of human development;
II. Digital literacy – the bridge to opportunities in the modern world; and
III. Human values – the compass that ensures progress remains humane and inclusive.

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Bridging Skill Gaps in India: An Analysis of Vocational Program Implementation Under NEP 2020

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Abstract: The implementation of vocational programs in India presents a complex landscape of challenges and opportunities under the National Education Policy (NEP) 2020. This research examines systemic barriers—such as infrastructure deficits, inadequate teacher training, and social stigma—alongside transformative possibilities like industry-academia partnerships and technology-enabled learning. While the policy targets 50% vocational exposure by 2025, current enrollment remains under 5%, necessitating strategic interventions to bridge the gap between policy and practice. This paper explores the transition from a certification-based approach to a competency-based model, emphasizing the need for a paradigm shift in the Indian educational psyche.

Introduction and the Demographic Dividend: The concept of Vocational Education and Training (VET) has evolved from being a secondary alternative to becoming a critical pillar of national economic strategy. In the context of India, the "Demographic Dividend" refers to the fact that India has one of the youngest populations globally, with over 62% of its population in the working-age group (15–59 years) and more than 54% below the age of 25. However, this dividend risks becoming a "demographic disaster" if the youth are not equipped with employable skills.

Global Benchmarking and the Indian Reality- The skills gap in India is stark when compared to developed economies. Currently, only about 4.1% of the Indian workforce has received formal vocational training. In contrast, countries that have achieved high-income status often prioritize skill-based learning early in the educational cycle. For instance, South Korea reports 96% of its workforce as vocationally trained, while Japan and Germany stand at 80% and 75%, respectively. This discrepancy highlights why Indian graduates often struggle with "employability" despite holding formal degrees.

The NEP 2020 Vision-The National Education Policy 2020 seeks to dismantle the silos between "academic" and "vocational" streams. It mandates that vocational education be integrated into all educational institutions—schools, colleges, and universities—in a phased manner.

1. **Early Exposure:** Starting from Grade 6, students will be introduced to "bagless days" where they engage with local vocational experts (potters, gardeners, electrics, etc.).
2. **Target 2025:** The policy sets an ambitious goal: by 2025, at least 50% of learners through the school and higher education system shall have exposure to vocational education. This requires a massive scaling of existing infrastructure and a complete reimagining of the curriculum.

Historical Context and Theoretical Framework

Evolution of Policy- Vocational training in India is not a new concept; however, its formalization has been historically weak. In ancient India, the *Gurukul* and apprenticeship systems were the primary modes of skill transfer. During the British era, the education system shifted toward producing administrative clerks, sidelining manual and technical skills.

Post-independence, the Kothari Commission (1964-66) was the first major body to recommend the "vocationalization" of secondary education. While the 1986 National Policy on Education tried to implement these suggestions, the programs were largely unsuccessful. They were often viewed as "terminal" tracks for students who could not succeed in mainstream academics, leading to a hierarchy of esteem where vocational training was seen as "lesser than."

Theoretical Framework: Human Capital Theory This research is grounded in **Human Capital Theory**, pioneered by economists like Gary Becker and Theodore Schultz. The theory posits that education and training are investments that increase an individual's productivity. In the 21st-century "Knowledge Economy," human capital is not just about literacy but about *competency*. NEP 2020 aligns with this by shifting the focus from "what one knows" to "what one can do," thereby reducing structural unemployment where jobs exist but the workforce lacks the specific skills to fill them.

Multidimensional Challenges in Implementation: Despite the robust framework of NEP 2020, the journey

from policy to classroom faces significant friction.

Infrastructure and Digital Divide: The physical reality of Indian schools poses a major hurdle. Vocational education requires specialized labs, equipment, and high-speed internet—resources that are disproportionately distributed. In rural India, where the majority of the student population resides, the lack of electricity and hardware makes "Technology-Enabled Learning" difficult. Without a massive infusion of capital into rural infrastructure, the vocational gap between urban and rural youth will only widen.

Teacher Capacity and Professional Stature: The success of any educational reform depends on the frontline executors: the teachers. Currently, India faces a dual crisis in vocational instruction:

1. **Lack of Specialized Training:** Most school teachers are trained in traditional pedagogy. They lack the "hands-on" industry experience required to teach modern skills like data analytics, solar panel installation, or advanced hospitality.
2. **The Contractual Trap:** A significant portion of vocational instructors are hired on a short-term, contractual basis with lower pay than "regular" academic teachers. This creates a lack of job security, leading to high turnover and low motivation.
3. **Regulatory Rigidity:** Until recently, the system made it difficult for a master artisan or an industry expert to teach in a school because they lacked a B.Ed. degree, despite having superior practical knowledge.

Socio-Cultural Barriers and Industry Disconnect: Perhaps the most difficult barrier to overcome is the **"Mindset Gap."** In Indian society, white-collar jobs are culturally prioritized. Vocational paths are often stigmatized as being for "dropouts" or lower socioeconomic classes. Furthermore, there is a documented **Industry Disconnect**. Since the inception of the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) in 2015, over 1.6 crore youth have been trained. However, the placement rate remains below 15%. This is largely because the training provided is often outdated or does not match the specific needs of local industries, leading to "certified but unemployed" youth.

Strategic Opportunities under NEP 2020: While the challenges are daunting, NEP 2020 provides several "game-changing" mechanisms to revitalize the system.

Seamless Integration and the National Credit Framework (NCrF): One of the most transformative aspects of NEP 2020 is the introduction of the National Credit Framework. This allows for **Horizontal and Vertical Mobility**. A student can take a vocational course in Grade 11, earn credits, and later use those credits to enter a mainstream degree program. This "mainstreaming" removes the "dead-end" nature of vocational education, ensuring that choosing a skill-based path does not close the door to higher education.

The Hub and Spoke Model: To solve the infrastructure crisis, the government is promoting the "Hub and Spoke" model.

1. **The Hub:** An existing Industrial Training Institute (ITI), Polytechnic, or well-equipped private industry center.
2. **The Spoke:** Surrounding local schools that lack equipment. Students from the "Spoke" schools travel to the "Hub" for practical sessions. This optimizes the use of expensive machinery and ensures that even small rural schools can offer high-quality vocational training without needing an on-site lab. Pilot programs in states like Odisha and Madhya Pradesh have already shown promising results in maximizing resource utilization.

Technology and Quality Assurance: Digital platforms are being used to standardize vocational content.

1. **Skill India Digital:** A unified platform that aggregates all skilling initiatives, providing a "digital CV" for students.
2. **NCVET and NSQF:** The National Council for Vocational Education and Training (NCVET) now oversees the National Skills Qualifications Framework (NSQF). By standardizing "Levels" (from Level 1 to 10), employers can be certain of what a candidate actually knows, regardless of where they were trained.

Recommendations and Conclusion

Key Recommendations for Stakeholders: To bridge the gap between the vision of 50% exposure and the current reality, the following interventions are critical:

1. **Industry-Integrated Curriculum:** Every district should have an "Industry Advisory Board" consisting of local employers who review vocational curricula annually. This ensures that students are learning skills that are actually in demand (e.g., Drone piloting in agricultural zones).
2. **Corporate Social Responsibility (CSR) Synergy:** The government should incentivize corporations to use their CSR funds to "adopt" rural schools, providing them with modern digital labs and trainers.
3. **Teacher Professionalization:** Introduce a "Vocational Instructor" cadre with pay parity to academic teachers. Encourage "Lateral Entry" for industry professionals to teach in schools part-time.
4. **Gamification and Awareness:** To fight social stigma, vocational skills should be celebrated through "Skills Competitions" (similar to WorldSkills) at the district and state levels.
5. **Offline-First Digital Content:** Given the internet disparity, vocational modules should be developed as "Offline-First" apps that can be pre-loaded onto tablets, allowing students in remote areas to learn via simulations.

Conclusion: NEP 2020 provides the most comprehensive roadmap for vocational education in India's history. However, policy on paper does not equate toproficiency in the workforce. The transition from a "degree-obsessed" society to a "skill-valuing" society requires more than just government funding; it requires a collective shift in the mindset of parents, educators, and employers. By addressing infrastructure deficits, empowering teachers, and aligning training with the "Industry 4.0" landscape, India

can finally capitalize on its demographic dividend and become the "Skill Capital of the World." The window of opportunity is narrow, and the time for strategic implementation is now.

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Various Dimensions of Vocational Education

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Abstract: This paper provides a condensed yet exhaustive analysis of vocational education—also known as Career and Technical Education (CTE) or Technical and Vocational Education and Training (TVET). It explores its evolution from a tool of social stratification into a modern driver of economic growth and workforce development. The research highlights TVET's significant economic impact in bridging skills gaps and its social potential for upward mobility, despite persistent societal stigmas. Furthermore, it details pedagogical frameworks like work-integrated learning, analyzes international models such as Germany's dual system, and assesses the transformative influence of technologies like AI and VR. Concluding with policy recommendations, the analysis positions vocational education at the center of the "reskilling revolution" and the transition to a sustainable "green economy."

Introduction: The Modern Landscape of Vocational Education: Vocational education is a vital learning stream that prepares individuals for specific careers through the acquisition of practical, job-specific skills. Unlike traditional academic education, which stresses theoretical abstraction, modern vocational education aims to make learners "work-ready." The field is globally transitioning its terminology—such as adopting CTE in the US and TVET globally—to rebrand itself as a high-skill pathway offering parity with academic routes. In today's globalized economy, robust investment in TVET is no longer a peripheral concern but a central pillar of economic policy. It addresses pervasive "skills gaps" by aligning classroom learning with labor market needs, providing the agility to upskill workforces in response to rapid technological shifts, and ensuring sustained national economic resilience.

The Historical Trajectory: From Stratification to Integration: The origins of vocational education lie in the ancient apprenticeship model, which was formalized into school-based trade training during the Industrial Revolution to meet the demands of a rapidly changing economy. Early legislative frameworks, such as the 1917 Smith-Hughes Act in the U.S., legitimized these programs but inadvertently established a legacy of social tracking. Tools like aptitude testing frequently steered wealthier students toward liberal arts and marginalized students toward vocational tracks, creating a two-tiered system that stifled social mobility. Recognizing these flaws, late 20th-century reforms fundamentally shifted the paradigm. Modern legislation, like the Perkins Act, mandates a "coherent sequence of courses" that integrates academic and vocational content, repudiating rigid tracking and establishing CTE as a seamless, high-quality option for all students.

Economic Dimensions: Fueling Workforce Development: Vocational education drives economic development by directly connecting human capital with industry demands. By mitigating the "skills gap," TVET reduces youth unemployment and enhances individual employability. Beyond individual employment, a skilled workforce is fundamentally more productive and serves as a catalyst for innovation. Workers with deep technical understanding improve output quality and adapt swiftly to industrial advancements, translating to a significant positive impact on a nation's Gross Domestic Product (GDP). Furthermore, vocational education offers a rapid and highly efficient return on investment (ROI). Students benefit from shorter, less expensive programs and faster job entry, while governments and businesses benefit from increased tax revenues, reduced social support costs, and savings on foundational training for new hires.

Social Dimensions: Mobility, Equity, and Stigma: TVET serves as a powerful engine for social and economic mobility. By offering accessible and affordable pathways to lucrative careers, it helps marginalized groups break cycles of poverty. However, achieving true inclusivity remains a challenge due to structural barriers and the deep-seated stigma surrounding skilled trades. This stigma—fueled by parental bias toward four-year degrees, outdated media portrayals, and gender biases—perpetuates the false narrative that vocational paths are a secondary option for those who are not "college material." Overcoming these misconceptions is vital. Modern skilled trades often surpass traditional university graduates in job satisfaction and early earning potential, making the cultural destigmatization of

CTE an urgent priority for educators and policymakers.

Pedagogical Dimensions: Evolving Methodologies: Modern vocational pedagogy has shifted from traditional knowledge transmission to learner-centered, constructivist models focused on competency. *Work-Integrated Learning (WIL)* and the modern apprenticeship form the core of this approach, combining paid on-the-job training with technical classroom instruction to ensure authentic skill acquisition. Additionally, *Competency-Based Training (CBT)* replaces traditional "seat time" with demonstrated mastery of specific skills, allowing learners to advance at their own pace and guaranteeing to employers that graduates possess industry-validated capabilities. Finally, the use of project-based learning and high-fidelity simulations provides safe, controlled environments for students to practice complex, high-risk skills (e.g., healthcare, aviation), bridging the gap between theory and practical competence.

Global Dimensions: International Systems and Linkages: Vocational systems vary globally, yet comparative analysis reveals that the strength of the education-employment linkage is the universal determinant of success.

1. **The Dual System (Germany, Switzerland):** Shares training responsibility between the state (theory) and private industry (apprenticeships). Its deep integration ensures high relevance and smooth school-to-work transitions.
2. **The School-Based Model (France):** Centralizes training within public vocational schools, offering standardized curricula but risking a disconnect from immediate workplace needs.
3. **The Market-Driven Model (US, UK):** Decentralized and flexible, relying on diverse providers based on market demand, though it can suffer from variable quality. Ultimately, successful policy adaptation does not mean blindly copying a foreign model, but rather institutionalizing collaboration to ensure employers actively co-design curricula and assessment standards.

Technological Dimensions: Innovation in Training: Technology is fundamentally reshaping vocational education, altering both pedagogical methods and in-demand skills. Digital tools like Virtual Reality (VR) and Augmented Reality (AR) create safe, immersive environments for mastering complex procedures, from virtual surgeries to operating manufacturing machinery. Simultaneously, Artificial Intelligence (AI) enables adaptive learning platforms that provide real-time, customized feedback to students. To prepare the workforce for *Industry 4.0/5.0*, TVET must shift from merely teaching *with* technology to teaching *about* it. Curricula must embed digital literacy and interdisciplinary skills to ensure graduates can navigate cyber-physical systems, IoT, and automated environments, thereby transforming the outdated image of vocational education into a cutting-edge sector.

Systemic Challenges: Funding, Relevance, and Quality: The TVET sector faces a vicious cycle of interconnected systemic challenges. *Inadequate funding* limits capital-intensive programs from upgrading specialized workshops and industry-standard equipment, leading to a reliance on obsolete infrastructure. This underfunding directly impacts *curriculum relevance*; as technological changes accelerate, failure to update training environments results in a "skills mismatch" that damages the sector's credibility. Compounding these issues is the need for *robust Quality Assurance (QA)*. Without stringent, standardized QA frameworks that track instructor qualifications and graduate employment rates, low-quality providers persist, further deteriorating public trust and making it politically difficult to secure necessary funding.

The Future Horizon: Automation and the Green Economy: Vocational education is uniquely positioned to guide the workforce through the dual megatrends of automation and environmental sustainability. The AI-driven "Reskilling Revolution" necessitates a shift from front-loaded education to a lifelong learning ecosystem centered on micro-credentials and human-centric skills. Concurrently, the transition to a sustainable economy demands the cultivation of "Green Skills." TVET is central to ensuring a "Just Transition" by training professionals in renewable energy, sustainable agriculture, and eco-friendly construction. By greening the curriculum and expanding flexible retraining pathways, vocational education can turn the disruptions of automation and climate change into opportunities for inclusive economic growth.

Conclusion and Policy Recommendations: Vocational education has evolved into an indispensable, high-skill pathway critical for global economic resilience and social mobility. To fully realize its potential and overcome systemic hurdles, a coordinated effort among policymakers, educators, and industry is required:

1. **Rebrand and Destigmatize:** Launch public campaigns alongside industry partners to highlight the high earning potential and vital societal role of 21st-century skilled trades.
2. **Strategic Funding:** Treat TVET as a high-return national investment by establishing predictable, adequate funding for equipment upgrades and competitive instructor salaries.
3. **Institutionalize Linkages:** Mandate industry participation in curriculum design and standard-setting, and utilize tax incentives to encourage small and medium enterprises (SMEs) to offer apprenticeships.
4. **Agile, Future-Focused Curriculum:** Utilize real-time labor market data to continuously update curricula, ensuring the mandatory integration of digital literacy (AI/automation) and green skills across all programs.

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Importance of Vocational Education for Startup and Self-Employment

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Abstract: Vocational education and training (VET) equips youth and adults with practical, job-ready skills that enhance employability, entrepreneurship, and startup creation. This paper examines the role of vocational education in promoting self-employment, explores policy frameworks and institutional models, identifies challenges, and provides recommendations for strengthening linkages between VET and entrepreneurship ecosystems. Drawing on evidence from India and global initiatives, this paper highlights the importance of industry alignment, entrepreneurship modules, financial and incubation support, and targeted measures for women and disadvantaged groups.
Keywords: Vocational education, TVET, entrepreneurship, startups, self-employment, skills, India.

Introduction - In pursuit of inclusive growth and sustainable employment, vocational education and training (VET) has emerged as a strategic tool. VET emphasizes competency-based learning that aligns with labour market demands, bridging the gap between formal education and job-ready skills. In India, youth unemployment remains a challenge, and VET provides a pathway to self-reliance through entrepreneurship and startup creation. UNESCO's TVET Strategy (2022–2029) highlights VET's role in fostering green and digital skills, entrepreneurial mindsets, and economic resilience [1].

Importance of Vocational Education for Startups and Self-Employment: VET contributes to self-employment by offering practical skills, reducing entry barriers, and fostering entrepreneurial competence [2][3].

Practical Skills: VET programs teach hands-on skills in sectors such as tailoring, food processing, electrical work, and digital freelancing, directly applicable to small business operations [3].

Entrepreneurial Competence: Modules on business planning, accounting, marketing, and compliance prepare trainees to launch and sustain enterprises [2].

Faster Transitions: VET graduates adapt more quickly to self-employment, particularly when formal jobs are scarce [3].

Mechanisms Promoting Entrepreneurship:

1. **Simulated Workplaces:** Realistic training environments build confidence and tacit knowledge.
2. **Industry Partnerships:** Collaborations provide mentorship, market exposure, and client networks [4].
3. **Incubation Linkages:** Co-located incubators allow graduates to test ideas with lower risk and access guidance and seed funding [5].
4. **Financial Literacy and Credit Access:** Integrating financial education and microcredit schemes supports startup feasibility [4].

Policy and Institutional Support

Global Initiatives: UNESCO emphasizes entrepreneurship and youth employability in VET strategies [1].

European Models: Cedefop reports demonstrate entrepreneurship competencies embedded in European VET curricula [2].

Indian Programs:

1. **PMKVY:** Short-term training aligned with market needs [5].
2. **STRIVE:** Strengthens industry–VET linkages [4].
3. **NSDC:** Facilitates private sector involvement in skill development.
4. **Startup India / Stand-Up India:** Provides financial and mentoring support to entrepreneurs [5].

Challenges:

1. **Curriculum Relevance:** Rapid technological changes require frequent updates [6].
2. **Limited Industry Engagement:** Weak employer participation reduces mentorship and internships.
3. **Access to Finance:** Many skilled graduates lack startup capital [4].
4. **Social and Gender Barriers:** Women and marginalized groups face mobility, safety, and societal constraints [6].

Case Studies and Best Practices:

1. **Integrated Incubation-VET Models:** Programs combining skills training with incubation report higher enterprise success rates [5].
2. **Challenge-Based Learning:** Addressing local problems fosters entrepreneurial intent among learners [8].
3. **Digital Skill Hubs:** Initiatives like Skill India Digital enable remote work and freelancing.
4. **Women-Focused Programs:** Schemes such as Mahila E-Haat and Udyam Sakhi promote women entrepreneurs [6].

Table 1: Example of VET Programs and Entrepreneurial Outcomes

Program	Skills Taught	Startup/Employment Outcomes	Refer -ence
PMKVY	Digital, Technical	30% trainees start micro-enterprises	[5]
STRIVE	Apprenticeships, Business	25% self-employment	[4]

Recommendations:

1. Embed entrepreneurship modules in all VET courses [2].
2. Strengthen industry partnerships for mentorship and curriculum relevance [4].
3. Integrate incubation facilities and financial support [5].
4. Focus on digital and green skills to align with emerging sectors [1].
5. Implement gender-sensitive measures including safety and targeted funding [6].
6. Use labor market intelligence to guide program design [7].

Conclusion: Vocational education is a strategic lever for economic empowerment, self-employment, and startup development. Alignment with industry needs and embedding entrepreneurship education can unlock the potential of India's youth and marginalized communities. Supported by strong policies and institutional frameworks, VET can drive inclusive growth, innovation, and sustainable livelihoods.

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Challenges and Opportunities in Vocational Education in India

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Abstract: Vocational education plays a crucial role in bridging the gap between traditional academic learning and the practical skills demanded by the job market. However, implementing vocational courses effectively presents both significant challenges and promising opportunities. One of the key challenges is the lack of infrastructure and skilled instructors, particularly in rural and underdeveloped regions. Inadequate funding, outdated curricula, and limited industry collaboration further hinder the quality and relevance of vocational training. Additionally, societal perceptions that favour academic degrees over skill-based education contribute to low enrolment and interest in vocational programs. Despite these challenges, vocational education offers immense opportunities for economic development and individual empowerment. It can reduce youth unemployment, address the skills mismatch in the labour market, and support the growth of small and medium enterprises (SMEs). With the advent of technology and digital platforms, vocational training can now be delivered more flexibly and at scale, reaching wider and more diverse populations. Public-private partnerships, curriculum modernization, and government initiatives like skill development missions can enhance the effectiveness and appeal of vocational programs.

To fully realize these opportunities, a strategic and inclusive approach is required. This involves aligning vocational curricula with industry needs, investing in teacher training, and promoting vocational education as a viable and respected career pathway. By overcoming existing barriers and leveraging technological advancements, vocational education can play a transformative role in shaping a more skilled, employable, and resilient workforce.In this paper, we will focus on the ways by which we can overcome the existing barriers of vocational education.

Introduction - Vocational programs, also known as skill-based or career-oriented training programs, play a crucial role in the educational and economic landscape of India. These programs are designed to equip individuals with specific skills required for various trades and industries such as carpentry, electrical work, tailoring, computer applications, hospitality, healthcare, and more. Unlike traditional academic education, vocational training focuses more on practical knowledge and hands-on experience, making it highly relevant for employment.

In India, where a significant portion of the population comprises youth, vocational education has become an essential tool for addressing the growing demand for skilled labour. The Indian government has launched several initiatives to promote vocational training, including the Skill India Mission, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), and the National Skill Development Corporation (NSDC). These initiatives aim to empower young people by providing them with market-relevant skills, improving their employability, and reducing the mismatch between industry requirements and the skill set of job seekers.

One of the main benefits of vocational programs in India is employment generation. With millions of students graduating from schools and colleges each year, not all find suitable employment due to lack of practical skills. Vocational training fills this gap by offering targeted training in specific job roles. It opens doors to employment in sectors like construction, manufacturing, retail, healthcare, tourism, and information technology. For rural youth and school dropouts, vocational programs offer a second chance to gain meaningful employment and improve their socio-economic status.

Another significant advantage is the promotion of entrepreneurship. Many vocational courses focus on self-employment skills, encouraging individuals to start their own businesses. For example, someone trained in tailoring or beauty therapy can open their own shop or salon. This not only creates jobs for themselves but also has the potential to employ others, contributing to local economic development.

Vocational programs also promote inclusivity and empowerment. They are particularly beneficial for women, differently-abled individuals, and marginalized communities who may not have access to higher education. By gaining

vocational skills, these individuals can become financially independent and contribute actively to society.

Moreover, vocational training enhances the overall productivity of the workforce. Industries benefit from hiring trained professionals who require less time and resources for on-the-job training. This leads to better efficiency, higher quality output, and improved competitiveness of Indian businesses in the global market.

Despite these benefits, vocational education in India still faces challenges such as lack of awareness, limited infrastructure, and social stigma attached to non-academic careers. However, with increasing recognition of its importance, efforts are being made to integrate vocational education into the mainstream education system and improve its quality.

Barriers to Vocational Education in India : Vocational education is essential for equipping individuals with practical skills and knowledge necessary for specific trades or careers. In India, where unemployment and skill gaps persist despite a large youth population, vocational training holds the potential to transform the workforce and strengthen the economy. However, its growth and effectiveness face several barriers.

1. Social Stigma and Perception: Social stigma and perception often act as significant barriers in vocational education. Many communities view vocational training as inferior to traditional academic pathways, associating it with low-status or low-paying jobs. This perception discourages students and parents from considering vocational options, even when these programs offer practical skills and strong career prospects. As a result, vocational education suffers from under-enrolment and limited societal support. Changing these attitudes requires awareness campaigns, success stories of vocational graduates, and industry partnerships that highlight the value and dignity of skilled trades. Overcoming stigma is essential for creating an inclusive and effective education system.

2. Lack of Awareness: There is a widespread lack of awareness about vocational education options, career prospects, and government initiatives. Many students, especially in rural areas, are unaware of the vocational courses available to them or the benefits these programs can offer in terms of job readiness and employability. This lack of information contributes to low enrolment in vocational streams.

3. Poor Infrastructure and Facilities: Poor infrastructure and facilities significantly hinder the effectiveness of vocational education. Many training centres lack modern equipment, proper classrooms, and access to necessary tools, making it difficult for students to gain hands-on experience. Inadequate facilities also affect the motivation of both learners and instructors. Without a conducive learning environment, vocational education fails to meet industry standards, limiting students' employability. Addressing these issues is crucial to ensure quality training and to bridge the gap between education and the labour market.

4. Shortage of Qualified Trainers: The effectiveness of vocational training depends heavily on the quality of instructors. However, India faces a severe shortage of skilled and qualified vocational trainers. Many trainers lack industry experience or up-to-date knowledge of modern technologies, leading to a mismatch between training and actual industry needs.

5. Industry Disconnect: Industry disconnect poses a significant barrier in vocational training education by creating a gap between classroom instruction and real-world job requirements. When training programs lack input from industry experts or fail to adapt to evolving market demands, students may graduate with outdated or irrelevant skills. This misalignment reduces employability, undermines the value of vocational education, and highlights the need for stronger collaboration between educators and industry partners to ensure workforce readiness.

6. Fragmented Governance: Vocational education in India is managed by multiple ministries and bodies, including the Ministry of Skill Development and Entrepreneurship, Ministry of Education, and state-level authorities. This fragmentation results in overlapping roles, inconsistent policies, and poor coordination, affecting the overall effectiveness of vocational training programs.

7. Limited Career Progression: Vocational courses, while providing practical skills and immediate job opportunities, often face limited career progression. Many such programs focus on specific trades, offering little scope for higher education or managerial roles. Graduates may find themselves restricted to entry-level or technical positions with fewer chances for promotion compared to academic degree holders. The lack of recognition and industry linkage further hampers advancement. To improve career growth, vocational education must integrate lifelong learning, certification upgrades, and industry collaboration.

8. Gender Disparities: Despite growing awareness, societal norms and stereotypes often discourage girls from pursuing technical or mechanical trades, while boys rarely opt for care giving or fashion-related fields. Limited access to training facilities, safety concerns, and lack of female role models further deepen the divide. This imbalance restricts equal opportunities for skill development and employment, hindering social and economic progress. Promoting inclusivity and breaking gender bias are essential for equitable vocational growth.

Ways to Remove Barriers in Vocational Courses : Vocational education plays a vital role in developing a skilled workforce that meets the needs of various industries. However, many barriers—social, economic, institutional, and psychological—limit access and participation in vocational courses. Removing these barriers is essential to ensure inclusivity, equality, and employability for all sections of society. Several strategic measures can be

adopted to make vocational education more accessible, effective, and respected in society.

One of the foremost barriers to vocational education is the **social stigma** attached to skill-based training. Many students and parents still perceive vocational courses as inferior to academic degrees. To remove this misconception, there is a need for **awareness campaigns and counseling programs** in schools that highlight the importance, career opportunities, and dignity of labor associated with vocational education. Government initiatives like *Skill India* and *Make in India* should be promoted more actively through community outreach, success stories, and industry partnerships to enhance the image of vocational careers.
Another significant barrier is the **lack of financial support**. Many students, especially from rural and economically weaker backgrounds, cannot afford the costs of vocational training. To overcome this, the government and private sectors should expand **scholarship schemes, subsidized training, and financial aid programs**. Additionally, introducing income-linked loan repayment systems and paid apprenticeship opportunities can make vocational courses more financially viable and attractive to young learners.

Infrastructure and accessibility also pose major challenges. In several areas, vocational institutes lack proper equipment, updated curricula, and trained instructors. To remove this barrier, there should be **continuous modernization of training centers**, with well-equipped workshops, modern technology, and practical learning environments. Collaboration with industries can ensure that students receive hands-on experience aligned with real-world needs. Establishing more vocational training centers in remote and rural areas, along with mobile training units, can help bridge the urban-rural divide.

Another way to overcome barriers is by **integrating vocational education with mainstream schooling**. Under the National Education Policy (NEP) 2020, there is a growing emphasis on blending vocational and academic learning from the school level. By offering vocational subjects as part of the regular curriculum, students can develop both theoretical and practical skills early on. This approach will also normalize vocational learning as an equal and valuable educational pathway.

Teacher training and industry collaboration are equally crucial. Teachers and trainers must be regularly trained in emerging technologies, industry trends, and innovative teaching methods. Industry partnerships should be strengthened to design relevant curricula, provide internships, and ensure that students are job-ready. Involving local industries in training programs can also promote community participation and create employment opportunities within the region.

Finally, **digital learning platforms** can play a transformative role in removing geographical and accessibility barriers. Online vocational courses, e-labs, and virtual apprenticeships can reach learners in remote areas and those unable to attend physical institutions. Providing digital devices and internet access to disadvantaged students will further bridge the digital divide.

In conclusion, removing barriers in vocational education requires a **multi-dimensional approach** involving awareness, financial aid, infrastructure development, policy reform, and social acceptance. When vocational education is made accessible, affordable, and respected, it not only empowers individuals but also strengthens the nation's economy by creating a skilled and self-reliant workforce.
Conclusion: Vocational courses in India play a vital role in bridging the gap between education and employment. They equip students with practical skills, industry-specific knowledge, and hands-on training that enhance employability and self-reliance. With the growing demand for skilled workers in sectors like healthcare, technology, manufacturing, and services, vocational education has become essential for national development. Initiatives such as Skill India, PMKVY (Pradhan Mantri Kaushal Vikas Yojana), and the National Skill Development Corporation have strengthened this system by promoting skill-based learning across rural and urban areas. However, there is still a need for greater awareness, infrastructure, and industry collaboration to make vocational education more accessible and respected. By integrating vocational training with mainstream education and aligning it with market needs, India can empower its youth, reduce unemployment, and build a strong, skilled workforce capable of driving the nation toward sustainable growth and prosperity.

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नई शिक्षा नीति में रोजगारपरक शिक्षा की भूमिका : 'राष्ट्रीय शिक्षा नीति 2020: रोजगारपरक शिक्षा, आत्मनिर्भरता और कौशल विकास की धुरी'

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शोध सारांश – यह शोध पत्र राष्ट्रीय शिक्षा नीति (NEP) 2020 के केंद्रीय स्तंभ के रूप में रोजगारपरक शिक्षा की भूमिका का विश्लेषणात्मक अध्ययन प्रस्तुत करता है। नीति का मुख्य उद्देश्य भारत की शिक्षा प्रणाली को सैद्धांतिक ज्ञान-केंद्रित मॉडल से बदलकर एक कौशल-केंद्रित , व्यावहारिक और आत्मनिर्भरता उन्मुख प्रणाली में रूपांतरित करना है। विश्लेषण में कक्षा 6 से व्यावसायिक शिक्षा का मुख्यधारा में समावेशन, बहु-प्रवेश/निकास (MEES) प्रणाली, एकेडमिक बैंक ऑफ क्रेडिट (ABC), और कोडिंग एवं AI जैसे 21वीं सदी के कौशलों पर विशेष जोर जैसे महत्वपूर्ण प्रावधानों को शामिल किया गया है।

शोध के निष्कर्ष बताते हैं कि NEP 2020 में रोजगारपरक शिक्षा का प्रावधान कौशल अंतर को पाटने, श्रम की गरिमा स्थापित करने और छात्रों को उद्यमी बनाने की अपार क्षमता रखता है। हालाँकि, नीति के सफल क्रियान्वयन के लिए शिक्षक प्रशिक्षण, पर्याप्त बुनियादी ढाँचे में निवेश (GDP का 6% लक्ष्य), और व्यावसायिक शिक्षा से जुड़ी सामाजिक हीन भावना को दूर करने जैसी महत्वपूर्ण चुनौतियों पर ध्यान केंद्रित करना आवश्यक है। यह नीति यदि प्रभावी ढंग से लागू होती है, तो यह भारत की युवा शक्ति को एक उत्पादक कार्यबल में बदलकर देश की आर्थिक वृद्धि और वैश्विक प्रतिस्पर्धात्मकता में निर्णायक योगदान दे सकती है।

शब्द कुंजी – राष्ट्रीय शिक्षा नीति 2020, रोजगारपरक शिक्षा, व्यावसायिक शिक्षा, कौशल विकास, आत्मनिर्भरता, मल्टीपल एंट्रीएग्जिट, उद्यमिता।

प्रस्तावना – भारतीय शिक्षा प्रणाली लंबे समय से सैद्धांतिक ज्ञान और परीक्षा-केंद्रित मूल्यांकन पर निर्भर रही है, जिसके परिणामस्वरूप एक बड़ा कौशल अंतर उत्पन्न हुआ है। राष्ट्रीय शिक्षा नीति (NEP) 2020 इस समस्या के समाधान के लिए एक व्यापक ढाँचा प्रस्तुत करती है। इसका मूल लक्ष्य भारत के विशाल जनसांख्यिकीय लाभांश को एक कुशल कार्यबल में बदलना है। NEP 2020 में रोजगारपरक शिक्षा का उद्देश्य 2025 तक स्कूल और उच्च शिक्षा में 50% छात्रों को व्यावसायिक शिक्षा से जोड़ना है।[1] इस पेपर में हम नीति के प्रमुख प्रावधानों, इसके महत्व और कार्यान्वयन की चुनौतियों का गहन विश्लेषण करेंगे।

रोजगारपरक शिक्षा के संरचनात्मक प्रावधान – NEP 2020 ने शिक्षा के विभिन्न स्तरों पर व्यावसायिक और कौशल विकास को एकीकृत करने के लिए अभूतपूर्व बदलाव पेश किए हैं:

स्कूली शिक्षा में व्यावसायिक एकीकरण (कक्षा 6 से) – नीति कक्षा 6 से ही व्यावसायिक शिक्षा को मुख्यधारा के पाठ्यक्रम का अनिवार्य हिस्सा बनाने का प्रस्ताव करती है।स्थानीय कौशल पर जोररू छात्रों को स्थानीय व्यवसायों, कारीगरों, और NSQF (National Skills Qualifications Framework) से जुड़े कौशलों, जैसे कि कोडिंग, बागवानी, इलेक्ट्रॉनिक्स, आदि से परिचित कराया जाएगा।[5] इंटर्नशिप: छात्रों को सीखने के लिए वास्तविक कार्य वातावरण का अनुभव देने हेतु स्थानीय उद्योगों, कारीगरों और तकनीकी संस्थानों में 10 दिवसीय बैगलेस इंटर्नशिप अनिवार्य होगी। इससे 'श्रम की गरिमा' की भावना विकसित होगी।

उच्च शिक्षा में लचीलापन और क्रेडिट सिस्टम – उच्च शिक्षा को अधिक लचीला और रोजगारोन्मुखी बनाने के लिए दो प्रमुख पहल की गई हैं:

बहु-प्रवेश/निकास प्रणाली (MEES): यह प्रणाली छात्रों को अपनी आर्थिक या व्यक्तिगत आवश्यकताओं के अनुसार शिक्षा को बीच में छोड़ने और बाद में फिर से शुरू करने की स्वतंत्रता देती है।[2,9]

1 वर्ष पूर्ण होने पर: व्यावसायिक प्रमाणपत्र (Vocational Certificate)
2 वर्ष पूर्ण होने पर: व्यावसायिक डिप्लोमा (Vocational Diploma)
3/4 वर्ष पूर्ण होने पर: डिग्री

यह सुविधा उन छात्रों के लिए वरदान है जिन्हें कम समय में ही कौशल-आधारित प्रमाणन प्राप्त कर नौकरी बाजार में प्रवेश करना होता है।

अकादमिक बैंक ऑफ क्रेडिट (ABC): यह एक डिजिटल तंत्र है जो छात्रों द्वारा विभिन्न शैक्षणिक संस्थानों में अर्जित क्रेडिट्स को संग्रहीत करता है। यह सामान्य और व्यावसायिक पाठ्यक्रमों के बीच क्रेडिट पोर्टेबिलिटी सुनिश्चित करता है, जिससे छात्रों की ऊर्ध्वाधर और क्षैतिज गतिशीलता बढ़ती है।[3]

भविष्योन्मुखी कौशल और डिजिटल साक्षरता– NEP 2020 का फोकस 21वीं सदी के कौशल पर है-

तकनीकी साक्षरता: आर्टिफिशियल इंटेलिजेंस (AI), डेटा साइंस, मशीन लर्निंग और कोडिंग को पाठ्यक्रम में प्राथमिकता दी गई है ताकि छात्र भविष्य

के तकनीकी रोजगारों के लिए तैयार हों।[6]

बहु-विषयक दृष्टिकोण: कला और विज्ञान के बीच की कठोर सीमाओं को हटाकर छात्रों को संयोजन कौशल विकसित करने की अनुमति दी गई है (उदाहरणार्थ इंजीनियरिंग के साथ दर्शनशास्त्र या इतिहास के साथ डेटा विश्लेषण)। यह उद्योग की बहु-विषयक मांगों को पूरा करने के लिए आवश्यक है।[7]

आत्मनिर्भरता और उद्यमिता संवर्धन- नीति का दीर्घकालिक लक्ष्य केवल कर्मचारियों का निर्माण करना नहीं, बल्कि उद्यमियों का निर्माण करना है।

उद्यमिता विकास मॉड्यूल: स्नातक पाठ्यक्रमों में उद्यमिता , व्यवसाय प्रबंधन और स्टार्ट-अप से संबंधित अनिवार्य मॉड्यूल शामिल किए जाएंगे।

उद्योग-संस्थान साझेदारी (IIP): उच्च शिक्षण संस्थानों को उद्योगों के साथ साझेदारी (MoUs) स्थापित करने और परिसर में ऊष्मायन केंद्र स्थापित करने के लिए प्रोत्साहित किया जाएगा। इससे छात्रों को वास्तविक व्यावसायिक परियोजनाओं पर काम करने और अपने स्टार्टअप विचारों को मूर्त रूप देने का अवसर मिलेगा।

लोकल फॉर वोकल का समर्थन: स्थानीय अर्थव्यवस्था को मजबूत करने के लिए क्षेत्रीय और स्थानीय स्तर पर प्रासंगिक कौशलों, जैसे कि जैविक कृषि, स्थानीय कारीगरी और कलाओं को व्यावसायिक शिक्षा में शामिल किया जाएगा।

कार्यान्वयन की चुनौतियाँ - NEP 2020 की सफलता इसके प्रभावी कार्यान्वयन पर निर्भर करती है, जिसके मार्ग में कुछ प्रमुख बाधाएँ हैं:

शिक्षकों का प्रशिक्षण और उपलब्धता

कौशल-संपन्न शिक्षकों की कमी: व्यावसायिक शिक्षा के जटिल और विविध विषयों को पढ़ाने के लिए आवश्यक विशेषज्ञता वाले शिक्षकों की भारी कमी है। मौजूदा शिक्षकों को नए, तकनीकी रूप से उन्नत पाठ्यक्रम के लिए प्रशिक्षित करना एक विशाल और महंगा कार्य है।[4]

बुनियादी ढाँचा और वित्तीय निवेश

वित्तीय लक्ष्य: शिक्षा पर सकल घरेलू उत्पाद (GDP) का 6% खर्च करने का लक्ष्य अभी भी दूर है। व्यावसायिक प्रशिक्षण के लिए आवश्यक अत्याधुनिक प्रयोगशालाएँ, उपकरण, और कार्यशालाएँ स्थापित करने के लिए बड़े पैमाने पर पूंजी निवेश की आवश्यकता है।

सामाजिक और प्रशासनिक प्रतिरोध

मानसिकता में परिवर्तन: व्यावसायिक शिक्षा को हमेशा अकादमिक शिक्षा से 'कमतर' माना गया है। इस सामाजिक पूर्वाग्रह को समाप्त करने और अभिभावकों को यह विश्वास दिलाने में समय लगेगा कि कौशल-आधारित करियर भी सम्मानजनक और लाभदायक हो सकते हैं।[8]

प्रशासनिक समन्वय: शिक्षा के विभिन्न स्तरों (स्कूल, उच्च शिक्षा, कौशल मंत्रालय) के बीच सामंजस्य स्थापित करना और सभी राज्यों में एकरूपता सुनिश्चित करना एक प्रशासनिक चुनौती है।

निष्कर्ष - राष्ट्रीय शिक्षा नीति 2020 में रोजगारपरक शिक्षा की भूमिका एक रणनीतिक आवश्यकता है जो भारत को एक ज्ञान-आधारित समाज से कौशल-आधारित अर्थव्यवस्था में परिवर्तित करने का मार्ग प्रशस्त करती है। कक्षा 6 से इंटर्नशिप और उच्च शिक्षा में क्रेडिट आधारित लचीलापन जैसे प्रावधानों के माध्यम से, यह नीति एक ऐसे कार्यबल का निर्माण करने का लक्ष्य रखती है जो नवाचारी, कुशल और आत्मनिर्भर हो।

नीति की पूरी क्षमता को साकार करने के लिए, सरकार को शिक्षक विकास और बुनियादी ढांचे में निवेश को प्राथमिकता देनी होगी, जबकि समाज को कौशल-आधारित शिक्षा के प्रति अपना दृष्टिकोण बदलना होगा। यदि इन चुनौतियों का प्रभावी ढंग से समाधान किया जाता है, तो NEP 2020 भारत की विशाल युवा शक्ति को वैश्विक स्तर पर प्रतिस्पर्धी बनाकर आत्मनिर्भर भारत के लक्ष्य को प्राप्त करने में निर्णायक साबित होगी।

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Vocational Education: Meaning, Importance and Dimensions

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Abstract: Education is the foundation of human development. It equips individuals with knowledge, values, and skills essential for leading productive and meaningful lives. However, in most traditional systems, education has focused primarily on theoretical learning rather than practical application. This imbalance often leads to unemployment or underemployment, especially among educated youth who lack job-ready skills.Vocational educationalso known as technical or skill-based educationhas emerged as a solution to this gap. It emphasizes the acquisition of specific skills and competencies that enable individuals to perform particular occupations efficiently. In today's dynamic world, where technology and industry are rapidly changing, vocational education has become a vital component of both personal and national development.

Meaning and Nature of Vocational Education: Vocational education refers to organized programs designed to provide learners with the practical skills, technical knowledge, and hands-on experience needed for a specific job or trade. Unlike general academic education, which primarily focuses on intellectual growth, vocational education focuses on employability and productivity.It covers a wide range of fields, including agriculture, healthcare, engineering, hospitality, business, information technology, and many more. The core principle behind vocational education is "learning by doing." Students receive training through workshops, laboratories, and on-the-job internships that prepare them to enter the workforce immediately after completing their course.

The essential characteristics of vocational education include:

1. Practical orientation – Emphasizing skill development through real-world practice.
2. Occupational focus – Preparing students for specific careers or trades.
3. Industry linkage– Training that aligns with labor market and employer needs.
4. Certification and recognition – Credentials that validate professional competence.

Historical Background: Vocational training has existed since ancient times, though in informal forms. In traditional societies, skills such as carpentry, pottery, weaving, and blacksmithing were passed down through apprenticeships within families or guilds.During the Industrial Revolution in Europe, the demand for trained workers in factories and industries led to the establishment of technical schools and trade training institutes. Vocational education became institutionalized as countries realized that industrial progress depended on skilled labor. InIndia, vocational education gained attention after independence. The government established Industrial Training Institutes (ITIs) and Polytechnic Colleges to promote skill development[1]. The National Policy on Education (1968) and later the National Education Policy (2020) emphasized integrating vocational education into mainstream learning. Programs like the Skill India Mission andPradhan Mantri Kaushal Vikas Yojana (PMKVY) have further expanded access to vocational training across the countryglobally[1]. Organizations such as UNESCO, ILO, and the World Bank have promoted vocational education as an essential component of sustainable development, linking it to the United Nations Sustainable Development Goal 4 (SDG 4**)**, which ensures "inclusive and equitable quality education and lifelong learning opportunities for all[2]."

Importance of Vocational Education Vocational education holds tremendous importance for both individuals and society as a whole. Its benefits can be observed across several dimensions—economic, social, educational, and technological.

1. Economic Importance: One of the most significant contributions of vocational education lies in its impact on the economy. It produces a skilled and efficient workforce, which is the backbone of any nation's industrial and service sectors.

1. Employment generation**:** By providing market-oriented skills, vocational education reduces unemployment and underemployment.

2. Increased productivity: Skilled workers perform tasks more efficiently, boosting national productivity and economic growth.
3. Entrepreneurship promotion: Vocational education encourages self-employment, enabling individuals to start their own businesses.
4. Economic stability: A skilled labor force helps industries remain competitive in global markets.

2. Social Importance: Vocational education contributes to social empowerment and inclusive growth. It provides opportunities to those who might not pursue academic education, such as rural youth, women, and economically weaker sections.

1. Social inclusion**:** It bridges the gap between privileged and underprivileged groups by offering equal learning and employment opportunities.
2. Dignity of labor**:** Vocational education promotes respect for all kinds of work, reducing social biases against manual or technical professions.
3. Gender equality: By training women in technical and professional skills, vocational education empowers them economically and socially.
4. Community development**:** Skilled individuals contribute to local industries, thereby uplifting entire communities.

In India, initiatives like the Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) have empowered thousands of rural youth by providing them with skill-based employment opportunities[3].

3. Educational Importance: Vocational education plays a complementary role to general education by making learning more relevant and practical. It focuses on holistic development by blending theory with application.

1. It promotes experiential learning, which helps students understand real-world problems.
2. It encourages lifelong learning and adaptability, essential in rapidly changing job markets.
3. It develops critical thinking, teamwork, and communication skills.
4. It provides multiple entry and exit points, allowing students to shift between vocational and academic streams.

The National Education Policy (2020) has recognized this importance and aims to provide vocational exposure to at least 50% of students by 2025. This integration will ensure that every student acquires some practical skills alongside academic knowledge.

4. Technological Importance: We are living in the age of the Fourth Industrial Revolution, characterized by automation, artificial intelligence, robotics, and digital transformation. Vocational education must adapt to these technological shifts.

1. Digital skills training**:** Learners need knowledge of computer applications, programming, and data analysis.
2. Use of technology in teaching**:** Online platforms, virtual labs, and simulation tools are increasingly used to train students efficiently.
3. Green technologies**:** With global emphasis on sustainability, vocational programs now include renewable energy, waste management, and eco-friendly manufacturing.
4. Industry 4.0 readiness**:** By aligning with modern technologies, vocational education ensures the workforce remains relevant.

Countries like Singapore and South Korea have successfully used technology-driven vocational systems to maintain global competitiveness.

5. Global Importance: In the modern era of globalization, vocational education extends beyond national boundaries. Skilled professionals are in demand worldwide, creating opportunities for international employment.

1. Standardization of skills: International qualifications frameworks ensure that vocational certificates are recognized globally.
2. Mobility of labor: Skilled workers can migrate easily and find better opportunities abroad.
3. Cross-border collaboration**:** Nations share best practices, research, and innovations in vocational training.
4. Cultural exchange and diversity**:** Global mobility of skilled labor fosters cultural understanding and cooperation.

Organizations such as UNESCO–UNEVOC are promoting global partnerships in Technical and Vocational Education and Training (TVET) to improve the quality and relevance of skills education worldwide[4].

Challenges Facing Vocational Education: Despite its undeniable importance, vocational education faces several challenges, especially in developing countries like India:

1. Social stigma**:** Many people still perceive vocational education as inferior to academic education.
2. Limited infrastructure: A large number of institutions lack modern equipment and training facilities.
3. Skill mismatch: Often, the skills taught do not match the actual requirements of industries.
4. Lack of qualified trainers: There is a shortage of well-trained instructors who can deliver high-quality practical training.
5. Funding constraints: Insufficient financial support limits the reach and quality of programs.
6. Gender and regional disparities**:** Rural areas and women still have less access to quality vocational training.

Addressing these challenges requires coordinated efforts between the government, private sector, and educational institutions.

Future Prospects and Recommendations: To strengthen vocational education and make it a mainstream component of the education system, the following measures are recommended:

1. Integration with mainstream education:Vocational subjects should be introduced from the school level to create awareness and respect for skill-based learning.
2. Industry–academic collaboration**:** Partnerships with industries will ensure that curricula remain relevant and updated with real-world practices.
3. Digital transformation**:** Online platforms, artificial intelligence, and virtual training systems can expand access and flexibility.
4. Skill mapping**:** Regular analysis of emerging industries and job trends will help align training programs with future market needs.
5. Standardization and certification**:** National and international qualification frameworks should be used to ensure the credibility of training programs.
6. Inclusion and equity: Special programs should be developed for women, differently-abled persons, and rural youth to ensure equal opportunities.
7. Awareness campaigns: Society must be educated about the value and dignity of skilled work to eliminate social prejudices.

With these reforms, vocational education can become a major driver of innovation, employment, and sustainable growth.

Conclusion: Vocational education represents the heart of a nation's skill development system. It equips individuals with practical abilities, confidence, and self-reliance, enabling them to contribute meaningfully to society. In the face of rapid technological change and global competition, a skilled workforce is the foundation of economic resilience and social progress. For India, where a large portion of the population is young, strengthening vocational education can transform demographic potential into economic power. By recognizing the multiple dimensions—economic, social, educational, technological, and global—of vocational education, policymakers and educators can create a balanced, inclusive, and future-ready system. Vocational education is not merely an alternative form of learning; it is the education of the future, one that empowers individuals.

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Exploration on Higher Vocational Computer Education Under the Background of Big Data

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Abstract: With the application of big data technology becoming more and more mature, in the process of computer education in higher vocational colleges, we should adapt to the basic environment of the rapid development and application of intelligent technology, and stress the professional characteristics, it is necessary to work out a talent training plan that integrates big data and computer education in higher vocational colleges, reconstruct the computer education mode and teaching idea, and improve the training efficiency of computer talents in higher vocational colleges. Based on the big data environment, this paper puts forward the corresponding reform strategies in view of the practical problems existing in higher vocational computer education.
Keywords: Big Data, Higher vocational education, Computer, Education model.

Introduction - It is of great significance to promote the further development of computer teaching reform, optimize the way of computer teaching, form a perfect computer teaching system and promote the all-round development of students. Under the background of big data, it is necessary for computer teachers in higher vocational colleges to strengthen the application of big data information technology. The main characteristic of higher vocational education is to pay attention to the training of employment-oriented specialized talents. Therefore, the reform of higher vocational education should start from this characteristic and look for the educational reform mode that satisfies the characteristics and educational orientation of higher vocational colleges, computer Technology is a very strong tool of professional, so in the relevant teaching courses to focus on training students' practical ability and professional quality, with a certain degree of college characteristics.

With the deepening of the education system reform in China, the students need more and more computer teaching resources, and the traditional computer education model is difficult to adapt to the current changes in education. At the present stage, we should also play a role in promoting the teaching reform of big data resources, and make great efforts to eliminate the disadvantages of indoctrination and mechanical teaching in the past, and further improve students' practical ability as the main direction of the teaching reform, to solve the problems of teachers as the main body in the past, to effectively improve students' initiative in autonomous learning, to break through the problems of lack of practical teaching in higher vocational computer education, too rigid teaching ideas, and low participation of students in learning, etc. improving the quality of computer teaching in higher vocational colleges. From an objective point of view, the vast majority of higher vocational colleges still continue the traditional "cramming and inculcating" teaching mode when they carry out computer education, it makes it difficult for students to digest the computer knowledge they have learned in the actual learning process, and does not serve the purpose of strengthening and exercising their computer ability. Teachers occupy the main position in the whole teaching process, and students are too passive, thus causes the higher vocational college computer education level to be on the low side, the effect is not ideal and so on present situation.

Innovation strategy of higher vocational computer education under the background of big data: The reform of computer education system in higher vocational colleges in the era of big data should always take employment as the ultimate goal and combine with the new employment situation at present to train applied talents in different directions in the course setting, students' interests should also be taken into account to ensure that their choice of major direction is in line with their own positioning and interests. In the era of big data, the setting of computer education courses in higher vocational colleges should always meet the impact of the times and society on the employment of students according to the needs of enterprises and posts, only in this way can the employment problem of students be guaranteed to the greatest extent.

Cultivating student's big data thinking through big data applications : When teachers explain the basic course of

computer application, they can introduce the explanation and application of big data technology into the classroom, and train students' thinking through the explanation of big data, let students have big data thinking ability while learning computer technology, so that students can adapt to the big data era, better use of computer technology in society. At present, the traditional basic courses of computer application mainly focus on the maintenance of computer hardware, the use of tools and other knowledge points that do not involve big data, and have not been updated, at the same time in the teaching mode is still the teacher to impart knowledge, but not let students practice the link, it is easy to cause students in their own practice when it is difficult to apply basic computer knowledge. Teachers can use big data technology to help students understand the changes in computer applications. For example, when explaining the "network tools software", teachers can introduce students to such as: "Questionnaire Star" and other online questionnaire tools, to the network of the questionnaire. The teacher can do a small experiment, the teacher designs the content of the questionnaire as: "Can you use Microsoft Office software skillfully, such as PPT?" The teacher can put the questionnaire on the website or some platform for several days. When the next class, teachers can through the Internet questionnaire results, so that students see all the data and analysis of the situation. Big data refers to the analysis and processing of all collected data, rather than a sample survey. Teachers can through such a small experiment, so that students can see the simple application of big data technology, but also can train students big data thinking. At the same time, teachers can also stimulate students to think about big data by asking them questions about it. Teachers can ask students to answer questions such as: "What do you think are the drawbacks of big data? What do you think big data has done to your life?" Teachers can ask students to reflect on big data, let the students improve their big data thinking, form the thinking habit of big data, change the big data learning concept.

Fully interactive teaching using Internet technology : With the vigorous development of information technology, Internet technology has also been sublimated. The cost of communicating over the internet is getting lower and lower, so there are more and more applications of the Internet. The development of Internet technology has also led to the development and sublimation of the field of education, so that teachers can use the internet to carry out teaching activities, teaching without interruption, regardless of location. Teachers are one of the important tools and directions for cultivating students in colleges and universities. Teachers' practical ability and teaching experience directly affect students' learning ability. In addition, the computer industry requires a high level of hands-on ability for the relevant professionals. Therefore, when training students, the relevant computer education teachers should fully consider the training of students' hands-on ability and pay attention to the combination of theory and practice, and mainly practice-oriented, through training students to understand how to master the corresponding computer knowledge applied to practice, which plays a vital role in improving students' employability. Enhanced interaction via the Internet can make students more willing to ask questions of teachers, thus making students more proficient in computer technology and computer operation.

Pay attention to student's individual demand and reconstruct computer classroom : The "Internet +" teaching model grasps the student study process data through the Internet technology and the big data analysis, the system can formulate the corresponding study plan for each student, personalized tutoring teachers can use internet technology to constantly improve communication and communication with students in the classroom, to keep the whole process of interaction and exchange of views in the classroom, so that students can participate in the classroom, with the teacher's teaching rhythm, it can improve the efficiency and interest of the class, stimulate students' interest and confidence in learning the basic technology of computer application, and realize all-round interactive learning. For example, teachers can use classroom interaction in platforms such as Tencent classroom to teach, allowing students to seek help from teachers at any time. At the same time, when teachers assign homework, when students have problems that can not be solved when using the software, they can ask teachers for help at home through the chat software, and do not need to call or personally looking for teachers, so that students at home can also accept the teacher's guidance, greatly enhanced the interactive teaching. Because students often do not want to meet teachers directly to solve problems, so choose online teaching platform to help teachers is more likely to be accepted by students. Similarly, when teachers teach in class, they can use platforms such as "Rain Class" to let students exchange bullet-screen information, so that students can directly ask for help from bullet-screen when they have problems, and do not need to interrupt the teacher's rhythm of class, so that can achieve a comprehensive interactive teaching arrangements.

Improving teaching content through big data technology : With the development of network technology, more and more people are willing to share their own resources and some teaching contents in the network. Many teaching skills and teaching methods can be changed by analyzing these teaching resources, according to the other teacher's teaching experience summary to perfect own teaching way and the teaching content. When arranging lesson preparation, the teacher can pass big data technology, select a few resources in the network to undertake summary and analysis. For example, when explaining an Excel spreadsheet design course, a teacher

can use the internet to look at the teaching records shared by other teachers, and to look at the teaching difficulties. Teachers may find that in most lesson plans, the use of Excel functions is listed as a teaching difficulty. According to the result of this analysis, the teacher can choose to write a summary of the table function in common use when preparing the lesson, so that the students can first master some common table functions, use these common functions as a base to learn more difficult and longer function expressions. By analyzing other teachers' teaching resources, teachers can get teaching difficulties and explain them, which can improve their own teaching contents to a great extent. Similarly, teachers can use big data technology, through the network database, compare some of the more commonly used Excel table function expressions, to enable students to effectively master the skills of daily use of forms in a shorter time, so as to achieve the goal of efficient learning of basic computer application courses, so that students can reduce the pressure. Teachers can then use the internet to summarize the latest library of functions and their meanings in a table that interested students can query to get the usage and expression of the function they want to use.

Conclusion : The era of big data has begun, and the application scope of big data technology has gradually expanded. At the same time, it brings great challenges to computer teaching in higher vocational colleges, it also requires teachers to create new ways of educating students about the role of big data, so that they can use the right thinking and vision to look at big data, learn about computers, and improve their operational skills, to meet the relevant needs of enterprises for computer talents.

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Vocational Education and Its Dimensions for Indian Society: The New Education Policy

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Abstract: Vocational education holds immense significance for India's socioeconomic fabric, especially as the country aspires for a skilled workforce aligned with global demands. The National Education Policy (NEP) 2020 ushers in a paradigm shift by integrating vocational training into mainstream academics, aiming for inclusivity, relevance, and employability. This paper explores the core dimensions of vocational education as reimagined by NEP 2020, its importance for Indian society, implementation strategies, and the challenges encountered, with practical recommendations for future progress.

Introduction - Vocational education, often sidelined in traditional Indian curricula, has long been associated with manual or technical professions and viewed as secondary to academic learning. The NEP 2020 marks a fundamental policy shift by recognizing vocational education as central to holistic and equitable national development. It envisions at least 50% exposure for all students to vocational training by 2025, blurring the historic divide between 'academic' and 'skill-based' streams.

Key Dimensions of Vocational Education under NEP 2020

Integration with Mainstream Education :

1. NEP 2020 mandates vocational education will no longer be isolated from mainstream academics.
2. The aim is for universal access to holistic education, allowing flexible subject choices— academics and vocational skills side by side.

Early Introduction & Hands-on Learning :

1. Vocational exposure is to start as early as Grade 6, supplemented by "bagless days," internships, and interactive modules for experiential learning.
2. Every student will participate in at least one vocational skill and explore several others through school and higher education.

Credit-Based Framework :

1. NEP 2020 proposes a credit-based system to enable seamless movement between vocational and academic education, ensuring parity and recognition for skill-based courses.
2. This approach aims to eradicate bias and elevate the status of vocational streams.

Need-Based & Localized Curricula :

1. Curricula design is informed by skill-gap analysis, local industry requirements, and mapping employment opportunities, thus fostering context-specific training.
2. Traditional Indian vocational knowledge—Lok Vidya—will also be integrated to preserve indigenous crafts while promoting employability.

National Coordination & Implementation :

1. The National Committee for Integration of Vocational Education (NCIVE) will oversee alignment with industry needs and coordinate funding, teacher training, and resource allocation.
2. The revamped Samagra Shiksha Scheme expands vocational exposure to government-aided schools, introducing "hub-and-spoke" models for resource sharing.

Societal Impact and Benefits

Reducing Unemployment & Ensuring Employability :

1. Vocational education aligns youth skills with labor market demands, thus curbing unemployment through job-ready graduates.
2. The emphasis on employability includes training in communication, self-management, ICT, and entrepreneurship.

Socioeconomic Upliftment & Equity :

1. The NEP emphasizes inclusive access for marginalized communities, women, and rural populations, thus narrowing social divides and promoting economic justice.
2. By celebrating the dignity of labor and artisan vocations, societal perceptions are expected to shift toward valuing all forms of work.

Economic Growth & Innovation :

1. A skilled workforce boosts productivity and facilitates technological adoption, essential for India's industrial

and digital advancement.
2. By fostering entrepreneurship and adaptability, vocational education supports both self employment and industry-led growth.

Challenges and Obstacles :

1. Stigma and societal bias against vocational streams persist, with many considering them suitable only for those unable to succeed academically.
2. Infrastructure and resource constraints, especially in rural areas, hinder the scaling of quality vocational education.
3. Teacher training and curriculum development must keep pace with rapidly evolving skill needs and local economic trends.
4. Effective implementation requires robust monitoring, cross-sector coordination, and sustained investment.

Recommendations and Future Directions :

1. Continuous sensitization campaigns are essential to improve perception and awareness around vocational professions.
2. Leveraging industry partnerships and alumni networks can enhance practical training opportunities and placements.
3. Data-driven planning, ensuring gender equity, and decentralized skill hubs will help adapt programs to diverse local contexts.
4. Investment in digital infrastructure and lifelong learning modules is crucial as India transitions to an innovation-based economy.

Conclusion: The National Education Policy 2020 represents a watershed moment in India's approach to vocational education, aiming to bridge the gap between knowledge and employable skills. Successful realization of NEP's vision will require societal commitment, adequate resourcing, and a unified policy push to ensure every youth is workforce ready, supported by lifelong and inclusive learning opportunities.

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A Broad Overview on Various Dimensions of Vocational Education in Global Perspective

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Abstract: Vocational Education and Training (VET) is a globally recognized dynamic and strategic tool essential for navigating shifting labour markets, technological advancements, and the pursuit of inclusive economic growth and social cohesion. It plays a critical economic role by providing job-specific skills that bridge the gap between education and employment, thereby supplying skilled labour crucial for industry needs and reducing informal employment. Educationally, VET offers vital alternatives to traditional academic pathways, often utilizing successful dual systems that combine classroom instruction with company apprenticeships and supports the necessity of lifelong learning for upskilling and reskilling. Furthermore, VET must continuously adapt to the Fourth Industrial Revolution by integrating digital transformation tools and expanding into emerging high-tech sectors (such as robotics and AI), as well as training workers in green skills essential for environmental sustainability. The social dimensions of VET include promoting equity and upward social mobility. Effective global implementation relies heavily on Public-Private Partnerships, quality assurance measures, and standardization initiatives to ensure the relevance and transferability of skills. Strengthening VET worldwide requires sustained investment and the integration of future-oriented skills.
Keywords: Vocational Education, Artificial Intelligence, VET, SDG.

Introduction - Vocational Education and Training (VET) play a critical role in equipping individuals with practical skills and knowledge for the workforce. As economies evolve and labour markets shift due to technological advancements, globalization, and demographic changes, vocational education has gained renewed importance across the globe. While approaches to vocational education differ by country and region, several common dimensions define its global landscape.

Economic Dimension:

1. **Skill Development for Employment**: Vocational education provides job-specific skills, bridging the gap between education and employment. Countries with strong VET systems (e.g., Germany, Switzerland) report lower youth unemployment and smoother school-to-work transitions.
2. **Support for Economic Growth**: VET contributes to productivity by supplying skilled labour tailored to industry needs, particularly in sectors like manufacturing, healthcare, construction, and information technology.
3. **Reducing Informal Employment**: In developing economies, vocational education can help formalize the workforce and reduce dependence on low-paying, informal jobs.

Educational Dimension:

1. **Alternative to Academic Pathways**: VET offers an alternative to traditional academic education, often better suited to learners with practical inclinations or those seeking quicker entry into the workforce.
2. **Dual Systems**: Some countries use a dual-track system (e.g., Germany, Austria) combining classroom instruction with apprenticeships in companies, providing real-world experience.
3. **Lifelong Learning**: VET increasingly supports upskilling and reskilling throughout individuals' careers, aligning with the global push for lifelong learning in dynamic job markets.

Technological Dimension:

1. **Digital Transformation**: Integration of digital tools in vocational training—such as simulators, e-learning platforms, and virtual labs-is becoming essential to prepare learners for tech-driven workplaces.
2. **Emerging Sectors**: VET is expanding to cover high-tech fields like robotics, AI, renewable energy, and digital design, adapting to the Fourth Industrial Revolution.
3. **Distance and Online VET**: Online and hybrid VET programs are growing, especially in response to the COVID-19 pandemic, although challenges remain in delivering hands-on training remotely.

Social Dimension:

1. **Equity and Inclusion**: Vocational education can offer marginalized groups-such as women, persons with

disabilities, and rural populations-better access to skills and employment opportunities.

2. **Social Mobility**: By offering a pathway to stable, skilled employment, VET can contribute to reducing poverty and promoting upward social mobility.

3. **Stigma Reduction**: In many cultures, VET suffers from a perception of being inferior to academic education. Global efforts are underway to raise its status and visibility.

Cultural and Regional Variations:

1. **European Models**: Strong emphasis on dual systems, employer partnerships, and government-industry collaboration.

2. **Asian Approaches**: Countries like South Korea and Singapore integrate VET within broader education systems, often focusing on high-skill technical training.

3. **Developing Countries**: Challenges include underfunding, lack of infrastructure, poor linkages with labour markets, and outdated curricula. International organizations (e.g., UNESCO, ILO, World Bank) often support reforms.

4. **Anglo-American Models**: Generally, VET is delivered post-secondary or through community colleges, with more focus on adult learners and lifelong learning.

Policy and Governance Dimension:

1. **Public-Private Partnerships**: Effective VET systems often involve collaboration between governments, industry, and educational institutions.

2. **Standardization and Certification**: Global initiatives aim to harmonize qualifications, making skills transferable across borders (e.g., European Qualifications Framework).

3. **Quality Assurance**: Ensuring consistent standards and relevance of training programs is a major focus in both developed and developing countries.

Environmental and Sustainability Dimension:

1. **Green Skills**: VET is increasingly seen as key to training workers for green jobs in sectors like renewable energy, waste management, and sustainable agriculture.

2. **Sustainable Development Goals (SDGs)**: SDG 4 promotes inclusive and equitable quality education and lifelong learning opportunities, including technical and vocational training.

Schools Offering Skill/Vocational Courses & Student Uptake (Secondary Level,Grade9+)based on the PARAKH Rashtriya Sarvekshan 2024 report: The Times of India+2The Times of India+2

State / UT	% Schools (Grade 9+) Offering Skill Courses	% Student Enrol -ment in those Courses
Gujarat	57%	34%
Punjab	54%	42%
Odisha	50%	21%
Bihar	44%	21%
Maharashtra	46%	32%
Delhi	42%	54%
Chandigarh	40%	65%
Kerala	34%	36%
Uttar Pradesh	45%	24%
Haryana	46%	41%

This illustrates that while many schools *offer* vocational / skill based courses, student uptake is often much lower.

Conclusion: Vocational education is a dynamic and multifaceted component of global education systems. It is increasingly recognized not just as a means of employment, but as a strategic tool for inclusive economic growth, social cohesion, and innovation. While there is no one-size-fits-all model, cross-country collaboration, investment in quality and infrastructure, and integration of future-oriented skills will be key to strengthening vocational education worldwide.

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बाजारवाद और रोजगारपरक शिक्षा

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प्रस्तावना – वैश्वीकरण और उदारीकरण के इस युग में शिक्षा केवल ज्ञान अर्जन का माध्यम न रहकर एक आर्थिक निवेश और बाजार की आवश्यकताओं की पूर्ति का साधन बन गई है। शिक्षा प्रणाली पर बाजारवाद का प्रभाव इस हद तक बढ़ गया है कि आज शिक्षण संस्थान रोजगारपरकता को ही शिक्षा की गुणवत्ता का प्रमुख मानदंड मानने लगे हैं। प्रस्तुत शोध पत्र में बाजारवाद की अवधारणा, उसके शिक्षा पर प्रभाव, रोजगारपरक शिक्षा की प्रासंगिकता तथा इसके सामाजिक–सांस्कृतिक परिणामों का विश्लेषण किया गया है।

21वीं सदी की शिक्षा व्यवस्था में एक बड़ा परिवर्तन देखने को मिला है। जहां पहले शिक्षा का उद्देश्य व्यक्ति के सर्वांगीण विकास, नैतिकता, मूल्यबोध और समाजहित में योगदान देना था, वहीं आज शिक्षा का प्राथमिक लक्ष्य 'रोजगार प्राप्ति' बन गया है। इस परिवर्तन के मूल में बाजारवाद की नीतियाँ और वैश्विक पूंजी का दबाव है।

बाजारवाद उस प्रक्रिया को कहते हैं, जिसमें सामाजिक संस्थाओं विशेषकर शिक्षा को बाजार के सिद्धांतों, प्रतिस्पर्धा, उपभोक्तावाद और लाभ के आधार पर संचालित किया जाता है। परिणामस्वरूप शिक्षा एक सार्वजनिक सेवा न होकर वस्तु के रूप में परिवर्तित हो जाती है।

बाजारवाद की अवधारणा

बाजारवाद मूलत: पूंजीवादी अर्थव्यवस्था की देन है, जो प्रत्येक क्षेत्र को 'मांग और आपूर्ति' के सिद्धांत पर संचालित करना चाहता है। शिक्षा क्षेत्र में बाजारवाद का प्रवेश 1990 के दशक में आर्थिक उदारीकरण के साथ तेज हुआ। निजी विश्वविद्यालयों, तकनीकी संस्थानों और व्यावसायिक पाठ्यक्रमों की बाढ़ ने शिक्षा को एक 'सेवा उद्योग' में बदल दिया।

शिक्षा संस्थान अब 'ग्राहक' (छात्र) को आकर्षित करने के लिए विज्ञापन, ब्रांडिंग और प्लेसमेंट रिकॉर्ड का उपयोग करते हैं। शिक्षा के मूल मानवीय और नैतिक उद्देश्य पृष्ठभूमि में चले गए हैं।

रोजगारपरक शिक्षा की आवश्यकता और परिभाषा – रोजगारपरक या व्यावसायिक शिक्षा वह शिक्षा है जो व्यक्ति को किसी विशिष्ट व्यवसाय, उद्योग या सेवा क्षेत्र के लिए आवश्यक कौशल और दक्षता प्रदान करती है। आज के प्रतिस्पर्धी युग में ऐसी शिक्षा की आवश्यकता इसलिए बढ़ी है क्योंकि:

1. पारंपरिक शिक्षा रोजगार की गारंटी नहीं देती।
2. तकनीकी परिवर्तन और डिजिटलीकरण ने नए प्रकार के रोजगार उत्पन्न किए हैं।
3. युवाओं में आत्मनिर्भरता और उद्यमशीलता की भावना विकसित करनी आवश्यक है।

भारत में नई शिक्षा नीति (2020) ने भी कौशल–आधारित और रोजगारपरक शिक्षा को प्रमुखता दी है, जिससे शिक्षा सीधे आर्थिक गतिविधियों से जुड़ सके।

बाजारवाद और रोजगारपरक शिक्षा का संबंध – बाजारवाद और रोजगारपरक शिक्षा के बीच घनिष्ठ संबंध है। बाजार की मांगों के अनुसार ही शिक्षा के पाठ्यक्रम, विषय और प्रशिक्षण संरचना तैयार की जा रही है। उदाहरणस्वरूप आईटी, मैनेजमेंट, फिनटेक, डिजिटल मार्केटिंग, डेटा साइंस जैसे पाठ्यक्रम तेजी से लोकप्रिय हो रहे हैं। हालांकि, इस प्रक्रिया के दोहरे परिणाम हैं:

सकारात्मक पक्ष:

1. शिक्षा का व्यावहारिक और उपयोगी स्वरूप विकसित हुआ है।
2. युवाओं में रोजगार के नए अवसर उत्पन्न हुए हैं।
3. उद्योग–शिक्षा साझेदारी से नवाचार और प्रशिक्षण की गुणवत्ता में वृद्धि हुई है।

नकारात्मक पक्ष:

1. शिक्षा का व्यावसायीकरण बढ़ा है, गरीब वर्ग की पहुँच सीमित हुई है।
2. मानवीय मूल्य, नैतिकता और सामाजिक जिम्मेदारी की भावना कमजोर हुई है।
3. शिक्षा का उद्देश्य केवल 'नौकरी पाना' रह गया है, 'ज्ञान पाना' नहीं।

भारतीय संदर्भ में बाजारवादी शिक्षा – भारत में 1991 की नई आर्थिक नीति के बाद से शिक्षा क्षेत्र में निजी पूंजी का निवेश बढ़ा। तकनीकी और प्रबंधन संस्थानों की संख्या में विस्फोट हुआ। विश्वविद्यालय रोजगारपरकता के आँकड़ों के आधार पर अपनी रैंकिंग निर्धारित करने लगे। परिणामस्वरूप, पारंपरिक विषय–जैसे दर्शनशास्त्र, इतिहास, साहित्य, कमजोर पड़े, क्योंकि वे 'प्रत्यक्ष रोजगार' से नहीं जुड़े थे। वहीं इंजीनियरिंग, मैनेजमेंट और कंप्यूटर विज्ञान जैसे विषयों को अत्यधिक प्राथमिकता मिली। सरकारी संस्थानों की तुलना में निजी संस्थानों में शिक्षा महँगी हो गई, जिससे सामाजिक असमानता और बढ़ी।

सामाजिक और सांस्कृतिक प्रभाव – बाजारवादी शिक्षा ने समाज में कई स्तरों पर परिवर्तन किए हैं:

1. **मूल्यबोध में गिरावट:** विद्यार्थी अब 'सफलता' को आर्थिक दृष्टि से मापने लगे हैं।

2. **प्रतिस्पर्धा की प्रवृत्ति:** सहयोग की बजाय प्रतिस्पर्धा की भावना बढ़ी है।

3. **सांस्कृतिक असंतुलन:** पारंपरिक ज्ञान, भारतीय भाषाएँ और संस्कारों का स्थान घटा है।

4. **समानता पर संकट:** शिक्षा महँगी होने से सामाजिक विषमता गहराई है।

समाधान एवं सुझाव – बाजारवाद के प्रभाव को पूरी तरह समाप्त करना संभव नहीं है, परंतु शिक्षा को संतुलित दिशा दी जा सकती है। इसके लिए निम्नलिखित उपाय आवश्यक हैं:

1. **मूल्य आधारित शिक्षा:** रोजगारपरकता के साथ नैतिकता, नागरिकता और मानवीयता को जोड़ा जाए।

2. **सार्वभौमिक पहुँच:** गरीब और ग्रामीण विद्यार्थियों को भी गुणवत्तापूर्ण व्यावसायिक शिक्षा सुलभ हो।

3. **सरकारी निगरानी:** निजी शिक्षा संस्थानों पर प्रभावी नियंत्रण और गुणवत्ता सुनिश्चित की जाए।

4. **कौशल और संस्कृति का समन्वय:** शिक्षा में तकनीकी दक्षता के साथ भारतीय सांस्कृतिक दृष्टि को भी स्थान मिले।

5. **उद्यमशीलता का विकास:** युवाओं को नौकरी खोजने की बजाय नौकरी देने की मानसिकता विकसित की जाए।

निष्कर्ष – बाजारवाद ने शिक्षा को नया रूप अवश्य दिया है, परंतु उसका प्रभाव संतुलित न हो तो समाज में असमानता, मूल्यहीनता और व्यावसायिक निर्भरता बढ़ सकती है। रोजगारपरक शिक्षा आवश्यक है, क्योंकि वह युवाओं को आत्मनिर्भर बनाती है, परंतु इसे केवल 'बाजार की माँग' तक सीमित रखना खतरनाक है। शिक्षा का उद्देश्य केवल आर्थिक विकास नहीं, बल्कि मानवीय, नैतिक और बौद्धिक विकास भी होना चाहिए। इसलिए, एकऐसी शिक्षा नीति की आवश्यकता है जो बाजार की व्यावहारिकता और समाज की नैतिकता दोनों के बीच संतुलन स्थापित कर सके।

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Various Aspects of Vocational Education in NEP 2020

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Abstract: The significance of career training has gained a sudden focus. As the industries grow at a rapid pace and the number of professional people is on the rise. Conventional academic courses only teach theory without application. However, vocational courses have relevant skills that help the learners get directly into the job market or start a business. Be it healthcare, engineering, beauty, agriculture and IT, vocational training can provide various ways to secure stable and gratifying careers. Vocational education in India seems to be on track toward bridging the gap in skills.This paper discusses the meaning, advantages, and future of vocational education.

The NEP 2020 is also supposed to be a significant change as it proposes integrating vocational studies starting with Grade 6. There will be early exposure to practical training. The super structure of 10+2 is being waived with greater flexibility and skills oriented curriculum. The percentage of students exposed to vocational education is to reach 50 and above by the year 2025.

Keywords- vocational,curriculum.careers, distance learning programs,entrepreneurship.

Introduction - Vocational education emphasizes the inculcation of hands-on skills and technical expertise to a particular profession or vocation. In contrast to academic education, vocational education offers practical. It provides on-the-job experience which can give students a chance of having a direct entry to the workplace.

The world in 2025 is experiencing unprecedented demand in the skilled labor force. It includes industries and sectors from healthcare to IT, farm to hotel industries, etc. Therefore, vocational education has taken the middle stage in workforce development policies.Particularly in countries where filling the skilled gap is a key to economic development such as India.

Industrial Training Institutions (ITI), polytechnics, and privately run training institutes are categorized as vocational training. And the high schools under government initiatives such as Skill India, PMKVY, and Samagra Shiksha Abhiyan also do the same.

Education is fundamental for achieving full human potential, developing an equitable and just society, and promoting national development. Providing universal access to quality education is the key to India's continued ascent, and leadership on the global stage in terms of economic growth, social justice and equality, scientific advancement, national integration, and cultural preservation. Universal high-quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country, and the world.

With "an education system rooted in Indian ethos that contributes directly to transforming India, that is Bharat, sustainably into an equitable and vibrant knowledge society, by providing high quality education to all, thereby making India a global knowledge superpower," the National Education Policy, 2020 (NEP) aims to drastically transform education. The five pillars of Access, Equity, Quality, Affordability, and Accountability are the foundation of NEP2020**.** It will equip our young people to handle the various domestic and international issues of the present and the future.

Importance of Vocational Education in India: Vocational education was new to people of India. But, because of its versatility and prominence**,** it has been beyond useful. The following significance of vocational education has helped it in taking place in the heartsof the Indian population.

1. Filling Skills Gap There is a paradox of million graduates and very few employable candidates.This is because of the mismatch between educational learning and industrial requirements in India. NITI Aayog has laid its hands on skill development, employment generation, and social welfare by collaborating with multiple organizations.Vocational training offers market aligned relevant training that makes a person job ready, which solves the problem of underemployment and shortage of skills.

2. Increasing Employability and Minimizing Unemployment: An important report was published by the National Skill Development Corporation (NSDC). It shows that only about one-fifth of the Indian workers have received formal skill training. The focus of NSDC was to catalyze private sector participation in skill development, advocating training of 5 million people. The vocational subjects also prepare learners with practical skills like training in using equipment, networks or supporting health. Thus increasing their chances of being employed shortly after training.

3. Fostering Entrepreneurship: Vocational training promotes self-employment and micro-entrepreneurship. For example, tailoring, mobile repair, and food processing courses allow learners to start personal business, in rural and semi-urban regions. This does not only stimulate financial investments but also provides other people with employment.

4. Advocating Marginalized Groups: Vocational training enables the economically and sociallydisadvantaged group to develop skills. It establishes upward mobility through subsidized training or government assistance of the marginalized youth, who can access the formal economy.

5. Encouraging Socio-Regional Development: Vocational institutes established in rural or underserved areas serve as centers of growth since they make a competent local workforce. This minimizes inter-city migration, evens out the progress of regional economies, and results in independent communities.

6. Empowering Productivity and Innovation: When job-specific training is done, these employees are efficient, productive, and innovative in their jobs. This boosts business production, service delivery and sustains national productivity indicators.

7. Handling the Changing Industry Needs: Technology is changing in fast paced industries and so is vocational education. New subjects like renewable energy, electric cars, AI, and robotics will become part of newer curriculums. This is so that students stay afloat in a rapidly evolving labor world.

8. In line with National Education Policy (NEP) 2020: The NEP 2020 is also supposed to be a significant change as it proposes integratingvocational studiesstarting with Grade 6. There will be early exposure to practical training. The super structure of 10+2 is being waived with greater flexibility and skills oriented curriculum. The percentage of students exposed to vocational education is to reach 50 and above by the year 2025.

Different Types of Vocational Education: Vocational education consists of many types of programs and kinds of training methods. Here are some common types:

1. High School Career and Technical Education (CTE) Programs: CTE programs allow a student to enroll in high school and study different careers before the completion of high school education.These programs comprise general education and technical training giving learners a boost in their area of specialty.

2. Tech Prep Education: Tech Prep programs integrate a clear line between high school and postsecondary education for the students.They are commonly a collaborative effort of high school, community college as well as technical institutes where high school students can attain college credits and progress to advanced education vocational training.

3. Postsecondary Vocational Schools: Career colleges or postsecondary vocational schools provide certain courses or training in vocational trades or occupations.These institutions offer Academic courses which are brief computerised technical programs and heterogeneous that take about six months to two years and offer certificates, diplomas, or associate degrees.

4. Apprenticeship Programs: Apprenticeships involve the use of practical sessions that enable the student to learn while carrying out practical tasks in the workplace.The apprentices are paid employees who learn from the masters employing the practical session skills and knowledge acquired.

5. On-the-Job Training: On-the-job training means training that is provided to the employees where they get first-hand experience of the particular job they will be performing.In this approach of learning, employees are normally taught or coached by their employers or senior experienced subordinates. This kind of vocational training is useful in organisations that require hands-on experience.

6. Standalone Courses: These are low-level courses that primarily take a short period to complete and are largely focused on skills or certification.Such classes can be taken in the community college, technical institutes, or through online methods.

They afford the learner an easy means of acquiring a new skill or improving on an existing one without enrolling in a formal course.

7. Distance Learning Programs: Distance learning programs provide vocational courses online so that education reaches the maximum number of people.These kinds of programs offer comfort and ease to the student since they come in a format that is self-paced and online.The 21K School, being a school that offers various curricula, makes such distance learning opportunities possible and a student can earn a quality vocationally oriented education without having to attend classes.

Vocational Education as Key aspects of NEP 2020:

1. Holistic and Integrated Education:

- 5+3+3+4 Curricular Structure: This structure divides schooling into:
  - Foundational Stage (ages 3-8): Includes 3 years of pre-school (Anganwadi) and Grades 1-2.
  - Preparatory Stage (ages 8-11): Grades 3-5.
  - Middle Stage (ages 11-14): Grades 6-8.
  - Secondary Stage (ages 14-18): Grades 9-12, with a

multidisciplinary approach.

- No Rigid Separation: NEP 2020 eliminates the rigid separation between arts and sciences, curricular and extracurricular activities, and vocational and academic streams.
- **Vocational Education: Vocational training will be introduced from Grade 6, including internships.**
- Multilingualism: Emphasis on mother tongue/regional language as the medium of instruction until at least Grade 5, and preferably till Grade 8 and beyond.

2. Focus on Foundational Literacy and Numeracy:
3. Assessment Reforms:
4. Teacher Education:
5. Equity and Inclusion:
6. Integration of Technology:
7. Higher Education Reforms:

Conclusion: NEP 2020 heralds a new era in the Indian education system, focusing on holistic development, multidisciplinary learning, flexibility, technology integration, teacher empowerment, and assessment reforms. It paves the way for a student-centered, inclusive, and future-ready education system. By embracing the transformative changes brought about by NEP 2020, India is poised to nurture a generation of learners who are equipped with the necessary skills, knowledge, and competencies to thrive in a rapidly changing world.

Vocational education can no longer be considered as a second choice. It will soon be an important part of a modern skills oriented economy. Vocational training also allows students a shorter, easy, and in most cases quick way to gainful employment. This is because of its focus on practicality in trade and being based in the reality of industry.

It equips students with confidence, competence, ability to join the working force or develop their own businesses.Vocational education is moving into mainstream formal education with robust support of national policies and programs like NEP 2020 and PMKVY. With the world rapidly moving towards innovation, digitalization, and skills-based recruitment, vocational education will define the future work-culture in India.Not only remaining relevant but imperative to the overall sustainable development process.

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Skill Development for the Future Workforce: Employment Challenges in India

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Abstract: India stands at a critical juncture in its workforce evolution: with a large youth demographic and rapid structural shifts in the economy, the twin imperatives of skill development and employment generation have never been more urgent. This paper examines how skill development initiatives in India are shaping the future workforce, and explores the major employment challenges that accompany this transformation. First, it outlines the scale of the challenge: only a small fraction of India's working age population has formal vocational or industry aligned training, even while millions enter the labour market each year (Pratap and Biragon,2025). Second, the paper analyses key bottlenecks in the skill ecosystem: mismatch between training and industry requirements, weak industry-academia linkages, inadequate infrastructure, regional and social disparities in access, and a predominance of informal employment (Sharma and Nagendra, 2016). Third, it investigates how these constraints translate into employment challenges: under-employability, high numbers of youth in low skill jobs, inability to absorb new entrants into formal sectors, and vulnerability to technological disruption. The paper then assesses recent policy interventions and proposes a forward-looking agenda: aligning training with emerging digital and green economy roles, enhancing private-sector participation, improving labour market information systems, and tailoring programmes for inclusive reach (especially women and rural youth). In conclusion, the paper argues that for India to fully realise its demographic dividend and build a resilient future workforce, skill development must pivot from mere scale to relevance and employment-linkage.
Keywords: Skill development, Employability; Workforce transformation; Vocational training; Employment generation; Future skill.

Introduction - India, the world's most populous nation, is characterized by a vast and youthful workforce that presents both immense opportunities and pressing challenges for its socio-economic development. Nearly 65 percent of India's population is under the age of 35, giving the country a potential demographic dividend that, if effectively harnessed, can drive economic growth and innovation (NITI Aayog, 2022). However, this potential is hindered by the persistent mismatch between available skills and the requirements of the labour market. Despite an expanding educational base, India faces a paradox of simultaneous unemployment and skill shortages—a phenomenon that underscores the structural disconnect between education, training, and industry needs (International Labour Organization [ILO], 2020).

In an increasingly knowledge-driven global economy, skill development has emerged as a critical determinant of employability and productivity. India's skill development landscape has undergone significant transformation in the last decade, marked by the introduction of various national programs aimed at bridging the skill gap. The Government of India launched the *Skill India Mission* in 2015 with the objective of training over 400 million individuals by 2022 through initiatives such as the *Pradhan Mantri Kaushal Vikas Yojana (PMKVY)*, *National Skill Development Mission (NSDM)*, and *Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY)* (Ministry of Skill Development and Entrepreneurship [MSDE], 2023). The *National Skill Development Corporation (NSDC)* has also played a central role in promoting public–private partnerships, accrediting training providers, and standardizing qualifications under the *National Skills Qualification Framework (NSQF)* (NSDC, 2023).

However, despite these institutional efforts, India's skilling ecosystem continues to face deep-rooted challenges. A limited alignment between training content and industrial demand, inadequate participation from small and medium enterprises, and a lack of continuous upskilling opportunities have constrained the employability of trainees (FICCI–NASSCOM–EY, 2023). Additionally, the predominance of the informal sector—employing nearly 80% of India's workforce—limits the reach and sustainability

of formal skill development initiatives (ILO, 2020). Regional disparities further exacerbate these challenges, with rural and marginalized populations often excluded from structured training programs (NITI Aayog, 2022).

Therefore, addressing India's employment challenges requires a comprehensive approach that integrates education, training, innovation, and labour market policies. This paper aims to analyze the interrelationship between skill development and employment generation in India, examining the structural gaps in the current framework and proposing strategies to build a future-ready workforce. It argues that to realize its demographic dividend, India must shift from a quantitative approach—focused merely on numbers trained—to a qualitative paradigm emphasizing employability, adaptability, and lifelong learning.

Methodology

Research Design: The present study adopts a **descriptive and analytical research design**, combining both qualitative and quantitative approaches to examine the interrelationship between skill development initiatives and employment trends in India. This mixed-method design enables a comprehensive understanding of the effectiveness of government programs, challenges in implementation, and the alignment of workforce skills with industrial demand. The study emphasizes secondary data analysis supported by empirical findings from national surveys and institutional reports (Creswell & Plano Clark, 2018).

Data Sources: This research is primarily based on **secondary data**, collected from authentic and credible sources, including:

1. Government reports and publications such as those from the **Ministry of Skill Development and Entrepreneurship (MSDE)**, **National Skill Development Corporation (NSDC)**, **NITI Aayog**, and the **Ministry of Labour and Employment**.
2. Statistical data from **National Sample Survey Office (NSSO)**, **Periodic Labour Force Survey (PLFS)**, and **Centre for Monitoring Indian Economy (CMIE)**.
3. Research articles and policy papers published in peer-reviewed journals and reports from international organizations such as the **International Labour Organization (ILO)** and the **World Economic Forum (WEF)**.

Data Collection Procedure: Data were systematically collected from online databases, institutional archives, and official government websites to ensure reliability and accuracy. Relevant research articles were retrieved using keywords such as *"skill development in India,""employment generation,""workforce transformation,"* and *"industrial skill gap."* The inclusion criteria were limited to studies and reports published between **2015 and 2024**, ensuring the recency of the data and policy relevance.

Analytical Framework: The study employs a **descriptive statistical analysis** supported by **thematic content analysis** to interpret both quantitative and qualitative data. Quantitative data (such as employment rate, labour participation, and training outcomes) were analyzed using tabular and graphical representation to identify trends and patterns. Qualitative data were categorized thematically to explore recurring issues such as skill mismatch, training quality, gender disparities, and regional imbalances in skill programs (Bryman, 2016).

Limitations of the Study: The study is limited by its reliance on secondary data, which may reflect time lags and inconsistencies in reporting. Additionally, regional data disparities and the informal sector's underrepresentation may restrict the generalizability of the findings. However, triangulation of multiple data sources has been used to enhance the validity and robustness of the analysis.

Data Visualization and Analytical Tools: To enhance the interpretation of employment and skill development data, visual analytical tools such as **bar graphs and trend charts** were employed. These visuals depict the relationship between **labour force participation rate (LFPR)**, **unemployment rate**, and **percentage of formally trained individuals** in India from **2015 to 2023**, using data compiled from the *Periodic Labour Force Survey (PLFS)* and *National Skill Development Corporation (NSDC)* reports.

The data below illustrates India's progress and challenges in developing employable skills among its workforce.

Table 1. Trends in Unemployment Rate and Skilled Workforce (2015–2023)

(Source: PLFS, Government of India; NSDC, 2023)

Year	Unemployment Rate (%)	Formally Skilled Workforce (%)	Labour Force Participation Rate (%)
2015	5.0	4.5	52.4
2016	5.3	4.8	52.1
2017	6.1	5.1	51.6
2018	6.0	5.3	50.8
2019	5.8	5.6	50.2
2020	8.0	5.9	49.5
2021	7.2	6.2	49.8
2022	6.7	6.8	50.4
2023	6.1	7.1	51.0

(Note: Data synthesized from PLFS, ILOSTAT, and NSDC Annual Reports 2015–2023.)

Interpretation: The chart shows that while India's unemployment rate fluctuated between **5–8%**, the proportion of formally skilled workers has slowly increased from **4.5% in 2015 to 7.1% in 2023**, indicating gradual improvement but still lagging behind global averages (ILO, 2020). The **labour force participation rate** shows a marginal decline, suggesting that training efforts have not yet translated into significant job absorption.

This reflects the persistent **skill–employment disconnect**, particularly in rural and informal sectors where training accessibility remains limited (MSDE, 2023; NSDC, 2023).

Employment Scenario in India: India's employment scenario presents a paradox of a large, youthful labour force and persistent unemployment. Despite being one of the fastest-growing economies, job creation has not kept pace with population growth, leading to a widening skill and employment gap (NITI Aayog, 2022; ILO, 2023).

Table 2. Key Employment Indicators in India (2015–2023)

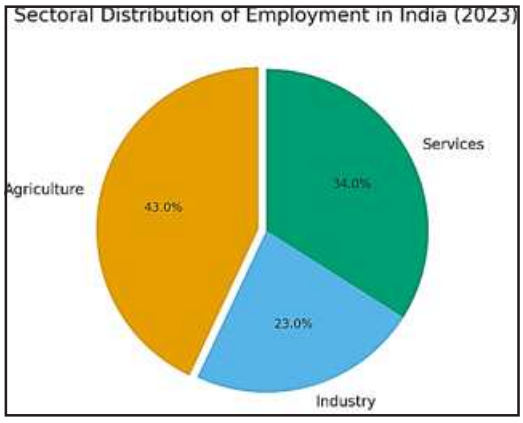
(Source: PLFS, MOSPI; ILOSTAT; NSDC Reports)

Year	Labour Force Particip -ation Rate (%)	Unemploy -ment Rate (%)	Youth Unemploy ment (15–29 yrs%)	Female LFPR (%)
2015	52.4	5.0	12.1	27.0
2017	51.6	6.1	14.3	28.2
2019	50.2	5.8	16.5	32.2
2020	49.5	8.0	19.8	34.6
2021	49.8	7.2	17.4	36.0
2023	51.0	6.1	16.8	37.0

Interpretation: The data indicate that India's **unemployment rate peaked during 2020** due to the pandemic but has since stabilized. However, **youth unemployment** and **female labour participation** remain areas of concern. Although the Female Labour Force Participation Rate (FLFPR) increased slightly from **27% (2015) to 37% (2023)**, it still falls far below the global average of 52% (World Bank, 2024).

Figure 1. Sectoral Distribution of Employment in India (2023)

(Source: Economic Survey, 2023; PLFS 2023)



Interpretation: The agricultural sector employs the largest share of workers but contributes the least to GDP, indicating **low productivity** and **underemployment**. Conversely, the service sector contributes over **50% of GDP**, reflecting its growing dominance but limited job absorption capacity.

Skill Development Initiatives in India: Skill development has emerged as a cornerstone of India's human capital strategy, aimed at enhancing employability, productivity, and inclusive economic growth. Given the country's large youth population and growing demand for skilled labour, the Government of India has implemented several flagship programs and institutional frameworks to strengthen vocational training and industry alignment (Ministry of Skill Development and Entrepreneurship [MSDE], 2023).

National Skill Development Mission (NSDM): Launched in **2015**, the **National Skill Development Mission** provides an overarching institutional framework to coordinate and integrate various skilling efforts across the country. It envisions creating a convergence of skill initiatives under a unified strategy to achieve the government's vision of *"Skilled India"*. The mission operates through seven sub-missions including institutional training, convergence, certification, and leveraging public–private partnerships (MSDE, 2023).

Pradhan Mantri Kaushal Vikas Yojana (PMKVY): The **Pradhan Mantri Kaushal Vikas Yojana (PMKVY)**, launched in **2015**, is the flagship outcome-based training program designed to provide short-term skill certification to unemployed youth. Implemented by NSDC under the aegis of MSDE, the scheme provides financial rewards upon successful completion of training and assessment.

Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY): The **DDU-GKY** targets *rural youth aged 15–35 years* from economically disadvantaged backgrounds. Implemented under the **Ministry of Rural Development (MoRD)**, it aims to diversify rural livelihoods beyond agriculture by linking training with employment opportunities in organized sectors.

National Apprenticeship Promotion Scheme (NAPS): The **NAPS** was launched in **2016** to encourage on-the-job training by providing financial incentives to employers who engage apprentices. The scheme aims to integrate theoretical education with practical industrial exposure, thereby improving employability.

Skill India Digital Platform and Future Skills PRIME: Recognizing the role of digital technologies in the future of work, the Government of India launched the **Skill India Digital Platform** in **2023**, integrating all skill-related databases, training modules, and e-learning content under a single portal.

Conclusion and Future Outlook: India stands at a pivotal juncture in its journey toward becoming a global knowledge and manufacturing hub. With over **65% of its population below the age of 35**, the country possesses a demographic dividend that can fuel long-term economic growth — but only if this potential is matched with relevant, high-quality, and future-ready skills.

This study has explored the **interconnected dynamics between skill development and employment generation** in India, highlighting the policy achievements, gaps, and emerging opportunities. Over the past decade, government-led programs such as **PMKVY**, **DDU-GKY**, **NAPS**, and **Skill India Mission** have played a vital role in creating a structured framework for vocational training and workforce empowerment. However, persistent challenges—such as

skill mismatch, inadequate infrastructure, weak industry linkages, and regional disparities—continue to limit the scalability and effectiveness of these initiatives (MSDE, 2023; NSDC, 2023).

Furthermore, India's skill ecosystem must align with the **Fourth Industrial Revolution**, emphasizing **digital literacy, artificial intelligence, renewable energy technologies, and data analytics** as key skill domains. Integration of **AI-based monitoring systems**, **real-time labour market intelligence**, and **public–private partnerships** can transform the skill landscape into a responsive, demand-driven model (ILO, 2020; NITI Aayog, 2021).

Looking ahead, the success of India's employment and skill development framework will depend on **policy convergence, robust governance, and social inclusivity**. A sustainable future lies in creating a workforce that is not only skilled but adaptable, innovative, and globally competitive—thereby ensuring that the nation's demographic dividend becomes a **demographic advantage** rather than a liability.

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Exploring Various Modes of Vocational Education

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Abstract: Vocational education and training (VET) is essential in preparing individuals for specific trades and careers, fostering a skilled workforce that meets the demands of various industries. This abstract provides an overview of the diverse modes of vocational education, including traditional classroom-based learning, apprenticeships, online and blended learning, and competency-based training.The effectiveness of these various modes is influenced by factors such as learner demographics, industry requirements, and technological advancements. As the landscape of work continues to evolve, the integration of innovative approaches and the collaboration between educational institutions and industries become crucial for developing relevant programs that enhance employability and address skills gaps.This exploration highlights the importance of adopting a multi-faceted approach to vocational education, recognizing that no single mode is universally applicable. By understanding the strengths and limitations of each mode, stakeholders can better design and implement vocational training programs that respond to the dynamic needs of the labor market, ultimately contributing to economic growth and social mobility.
Keywords: apprenticeships, modalities, accessibility, demographics, collaboration, exploration.

Introduction - Vocational education and training (VET) is essential in preparing individuals for specific trades and careers, fostering a skilled workforce that meets the demands of various industries. This abstract provides an overview of the diverse modes of vocational education, including traditional classroom-based learning, apprenticeships, online and blended learning, and competency-based training.Traditional classroom-based learning offers foundational knowledge and practical skills through instructor-led courses, while apprenticeships combine on-the-job training with classroom instruction, ensuring that learners gain hands-on experience in real-world settings. Online and blended learning modalities provide flexibility and accessibility, enabling learners to balance education with work and personal commitments. Theeffectiveness of these various modes is influenced by factors such as learner demographics, industry requirements, and technological advancements.

The various dimension of vocational education refers to the different aspects and factors that influence the delivery, effectiveness, and relevance of vocational training programs. Following are some key components of this dimension:

1. **Curriculum Variability**: Vocational education programs can differ significantly in their curriculum content, focusing on specific skills and knowledge relevant to various trades and professions. This variability can be influenced by industry needs, technological advancements, and regional economic conditions.
2. **Delivery Methods**: Vocational education can be delivered through various methods, including classroom instruction, hands-on training, apprenticeships, online courses, and blended learning approaches. Each method has its strengths and weaknesses, impacting student engagement and learning outcomes.
3. **Target Audience**: The demographic and educational background of students can vary widely, affecting how vocational education is structured. Programs may cater to high school graduates, adult learners, or individuals seeking to upskill or change careers.
4. **Industry Partnerships**: Collaboration with local businesses and industries can shape vocational education programs, ensuring that training aligns with current job market demands. These partnerships can also provide students with real-world experience through internships and job placements.
5. **Accreditation and Standards**: Different regions or countries may have varying accreditation standards for vocational education programs, affecting their recognition and quality. Compliance with these standards is crucial for ensuring that graduates meet industry expectations.
6. **Cultural Context**: The cultural attitudes toward vocational education can vary, influencing student enrollment and societal perceptions of skilled trades versus academic pathways. In some cultures, vocational training may be highly valued, while in others, it may be seen as a

lesser option.

7. **Technological Integration**: The incorporation of technology into vocational education, such as simulations, virtual reality, and online resources, can vary widely. This integration can enhance learning experiences but may also require additional training for instructors.
8. **Policy and Funding**: Government policies and funding mechanisms can significantly impact vocational education programs, affecting their availability, accessibility, and quality. Variations in support can lead to disparities in program offerings across different regions.

The target audience for vocational education can vary widely based on several factors, including the specific program, industry demands, and regional characteristics. Here are some key segments of the target audience:

1. **High School Graduates**: Many vocational programs are designed for students who have recently completed high school and are looking to enter the workforce with practical skills.
2. **Adult Learners**: This group includes individuals seeking to change careers, upskill, or enhance their qualifications. Adult learners often have different motivations and learning styles compared to traditional students.
3. **Unemployed or Underemployed Individuals**: Vocational education can serve those who are currently unemployed or underemployed, providing them with the skills needed to secure better job opportunities.
4. **Industry Professionals**: Some programs target existing professionals looking to specialize further or gain certifications in their field, helping them stay competitive in a rapidly changing job market. Engineers of PWDs and private developers get training at CRRI or Highway Institute to upscale their knowledge.
5. **Displaced Workers**: Individuals who have lost their jobs due to economic shifts or technological advancements may seek vocational training to transition into new careers.
6. **Youth at Risk**: Programs may also focus on at-risk youth, providing them with skills and opportunities to engage in productive careers and reduce the likelihood of negative outcomes.
7. **Employers and Industry Partners**: While not traditional students, employers are a crucial audience, as they often collaborate with educational institutions to shape programs that meet workforce needs.
8. **Community Organizations**: Nonprofits and community groups may also be involved in promoting vocational education to specific populations, such as minorities or low-income individuals.

By establishing strong industry partnerships, vocational education providers can create more dynamic and effective training programs that equip students with the skills and knowledge necessary to succeed in their chosen fields. The cultural context of vocational education encompasses the beliefs, values, practices, and social norms that influence how vocational training is perceived, implemented, and received within a specific society. Here are some key aspects to consider:

1. **Perception of Vocational Education**: In some cultures, vocational education is highly respected and seen as a viable pathway to successful careers, while in others, it may be viewed as a lesser option compared to traditional academic routes. This perception can affect enrollment rates and the societal status of skilled trades.
2. **Cultural Attitudes Toward Work**: Different cultures have varying attitudes toward work and education. In cultures that value hands-on skills and craftsmanship, vocational education may be more widely embraced. Conversely, cultures that prioritize academic achievement may lead to stigmatization of vocational paths.
3. **Gender Roles**: Cultural norms regarding gender can significantly impact participation in vocational education. In some societies, certain trades may be gendered, with expectations that women or men should pursue specific fields. This can limit opportunities and influence the types of programs offered.
4. **Economic Factors**: The economic context of a culture can shape vocational education. In regions with high demand for skilled labor, vocational programs may flourish, while in areas with fewer job opportunities, interest in such programs may wane.
5. **Community Engagement**: The role of community organizations and local businesses in promoting vocational education can vary. In some cultures, strong community ties can lead to robust support for vocational training, while in others, a lack of engagement may hinder program development.
6. **Language and Communication**: Language barriers can affect access to vocational education, particularly for immigrant populations. Programs that accommodate diverse linguistic backgrounds can enhance participation and success rates.
7. **Technological Adoption**: Cultural attitudes toward technology can influence how vocational education is delivered. Societies that embrace innovation may integrate advanced technologies into training programs, while others may rely on traditional methods.
8. **Policy and Governance**: Cultural values often shape educational policies and governance structures, affecting funding, curriculum design, and the overall approach to vocational education. Societies that prioritize workforce development may invest more in vocational training initiatives.

Vocational education has become highly relevant in today's rapidly changing job market for several reasons. Many industries face a shortage of skilled workers. Vocational education provides targeted training that equips individuals with the specific skills needed to fill these gaps, ensuring that graduates are job-ready and capable of meeting employer demands.

Vocational education plays a crucial role for upskilling

our youth for making them employable and be an active partner of Nation Building. Ministry of Skill Development And Entrepreneurship has established various department to frame policy guidelines, coordinate and impart vocational education as illustrated below:

1. The Directorate General of Training (DGT) in Ministry of Skill Development and Entrepreneurship is the apex organisation for development and coordination at National level for the programmes relating to vocational training including Women's Vocational Training.
2. The Directorate of Jan Shikshan Sansthan (DJSS), which is a sub-ordinate office of MSDE, is assigned responsibility of monitoring and supervision of the JSS Scheme. DJSSs implements JSS Scheme through the network of Jan Shikhan Sansthans NGOs.
3. The National Council for Vocational Education and Training (NCVET) was established in Dec,2018, by the Ministry of Skill Development and Entrepreneurship (MSDE), Government of India, as an overarching national regulator for setting standards and formulating comprehensive regulations for the vocational education, training, and skilling ecosystem for improving quality and outcomes.
4. The National Skill Development Corporation India (NSDC) was setup as a one of its kind, Public Private Partnership Company with the primary mandate of catalysing the skills landscape in India. The main objectives of the NSDC are to upgrade skills to international standards through significant industry involvement and develop necessary frameworks for standards, curriculum and quality assurance.Enhance, support and coordinate private sector initiatives for skill development through appropriate Public-Private Partnership (PPP) models; strive for significant operational and financial involvement from the private sector.Play the role of a "market-maker" by bringing financing, particularly in sectors where market mechanisms are ineffective or missing.Prioritize initiatives that can have a multiplier or catalytic effect as opposed to one-off impact.
5. NSDC achieved many milestones like they collaborated with 235 private sector partnerships for training and capacity building, each to train at least 50,000 persons over a 10-year period.38 Sector Skill Councils (SSC) approved in services, manufacturing, agriculture & allied services, and informal sectors. Sectors include 19 of 20 high priority sectors identified by the Government and 25 of the sectors under Make in India initiative.1386 Qualification Packs with 6,744 unique National Occupational Standards (NOS). These have been validated by over 1000 companies.Vocational training introduced in 10 States, covering 2400+ schools, 2 Boards, benefitting over 2.5 lakh students. Curriculum based on National Occupational Standards (NOS) and SSC certification. NSDC is working with 21 universities, Community Colleges under UGC/ AICTE for alignment of education and training to NSQF.

In summary, vocational education is not only relevant but essential in today's economy. It provides practical skills, supports economic growth, and offers diverse career pathways, making it a critical component of workforce development and individual success.

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रोजगारपरक शिक्षा व्यवस्था में सूचना प्रौद्योगिकी का महत्व एवं संभावनाएं

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शोध सारांश – 'शिक्षा सबसे शक्तिशाली हथियार है जिसे आप दुनिया बदलने के लिए इस्तेमाल कर सकते हैं' – नेल्सन मंडेला

वर्तमान युग में शिक्षा का उद्देश्य केवल ज्ञानप्राप्ति तक सीमित नहीं रहा, बल्कि यह जीवनोपयोगी कौशलों और रोजगार के अवसरों से भीजुड़ गया है। रोजगारपरक शिक्षा विद्यार्थियों को व्यावहारिक ज्ञान, तकनीकी दक्षताऔर उद्योग जगत की आवश्यकताओं के अनुरूप तैयार करती है। पिछले कुछ दशकों से प्रौद्योगिकी ने हर संभव मार्ग से हमारे जीवन को पूरी तरह बदल दिया है। भारत एक सफल सूचना और संचार प्रौद्योगिकी से सज्जित राष्ट्र होने के नाते सदैव सूचना और संचार प्रौद्योगिकी के उपयोग पर अत्याधिक बल देता रहा हैद्यवर्तमान युग में ऑनलाइन शिक्षा पद्धति एक शक्तिशाली औजार के रूप में सामने आई है। यह शोध पत्र भारत में रोजगारपरक शिक्षा के विभिन्न आयामों, चुनौतियों और संभावनाओं का विश्लेषण करता है।

शब्द कुंजी – रोजगारपरक शिक्षा,वर्तमान शिक्षण परिवेश, संचार माध्यम, तकनीकी विकास, ऑनलाइन शिक्षण पद्धति।

प्रस्तावना – शिक्षा समाज का दर्पण होती है। आज के प्रतिस्पर्धी युग में पारंपरिक शिक्षा के साथ-साथ व्यावसायिक या रोजगारपरक शिक्षा की आवश्यकता और भी अधिक हो गई है। राष्ट्रीय शिक्षा नीति (NEP2020) में भी इस बात पर बल दिया गया है कि विद्यार्थियों को ऐसी शिक्षा दी जाए जिससे वे आत्मनिर्भर बन सकें।शिक्षा नि: संदेह एक देश की मानव पूंजी के निर्माण में किए जाने वाले सर्वाधिक महत्वपूर्ण निवेशों में से एक है और एक ऐसा माध्यम है जो न केवल अच्छे साक्षर नागरिकों को गढ़ता है बल्कि एक राष्ट्र को तकनीकी रूप से नवाचारी भी बनाता है और इस प्रकार आर्थिक वृद्धि की दिशा में मार्ग प्रशस्ति होता है। भारत में ऐसे अनेक कार्यक्रम और योजनाएं, जैसे मुफ्त और अनिवार्य प्राथमिक शिक्षा, 'सर्व शिक्षा अभियान', राष्ट्रीय साक्षरता अभियान आदि शिक्षा प्रणाली में सुधार लाने के लिए सरकार द्धारा आरंभ किए गए हैं।

शिक्षा के क्षेत्र में सूचना और संचार प्रौद्योगिकी के सर्वाधिक महत्वपूर्ण योगदानों में से एक है अधिगम्यता पर आसान पहुंच संसाधन। सूचना और संचार प्रौद्योगिकी की सहायता से छात्र अब ई-पुस्तकें, परीक्षा के नमूने वाले प्रश्न पत्र, पिछले वर्षों के प्रश्न पत्र आदि देखने के साथ संसाधन व्यरक्तियों, मेंटोर, विशेषज्ञों, शोधकर्ताओं, व्यावसायिकों और साथियों से दुनिया के किसी भी कोने पर आसानी से संपर्क कर सकते हैं।सूचना और संचार प्रौद्योगिकी आधारित शिक्षा आपूर्ति (रेडियो और टेलिविजन पर शैक्षिक कार्यक्रमों का प्रसारण) से सभी सीखने वाले और अनुदेशक को एक भौतिक स्थान पर होने की आवश्यकता समाप्ती हो जाती है।जब से सूचना और संचार प्रौद्योगिकी को एक शिक्षण माध्यम के रूप में उपयोग किया गया है, इसने एक त्रुटिहीन प्रेरक साधन के रूप में कार्य किया है, इसमें वीडियो, टेलिविजन, मल्टीमीडिया कम्प्युटर सॉफ्टवेयर का उपयोग शामिल है जिसमें, ध्वनि और रंग निहित है। इससे छात्र सीखने की प्रक्रिया में गहराई से जुडते हैं।

परिचय– वर्तमान युग में शिक्षा का उद्देश्य केवल ज्ञान अर्जन तक सीमित नहीं रहा, बल्कि यह जीवनोपयोगी कौशलों, नवाचार और रोजगार के अवसरों से गहराई से जुड़ चुका है। तेजी से बदलते वैश्विक परिदृश्य में शिक्षा का स्वरूप भी परिवर्तित हुआ है, जहाँ केवल सैद्धांतिक ज्ञान पर्याप्त नहीं माना जाता, बल्कि व्यावहारिक अनुभव और तकनीकी दक्षता अधिक महत्त्वपूर्ण हो गई है। रोजगारपरक शिक्षा विद्यार्थियों को उद्योग जगत की आवश्यकताओं के अनुरूप तैयार करने का कार्य करती है। इसके माध्यम से शिक्षार्थी न केवल शैक्षणिक प्रवीणता अर्जित करते हैं, बल्कि वे आधुनिक प्रौद्योगिकी, उद्यमिता और नवाचार की दिशा में भी सक्षम बनते हैं।

भारत जैसे विकासशील देश में रोजगारपरक शिक्षा का प्रसार युवाओं को आत्मनिर्भर बनाने के साथ-साथ बेरोजगारी की समस्या को भी कम कर सकता है। हालाँकि, इस दिशा में कई चुनौतियाँ भी हैं, जैसे अपर्याप्त संसाधन, प्रशिक्षित शिक्षकों की कमी, तथा उद्योग और शिक्षा संस्थानों के बीच समन्वय की आवश्यकता। यदि सरकार, उद्योग जगत और शिक्षण संस्थान मिलकर एक सुदृढ़ व्यावसायिक शिक्षा ढाँचा तैयार करें, तो यह न केवल आर्थिक विकास में योगदान देगा बल्कि युवाओं को वैश्विक प्रतिस्पर्धा के लिए तैयार करेगा। इस प्रकार, रोजगारपरक शिक्षा आधुनिक भारत की प्रगति की एक प्रमुख कुंजी सिद्ध हो सकती है।

रोजगारपरक शिक्षा को बढ़ावा देने के लिए इसे डिजिटल प्रणाली से जोड़ा गया है।वर्तमान परिवेश में शहरों की तुलना में ग्रामीण क्षेत्रों का डिजिटल शिक्षण प्रणाली से जुड़ना मुश्किल लगता है क्योंकि हमारे देश में डिजिटल माध्यम के लिए आवश्यक संचार सुविधाओं का आभाव है, परन्तु भविष्य में सम्पूर्ण भारत वर्ष डिजिटल शिक्षण व्यवस्था से जुड़ने के लिए अग्रसर है।

इस प्रक्रिया में 9 राष्ट्रीय संस्थाएं है जो इस प्रकार व्यावसायिक

पाठ्यक्रमों को संचालित करती है –

इंदिरा गांधी राष्ट्रीय मुक्त विश्वविद्यालय (IGNOU), राष्ट्रीय मुक्त विद्यालयी शिक्षा संस्थान (NIOS), राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद (NCERT),नेशनल प्रोग्राम ओन टेक्नोलॉजी एनहांस्ड लर्निंग (NPTEL), विश्वविद्यालय अनुदान आयोग (UGC), अखिल भारतीय तकनीकी शिक्षा परिषद (AICTE), कंसोर्टियम फॉर एजुकेशनल कम्युनिकेशन (CEC), भारतीय प्रबंधन संस्थान बैंगलोर (IIM-B), नेशनल इंस्टीट्यूट ऑफ टेक्निकल टीचर्स ट्रेनिंग एंड रिसर्च (NITTTR) चेन्नई

रोजगारपरक डिजिटल शिक्षा प्रणाली को मजबूत करने के लिए SWAYAM PORTAL का भी उपयोग किया जा रहा है। जिसकी दो श्रेणियाँ हैं –

SWAYAM PRABHA मानव संसाधन विकास मंत्रालय की एक पहल है जो देश भर में DTH (डायरेक्ट टू होम) के जरिए 32 उच्च गुणवत्ता वाले शैक्षणिक चैनल उपलब्ध कराती है।

ePGPATHSHALA आईसीटी (एनएमई–आईसीटी) के माध्यम से यूजीसी द्वारा निष्पादित किए जाने वाले राष्ट्रीय मिशन के तहत एमएचआरडी की एक पहल है।

रोजगारपरक शिक्षा के प्रमुख आयाम:

1. **तकनीकी आयाम:** आईटीआई, पॉलिटेक्निक, स्किल इंडिया मिशन आदि।
2. **सामाजिक आयाम:** ग्रामीण युवाओं को आत्मनिर्भर बनाना, महिला सशक्तिकरण।
3. **आर्थिक आयाम:** बेरोजगारी दर में कमी, उद्यमिता को बढ़ावा।
4. **शैक्षणिक आयाम:** पाठ्यक्रम में व्यावहारिक प्रशिक्षण।
5. **मनोवैज्ञानिक आयाम:** आत्मविश्वास और आत्मनिर्भरता का विकास।

रोजगारपरक शिक्षा कीसरकारी योजनाएँ: स्किल इंडिया मिशन (2015), प्रधानमंत्री कौशल विकास योजना (PMKVY), राष्ट्रीय कौशल विकास निगम (NSDC) Startup India और Make in India, Digital India अभियान

रोजगारोन्मुखी पाठ्यक्रमों में सूचना प्रौद्योगिकी का प्रभाव: शिक्षा व्यवस्था में आई . सी . टी . के अभिग्रहण से निम्नलिखित सुविधाएँ प्राप्त होती हैं –

1. दूरवर्ती स्थानों में पढ़ाई की गुणवत्ता बढ़ाई जा सकती है।
2. डिजिटल शिक्षा प्रणाली के माध्यम से हम पूरे देश में बड़े पैमाने पर छात्रों की विस्तृत सहभागिता सुनिश्चित कर सकते है ।
3. शिक्षा संस्थानों में अधिक पारदर्शिता प्रणाली लाने से उनकी प्रक्रियाओं और अनुपालन मानदंडों को मजबूती मिलती है।
4. यह छात्रों के प्रदर्शन, नियुक्ति, वेबसाइट एनालिटिक्स और ब्रांड के ऑडिट के लिये सोशल मीडिया मेट्रिक्स का विश्लेषण करने के लिये प्रयोग किया जाता है।
5. इंटरनेट (वर्चुअल क्लास रूम) उपग्रह और अन्य माध्यमों द्वारा पाठ्यक्रम वितरण के साथ दूरस्थ शिक्षा सुविधाजनक बना दी गयी है।

रोजगारोन्मुखी पाठ्यक्रमों में ऑनलाइन शिक्षण प्रौद्योगिकी आधारित शिक्षण प्रणाली की चुनौतियाँ:

1. इंफ्रास्ट्रक्चर और हार्डवेयर सुविधाओं का अभाव जो ऑनलाइन सीखने की विश्वसनीयता को बाधित करता है ।
2. भारत के अनपढ़ ग्रामीण क्षेत्रों को प्रशिक्षित करने के लिए इच्छुक कुशल जनशक्ति खोजने में समस्या।
3. ग्रामीण विकास में आईसीटी के महत्व के बारे में अपने ज्ञान को बढ़ाने के लिए सरकारी प्राथमिक स्कूलों में छात्रों को सिखाया जाने वाला कोई कंप्यूटर या बहुत कम आधारित पाठ्यक्रम नहीं है ।

रोजगारोन्मुखी पाठ्यक्रमों में आर्टिफिशियल इंटेलिजेंस (ए.आई.)/ मशीन लर्निंग (एम.एल.) का महत्व एवं उपयोगिताएं:

1. **व्यक्तिगत शिक्षा:** ए.आई.और एम.एल.तकनीकें छात्रों की व्यक्तिगत जरूरतों और क्षमताओं के आधार पर शिक्षा को अनुकूलित करती हैं। उदाहरण के लिए, एक ए.आई.–संचालित प्लेटफॉर्म छात्र की सीखने की गति, रुचि और समझ के अनुसार पाठ्यक्रम को समायोजित कर सकता है।
2. **शिक्षण की गुणवत्ता में सुधार:** ए.आई. उपकरण शिक्षकों को उनके शिक्षण विधियों का विश्लेषण करने और सुधारने में मदद करते हैं। वे छात्रों के प्रदर्शन के आधार पर शिक्षण तकनीकों का मूल्यांकन कर सकते हैं और उन्हें बेहतर बनाने के लिए सिफारिशें प्रदान कर सकते हैं।
3. **आकलन और मूल्यांकन:** ए.आई.–आधारित सिस्टम स्वचालित रूप से छात्रों की परीक्षा और असाइनमेंट का मूल्यांकन कर सकते हैं। यह न केवल शिक्षकों का समय बचाता है बल्कि मूल्यांकन प्रक्रिया को भी अधिक सटीक और निष्पक्ष बनाता है।
4. **डेटा एनालिटिक्स;** ए.आई. और एम.एल. का उपयोग करके बड़े पैमाने पर डेटा का विश्लेषण किया जा सकता है। यह डेटा छात्रों की प्रगति, उनकी कठिनाइयों और अन्य महत्वपूर्ण पहलुओं की पहचान करने में मदद करता है, जिससे शिक्षकों को छात्रों के लिए अधिक प्रभावी शिक्षा योजनाएँ बनाने में सहायता मिलती है।
5. **इंटरएक्टिव लर्निंग:** ए.आई.–आधारित टूल्स और ऐप्स छात्रों को अधिक इंटरएक्टिव और आकर्षक तरीके से सीखने में मदद करते हैं। वर्चुअल रियलिटी (वी.आर.) और ऑगमेंटेड रियलिटी (ए.आर.) जैसी तकनीकों के माध्यम से छात्र जटिल अवधारणाओं को भी आसानी से समझ सकते हैं।
6. **भाषा अनुवाद:** ए.आई.–आधारित भाषा अनुवाद टूल्स छात्रों को विभिन्न भाषाओं में अध्ययन सामग्री उपलब्ध कराने में मदद करते हैं। यह विशेष रूप से उन छात्रों के लिए फायदेमंद है जो दूसरी भाषा में शिक्षा प्राप्त कर रहे हैं।
7. **स्मार्ट कंटेंट:** ए.आई. तकनीकें पाठ्यक्रम सामग्री को स्मार्ट और इंटरएक्टिव बनाने में सक्षम हैं। उदाहरण के लिए, ए.आई.–संचालित प्लेटफॉर्म टेक्स्टबुक्स को इंटरएक्टिव लेसंस में बदल सकते हैं, जो छात्रों के लिए अधिक आकर्षक और समझने में आसान होती हैं।

रोजगारोन्मुखी पाठ्यक्रमों में सुधार हेतु सुझाव:

1. स्कूल स्तर से ही कौशल शिक्षा अनिवार्य की जाए।
2. उद्योग–अकादमिक गठबंधन को मजबूत किया जाए।
3. Career Counselling Cells से की स्थापना की जाए।
4. महिलाओं और ग्रामीण युवाओं के लिए विशेष प्रशिक्षण कार्यक्रम चलाए जाएँ।
5. निजी क्षेत्र की भागीदारी को बढ़ावा दिया जाए।

निष्कर्ष – सूचना व संचार प्रौद्योगिकी उन कार्यों के लिए इस्तेमाल

किया जाता है, जो इस्तेमाल माध्यम से सूचना के प्रेषण, संग्रहण, निर्माण, प्रदर्शन या आदान – प्रदान में काम आते हैं। सूचना व संचार प्रौद्योगिकी की इस व्यापक परिभाषा के तहत रेडियो, टीवी, वीडियो, डीवीडी, टेलीफोन, स्मार्ट फोन, सैटेलाइट प्रणाली, कंप्यूटर और नेटवर्क हार्डवेयर एवं सॉफ्टवेयर आदि सभी आते हैं। इसके अलावा इन प्रौद्योगिकी से जुड़ी हुई सेवाएं और उपकरण, जैसे वीडियो कॉन्फ्रेंसिंग, ई–मेल और ब्लॉग्स आदि भी आईसीटी के दायरे में आते हैं। जब शिक्षा प्रणाली में इन सब वर्तमान संचार तकनीको का इस्तेमाल किया जाए तो शिक्षा व्यवस्था रोजगारपरक शिक्षा कहलाएगी और देश के विकास में अग्रणी भूमिका अदा करेगी रोजगारपरक शिक्षा केवल रोजगार प्राप्ति का साधन नहीं है, बल्कि यह समग्र मानव विकास की दिशा में एक महत्वपूर्ण कदम है। यदि इसे प्रभावी रूप से लागू किया जाए तो यह बेरोजगारी की समस्या को काफी हद तक दूर कर सकती है और युवाओं को आत्मनिर्भर बना सकती है।

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रोजगारपरक शिक्षा के विविध आयाम एवं उनका क्रियान्वयन

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शोध सारांश – वर्तमान समय में शिक्षा का उद्देश्य केवल ज्ञानार्जन तक सीमित नहीं रह गया है, बल्कि यह रोजगार एवं आजीविका से जुड़ चुका है। रोजगारपरक शिक्षा विद्यार्थियों को व्यावहारिक कौशल, तकनीकी दक्षता तथा आत्मनिर्भर बनने की क्षमता प्रदान करती है। इसके विविध आयामों में तकनीकी शिक्षा, व्यवसायिक प्रशिक्षण, सूचना प्रौद्योगिकी, कृषि एवं हस्तशिल्प आधारित प्रशिक्षण, उद्यमिता विकास तथा उद्योग–शिक्षा साझेदारी प्रमुख हैं। इन आयामों का उद्देश्य युवाओं को स्थानीय एवं वैश्विक बाजार की मांगों के अनुरूप तैयार करना है।

क्रियान्वयन के स्तर पर विद्यालयों, महाविद्यालयों तथा प्रशिक्षण संस्थानों में पाठ्यक्रमों का पुनर्गठन आवश्यक है ताकि शिक्षा प्रणाली को उद्योगों की आवश्यकताओं से जोड़ा जा सके। इसके लिए 'स्किल इंडिया मिशन', 'राष्ट्रीय शिक्षा नीति 2020' तथा 'प्रधानमंत्री कौशल विकास योजना'जैसे कार्यक्रमों का प्रभावी संचालन महत्त्वपूर्ण भूमिका निभा सकता है। साथ ही, शिक्षकों का प्रशिक्षण, आधुनिक उपकरणों की उपलब्धता और उद्योगों के साथ समन्वय भी अनिवार्य है।

इस प्रकार, रोजगारपरक शिक्षा युवाओं में न केवल रोजगार प्राप्त करने की योग्यता विकसित करती है, बल्कि उन्हें स्वरोजगार के लिए भी सक्षम बनाती है। यह शिक्षा प्रणाली को ज्ञानकेन्द्रित से कौशल केन्द्रित दिशा में रूपांतरित करने का माध्यम बन सकती है, जिससे राष्ट्र के सर्वांगीण विकास में योगदान सुनिश्चित किया जा सकता है।

शब्द कुंजी – रोजगार परक शिक्षा, कौशल विकास, व्यावसायिक शिक्षा, तकनीकी शिक्षा, उद्यमिता, कौशल प्रशिक्षण, आत्मनिर्भरता।

प्रस्तावना – भारत विश्व के उन देशों में से एक है जहाँ युवा जनसंख्या का अनुपात बहुत अधिक है। यह स्थिति देश के लिए एक अवसर भी है और चुनौती भी। यदि युवाओं को उचित शिक्षा और कौशल प्रशिक्षण प्राप्त हो तो वे देश की प्रगति में महत्वपूर्ण भूमिका निभा सकते हैं। दूसरी ओर यदि शिक्षा उन्हें रोजगार के योग्य नहीं बना पाती तो बेरोजगारी की समस्या बढ़ सकती है।पारंपरिक शिक्षा प्रणाली मुख्य रूप से सैद्धांतिक ज्ञान पर आधारित रही है, जिसके कारण विद्यार्थियों को वास्तविक कार्यक्षेत्र में आवश्यक कौशल प्राप्त नहीं हो पाता। परिणामस्वरूप अनेक शिक्षित युवा भी रोजगार प्राप्त करने में कठिनाई अनुभव करते हैं।इस स्थिति को सुधारने के लिए रोजगार परक शिक्षा की आवश्यकता महसूस की गई। रोजगार परक शिक्षा का उद्देश्य विद्यार्थियों को ऐसे ज्ञान और कौशल से लैस करना है जो उन्हें कार्यक्षेत्र में उपयोगी बनाते हैं। यह शिक्षा विद्यार्थियों को व्यावहारिक अनुभव प्रदान करती है तथा उन्हें आत्मनिर्भर बनने के लिए प्रेरित करती है।

रोजगार परक शिक्षा की अवधारणा – रोजगार परक शिक्षा वह शिक्षा है जिसमें विद्यार्थियों को किसी विशेष कार्य या व्यवसाय के लिए आवश्यक ज्ञान, तकनीकी दक्षता और व्यावहारिक प्रशिक्षण प्रदान किया जाता है। इसका मुख्य उद्देश्य विद्यार्थियों को रोजगार योग्य बनाना है।इस प्रकार की शिक्षा में सैद्धांतिक ज्ञान के साथ–साथ व्यावहारिक अनुभव को भी महत्व दिया जाता है। इसमें कार्यशालाओं, प्रयोगशालाओं, प्रशिक्षण कार्यक्रमों और इंटर्नशिप के माध्यम से विद्यार्थियों को वास्तविक कार्य परिस्थितियों से परिचित कराया जाता है।रोजगार परक शिक्षा विद्यार्थियों को केवल नौकरी प्राप्त करने के लिए ही नहीं बल्कि स्वयं का व्यवसाय शुरू करने के लिए भी प्रेरित करती है। इस प्रकार यह आत्मनिर्भरता और उद्यमिता को बढ़ावा देती है।

रोजगार परक शिक्षा के उद्देश्य – रोजगार परक शिक्षा के प्रमुख उद्देश्य हैं कि:

1. विद्यार्थियों को रोजगार प्राप्त करने के लिए आवश्यक कौशल प्रदान करना।
2. युवाओं में आत्मनिर्भरता की भावना विकसित करना।
3. शिक्षा को व्यावहारिक और उपयोगी बनाना ताकि सभी शिक्षा ग्रहण कर सके।
4. उद्योगों और शिक्षा संस्थानों के बीच समन्वय स्थापित करना। जिससे विद्यार्थी शिक्षा संस्थानों से ज्ञान अर्जित कर उद्योगों में अपने कौशल का उपयोग कर सके ।
5. युवाओं के शिक्षित एवं कौशलयुक्त होने से बेरोजगारी की समस्या को कम किया जा सकता है।
6. विद्यार्थियों में उद्यमिता और नवाचार की भावना विकसित करना।

रोजगार परक शिक्षा के विविध आयाम

कौशल विकास – कौशल विकास रोजगार परक शिक्षा का सबसे महत्वपूर्ण आयाम है। इसके अंतर्गत विद्यार्थियों को विभिन्न प्रकार के तकनीकी और व्यावहारिक कौशल सिखाए जाते हैं। उदाहरण के लिए कंप्यूटर संचालन, इलेक्ट्रॉनिक्स, मशीन संचालन, डिजाइनिंग, हस्तकला आदि। कौशल आधारित शिक्षा विद्यार्थियों को कार्यक्षेत्र में तुरंत कार्य करने के योग्य बनाती है और उनकी रोजगार क्षमता को बढ़ाती है।

व्यावसायिक शिक्षा – व्यावसायिक शिक्षा के माध्यम से विद्यार्थियों को किसी विशेष व्यवसाय या कार्य से संबंधित प्रशिक्षण प्रदान किया जाता है। इसमें औद्योगिक प्रशिक्षण संस्थान (आईटीआई), पॉलिटेक्निक संस्थान और अन्य तकनीकी प्रशिक्षण केंद्र महत्वपूर्ण भूमिका निभाते हैं। व्यावसायिक शिक्षा विद्यार्थियों को व्यावहारिक अनुभव प्रदान करती है और उन्हें विभिन्न तकनीकी क्षेत्रों में विशेषज्ञ बनाती है।

तकनीकी शिक्षा – तकनीकी शिक्षा आधुनिक उद्योगों और प्रौद्योगिकी के विकास के लिए अत्यंत आवश्यक है। इसके अंतर्गत इंजीनियरिंग, सूचना प्रौद्योगिकी, इलेक्ट्रॉनिक्स, कंप्यूटर विज्ञान आदि क्षेत्रों का अध्ययन शामिल है। तकनीकी शिक्षा विद्यार्थियों को वैज्ञानिक दृष्टिकोण प्रदान करती है तथा उन्हें आधुनिक तकनीकों के उपयोग के लिए तैयार करती है

उद्यमिता विकास – रोजगार परक शिक्षा का एक महत्वपूर्ण उद्देश्य विद्यार्थियों को उद्यमी बनाना भी है। उद्यमिता शिक्षा के माध्यम से विद्यार्थियों को व्यवसाय स्थापित करने, प्रबंधन करने तथा आर्थिक जोखिमों का सामना करने की क्षमता विकसित की जाती है। इससे विद्यार्थी केवल नौकरी पाने वाले नहीं बल्कि नौकरी देने वाले भी बन सकते हैं।

उद्योग–शिक्षा समन्वय – रोजगार परक शिक्षा के सफल क्रियान्वयन के लिए उद्योगों और शिक्षा संस्थानों के बीच सहयोग आवश्यक है। इसके माध्यम से विद्यार्थियों को इंटर्नशिप, प्रशिक्षण और औद्योगिक भ्रमण के अवसर मिलते हैं। इस प्रकार विद्यार्थियों को वास्तविक कार्य वातावरण का अनुभव प्राप्त होता है।

जीवन कौशल विकास – रोजगार परक शिक्षा में जीवन कौशल का भी महत्वपूर्ण स्थान है। संचार कौशल, नेतृत्व क्षमता, समय प्रबंधन, समस्या समाधान और टीमवर्क जैसे कौशल विद्यार्थियों को कार्यक्षेत्र में सफलता प्राप्त करने में सहायता करते हैं।

शोध पद्धति – इस शोध पत्र में मुख्यत:द्वितीयक स्रोतों (Secondary Sources) का उपयोग किया गया है। विभिन्न पुस्तकों, शोध पत्रों, सरकारी रिपोर्टों तथा शिक्षा से संबंधित लेखों का अध्ययन करके जानकारी एकत्रित की गई है। इस अध्ययन का उद्देश्य रोजगार परक शिक्षा के विभिन्न आयामों का विश्लेषण करना तथा उसके प्रभावी क्रियान्वयन के उपायों को समझना है।

रोजगार परक शिक्षा का क्रियान्वयन – रोजगार परक शिक्षा को प्रभावी बनाने के लिए निम्नउपाय अपनाए जा सकते हैं:

पाठ्यक्रम में सुधार: शिक्षा के पाठ्यक्रम को आधुनिक आवश्यकताओं के अनुसार संशोधित किया जाना चाहिए। इसमें कौशल आधारित और व्यावहारिक विषयों को शामिल किया जाना चाहिए।

व्यावहारिक प्रशिक्षण: विद्यार्थियों को प्रयोगशालाओं, कार्यशालाओं और उद्योगों में प्रशिक्षण प्रदान किया जाना चाहिए ताकि वे वास्तविक अनुभव प्राप्त कर सकें।

प्रशिक्षण संस्थानों का विकास: देश में अधिक से अधिक तकनीकी और व्यावसायिक प्रशिक्षण संस्थानों की स्थापना की जानी चाहिए ताकि युवाओं को कौशल आधारित शिक्षा प्राप्त हो सके।

सरकारी योजनाओं का विस्तार: सरकार द्वारा चलाए जा रहे कौशल विकास कार्यक्रमों को अधिक प्रभावी बनाया जाना चाहिए और उनका विस्तार किया जाना चाहिए।

उद्योगों की भागीदारी: उद्योगों को शिक्षा संस्थानों के साथ मिलकर प्रशिक्षण और इंटर्नशिप कार्यक्रम चलाने चाहिए ताकि विद्यार्थियों को कार्यक्षेत्र की वास्तविक जानकारी प्राप्त हो सके।

रोजगार परक शिक्षा की चुनौतियाँ – रोजगार परक शिक्षा के क्रियान्वयन में कई समस्याएँ सामने आती हैं:

1. पारंपरिक शिक्षा प्रणाली का प्रभुत्व तथा नई शिक्षा प्रणाली के प्रचार प्रसार का अभाव
2. पर्याप्त प्रशिक्षण संस्थानों की कमी तथा उनमें प्रवेश कि जटिलता
3. तकनीकी संसाधनों का अभाव
4. उद्योग और शिक्षा संस्थानों के बीच समन्वय की कमी
5. विद्यार्थियों और अभिभावकों में जागरूकता की कमी

इन चुनौतियों को दूर करने के लिए शिक्षा नीति में व्यापक सुधार की आवश्यकता है।

सुझाव– रोजगार परक शिक्षा को प्रभावी बनाने के लिए निम्न सुझाव दिए जा सकते हैं:

1. शिक्षा प्रणाली को अधिक व्यावहारिक और रोजगार परक बनाया जाए जिससे शिक्षा का लाभ सभी को प्राप्त हो सके।
2. विद्यालय स्तर से ही कौशल आधारित शिक्षा प्रारंभ की जाए और विधयार्थियों के कौशल के आधार पर उनको शिक्षा प्रदान की जाए।
3. उद्योगों और शिक्षा संस्थानों के बीच सहयोग बढ़ाया जाए।
4. विद्यार्थियों को उद्यमिता के लिए प्रोत्साहित किया जाए जिससे वे स्वयं का रोजगार उत्पन्न कर सके।
5. तकनीकी संसाधनों और प्रशिक्षण सुविधाओं को अत्यधिक विकसित किया जाए।

निष्कर्ष– रोजगार परक शिक्षा वर्तमान समय की एक महत्वपूर्ण आवश्यकता है। यह शिक्षा विद्यार्थियों को केवल ज्ञान प्रदान करने तक सीमित नहीं रहती बल्कि उन्हें जीवन के लिए तैयार करती है। यदि शिक्षा प्रणाली में कौशल विकास, तकनीकी प्रशिक्षण और उद्यमिता को उचित स्थान दिया जाए तो युवाओं की रोजगार क्षमता में उल्लेखनीय वृद्धि हो सकती है। इससे न केवल बेरोजगारी की समस्या कम होगी बल्कि देश के आर्थिक और सामाजिक विकास को भी गति मिलेगी।इसलिए सरकार, शिक्षा संस्थानों और उद्योगों को मिलकर रोजगार परक शिक्षा को बढ़ावा देना चाहिए ताकि युवा पीढ़ी आत्मनिर्भर बन सके और राष्ट्र के विकास में सक्रिय योगदान दे सके।

संदर्भ ग्रंथ सूची :–

1. राष्ट्रीय शिक्षा नीति (2020) – भारत सरकार
2. कौशल विकास और उद्यमिता मंत्रालय की रिपोर्ट
3. शिक्षा और रोजगार पर आधारित विभिन्न शोध पत्र एवं शैक्षणिक पुस्तकें
4. विश्वविद्यालय अनुदान आयोग (UGC) से संबंधित शैक्षणिक सामग्री

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The Interdisciplinary Nature of Vocational Education in The Context of STEM-Based Physics Teaching

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Abstract: The innovative development of the educational and scientific field based on STEM education, in particular its professionally oriented environment, is determined by the principles of Industry 4.0. In the vector of the introduction of the methodology of a transdisciplinary approach to teaching physics and professionally oriented training of future aviation specialists, it is important to develop new methods of a professional orientation based on STEM technologies. The authors consider this problem as complex, which in the course of their research covers the justification of the relevance and feasibility of introducing STEM-approach (as a kind of transdisciplinary) in the educational process of higher education institutions using STEM technologies. Since, the solution of such problems, in particular the analysis of the specifics of physical phenomena and laws, which a priori are a fundamental part of mastering any profession, is impossible within a narrow discipline. *The purpose of the research* is to theoretically substantiate the professional teaching of physics based on STEM technologies in transdisciplinary professional education and to develop appropriate methods that will provide training subjects with their active cognitive-exploratory, independent activities. This, in turn, helps to improve the quality of vocational education. The concept of the research is the formation and development of STEM skills in future technical specialists in the process of teaching physics and outlines the principles of fundamentality based on transdisciplinarity of vocational education, taking into account the readiness of subjects to solve learning problems based on STEM technologies.
Keywords: Transdisciplinarity, STEM-Education, Physics, Aviation Vocational Training, Higher Education, Vocational Education, Digitalization.

Introduction - Conceptually, the development of effective national economic systems prioritizes the implementation of a consistent state educational policy aimed at intensifying innovation processes, forming an appropriate culture of society, strengthening the scientific and educational potential of the country. This should contribute to the competitiveness of modern education in the global market of technology, scientific knowledge and human resources. Ensuring such direction of education development will be carried out under the condition of public perception of the formation of new educational structures, namely the introduction of STEM-oriented approach based on transdisciplinary, modernization and reform of socio-pedagogical systems taking into account European standards, the introduction of flexible educational programs, the subjects of the educational process have critical and creative thinking, creativity and a positive attitude to innovation [1].

Transformational changes that enable the innovation of education are a defining characteristic of scientific and technical, industrial, socio-economic, socially advanced perestroika. After all, the transition to an innovative type of development of higher education institutions, in particular taking into account the transdisciplinary features of STEM education is of great socio-economic and humanistic significance. It is because today the main attention is paid to the process of transforming higher education from agents of scientific, technological and social progress into its real subjects, which encourages the development of the creative potential of each person for its implementation in a competitive environment [2].

It should be noted that the study of the term “innovation” began in the early twentieth century in line with the development of economic and sociological sciences. Of course, the founders of the theoretical foundations of innovation as a new field of scientific knowledge then became H. Tard [3], M. Kondratiev [4], Y. Shumpeter [5]. According to them, the essence of innovation as such is not only to meet existing needs but also to produce new ones aimed at changing the needs of human life. It should be noted that

H. Tard rightly notes that the development of innovations can be carried out not only through adaptation and imitation but also through conflicts, the struggle between

tradition and innovation [3]. In the same sense, the experience of I. Bohdanova becomes interesting, who on the principle of innovation potential identifies such innovations [6] as improving, related to the modification, rationalization, modernization; radical, related to the transformation of the traditional education system into an alternative one; complex, covering elements of improvement and transformation. Characteristic features of these innovations are the scale of their consideration in the education system and the innovativeness of their potential [6], namely: at the macro level there is a transformation of innovations; at the meso level – staffing in the main areas of related innovations in each component of the education system; at the micro-level – modernization, modification and rationalization of the traditional pedagogical process, which determines the locality or singularity of innovations that are not related to each other, i.e. changes that lead to element-by-element changes.

Accordingly, analyzing the identified problems in the methodology of teaching physics and professionally oriented disciplines based on STEM-technologies in a transdisciplinary information and educational environment of technical institutions of higher education, identified and outlined certain contradictions between:

1. The existing needs of society in highly qualified specialists, able to quickly adapt to the requirements of the modern labor market, and insufficient compliance with the content of training of future specialists in the technical field of training in the context of STEM-education;
2. The prevalence of traditional methods of teaching physics and professionally oriented disciplines in technical institutions of higher education and the potential challenges of today to take into account the capabilities of the latest STEM-direction in the methodology of teaching physics;
3. Rapid transformational changes and technical and technological changes in society, encouraging the introduction of innovative approaches to teaching physics, and their fragmentation in the formation of strong and deep knowledge in the formation of professional STEM-competence of future professionals in a transdisciplinary approach.

Thus, from the standpoint of innovation in the teaching of physics on the basis of STEM education in transdisciplinary information and the educational environment of technical institutions of higher education, we focus on the results of training highly qualified professionals who will have the appropriate level of professional STEM-competencies, including technical direction. At the same time, at the present stage of postmodern education, the ability and readiness of higher education teachers to teach in complex problem situations related to practical activities using a transdisciplinary approach in the context of STEM education become relevant. Here it is appropriate to consider the interdisciplinary relationships of physics with disciplines of professionally oriented direction, where higher education students form subject competencies. In this context, we state that the innovative activity and fundamentalization of physical education based on the STEM approach is an integral and important component of the professional competence of future professionals. For these reasons, the teaching of physics involves the formation of a system of fundamental physical knowledge and skills of applicants for higher technical education in the study of disciplines of professionally oriented direction and the application of acquired opportunities in their own lives [7-10].

It is obvious that the trends associated with innovation, digitalization, significantly affect the introduction of STEM-technologies in the education of higher education. Taking them into account allows to determine the basis for the development of a methodological system of teaching physics in the development of STEM education, which, in our opinion, should improve the quality of their physics education in a transdisciplinary paradigm for further mastering disciplines (navigation; meteorology; basics aviation geography; meteorology and ecology; basics of aeronautics and aviation cartography; aircraft and the basics of flight theory, etc.)

Methodology: The purpose of the study is to theoretically substantiate professionally oriented teaching of physics-based on STEM technologies in the conditions of transdisciplinarity of education and to develop on this basis an appropriate methodology that will provide students with their active cognitive, independent activities. This, in turn, helps to improve the quality of vocational education.

The concept of the research is the formation and development of STEM competencies in future technical specialists in the process of professionally oriented teaching of physics, and also outlines the fundamentals of the transdisciplinary approach to vocational education. This takes into account the readiness of the subjects of the educational process (teachers and students) to solve educational problems based on STEM technologies (3-D modelling, robotics kits, 3-D printing, augmented and virtual reality, etc.) is an important aspect for the effective organization of training of future professionals.

Taking into account the purpose and hypothesis of the study, the authors used the following methods: theoretical analysis of textbooks, manuals and publications that reflect the problem of STEM education and clarification of ontological and semantic connections in the context of the term “transdisciplinarity;” specific pedagogical: teaching methods physicists who contribute to the study of modern physics scientific positions and achievements, trends in the development of physics in technical institutions of higher education); empirical (diagnostic and sociometric methods) (observations, surveys, content analysis) to determine the level of interest and activity of students in teaching physics and professionally- oriented disciplines using the STEM approach); pedagogical experiment, experimental verification of the author’s methods of teaching physics and

professionally-oriented disciplines based on STEM technologies, taking into account the professional orientation of the content of education [11]. The theoretical significance of the expected results includes:

1. conducting theoretical and logical-methodological analysis of the problem of development of teaching physics based on STEM-approach based on transdisciplinarity;
2. determination of the content of methods of using fundamental theories of the general course of physics in the context of possibilities of STEM technologies and their theoretical generalization taking into account transdisciplinary connections with disciplines of professionally oriented training;
3. creation of a methodical system of formation of physical knowledge in students taking into account the transdisciplinary approach with technical disciplines based on STEM management, which is based on the relationship of symmetry and asymmetry and corresponding methods of students' activities in teaching physics in technical institutions of higher education (HE).

Discussion: The definition of "transdisciplinarity" was proposed to the scientific circulation of Z. Piazhe "them, overcoming persistent disciplinary barriers". In our opinion, the post-pandemic world once again provides grounds for actualizing Z. Piazhe's thoughts. E. Yanch stressed that transdisciplinarity as a "new space without stable boundaries between disciplines," as a new field of knowledge, must be super- or hyper disciplined, it must be the coordinator of all disciplinary and interdisciplinary systems of learning and innovation based on a common axiomatic approach. In this vector, Ukrainian scientists began to unite like-minded people in the modern circle of the international scientific-practical web forum "Development of a Single Open Information Space for Lifelong Learning". In addition, the philosophy of a transdisciplinary approach to the creation of information and educational environments is presented through the introduction of appropriate methodologies based on the philosophy of transdisciplinarity, which erases the communicative and cognitive boundaries between certain disciplinary knowledge.

Note that the concept of "transdisciplinarity" A. Likhnerovich defined through "cross-games", able to describe "the homogeneity of theoretical activities in different fields of science and technology, regardless of the field where this activity is carried out". And, of course, this theoretical activity could be formulated only in mathematical language, which in turn reveals a component of STEM educational training.

Thus, the term "transdisciplinarity" is considered by researchers on various grounds. In the first sense, transdisciplinarity is proposed to be interpreted as a "declaration" that proclaims the equal rights of known and little-known scientists, large and small scientific disciplines, cultures and religions, in the study of the world. In the second sense, "transdisciplinarity" is interpreted as a high level of education, versatility, universality of knowledge of a particular person. In the third sense, it is the "rule of studying the world around us" (the option is considered that transdisciplinarity will be implemented if the problem is studied at several levels, such as physical and mental, globally and locally. Thus, in the analysis of these sources) in the system of transdisciplinarity we distinguish four main trends:

1. The first is based on the modern version of the epistemological search for systematic integration of knowledge, the roots of which go back to ancient Greece, medieval Christianity, the principles of universal causality of the Enlightenment, Hegel's philosophy, unified physics theory and others;
2. The second trend is based on the synthetic paradigm of postmodern content;
3. The third trend follows from the critical direction of interdisciplinary research, considering transdisciplinarity not only as a transition to a new quality but also overcoming existing disciplinary boundaries (transgression);
4. The fourth trend is caused by the concept of postnormal science and the "second method" of obtaining knowledge, which is based on the principles of logic, cybernetics, general systems theory, structuralism, organizational theory (inherent complexity, nonlinearity, heterogeneity, etc.) – public discussions with steak participants to obtain "reliable scientific knowledge" and "socially healthy knowledge."

In the fourth sense, "transdisciplinarity" is used as a "principle of organization of scientific knowledge", which opens wide opportunities for interaction of many disciplines in solving complex problems of nature and society [30]. Note that transdisciplinarity, in this sense, allows scientists to officially go beyond their discipline without fear of being accused of dilettantism. Transdisciplinarity is understood as non-scientific knowledge that does not form an array of scientific disciplines but is used in popular science programs. The problem of identifying transdisciplinarity resonates with the problem of its differentiation, in particular in comparison with other similar concepts. Therefore, the term "interdisciplinarity" means, first of all, the cooperation of different scientific disciplines, the use of common concepts and explanations of certain actions or objects.

Our assumption about improving the methodology of teaching physics in the development of STEM education is not only the need to form in higher education a certain system of knowledge, skills and abilities but also, respectively, helps to raise the role of each student and each teacher in the study of physics cognitive, independent activity; provides development of thinking and creative abilities; satisfies the requests and wishes, inclinations and plans for the future of each person; uses such practical and experimental tasks in terms of content and scope, which will have practical application in the process of studying physics in educational institutions. It should be noted that technical institutions of HE were selected for the experiment, the physics laboratories of which were better equipped with

equipment for staging an educational physical experiment based on STEM education technologies, which corresponded to the conditions of optimality. In these free economic zones, scientific work in physics was also carried out with students at the appropriate level, which contributed more to the conduct of the experiment and created the necessary conditions in the context of the development of STEM education. The groups were selected in such a way that they corresponded to the conditions of the pedagogical experiment, namely the number of students in the groups. Experienced scientific and pedagogical workers worked in the selected free educational institutions of the technical profile, who expressed their desire and readiness to work according to the proposed method of teaching physics based on STEM technologies in the conditions of transdisciplinarity.

Conclusion: In the course of the study, the authors found that the change in higher education, including technical, taking into account the development of STEM education involves revising the concept of training in each field, so modernizing the content of education requires updating the teaching base (goals, content, methods, forms and means), through which in the future will be the implementation of modern innovative approaches.

The essence of the concept of "transdisciplinarity" in the process of teaching physics based on STEM education in technical institutions of higher education is analyzed and highlighted. It is shown that the method of using modern technologies during physics classes with students of non-physical specialities of technical universities allows them to develop STEM competencies in physics. The expediency of subordinating the content of educational material in physics, based on fundamental concepts, one of which is symmetry, which is considered in many sections of physics, is considered. Accordingly, acquaintance and study of this concept by students will contribute to the formation of modern scientific thinking, as well as provide systematization of knowledge from the general course of physics in higher education and the formation of a professional scientific worldview. Some works of the physics workshop with the use of STEM technologies from all sections of the physics course have been developed, which contribute to the effective conduct of classes in HEI of the technical profile of training. Among them are: "Mechanics," "Molecular Physics and Thermodynamics," "Electrostatics," "Electric Field," "Electrodynamics," "Magnetic Field," "Electromagnetic Oscillations," "Electromagnetic Waves," "Optics," "Atomic and nuclear physics" [12-14]. The results of the pedagogical experiment showed an improvement in all indicators of the effectiveness of the developed methodology of teaching physics based on STEM technologies in a transdisciplinary approach and confirmed the main provisions of the goal and the hypothesis. In the future, research on this issue can be conducted in the following areas: development of a new approach to changing the structure and content of curricula; improving the content and system of teaching physics, taking into account digitization technologies; strengthening the connection between the teaching of physics course and the professional orientation of students of non- physics specialities of technical institutions of HE in the context of STEM education.

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A Review of Chemical Constituents and Bioactive Molecules present in Traditional Indian Spices

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Abstract: Traditional Indian spices have been integral to culinary, medicinal, and cultural practices for millennia. These spices are rich sources of diverse chemical constituents and bioactive molecules, many of which have significant biological activities such as antioxidant, antimicrobial, anti-inflammatory, and chemo-preventive effects. This paper examines the phytochemical profiles and bioactive components of commonly used Indian spices, including turmeric (Curcuma longa), black pepper (Piper nigrum), clove (Syzygium aromaticum), ginger (Zingiber officinale), cinnamon (Cinnamomum verum), and cardamom (Elettaria cardamomum). Analytical methods for compound identification, mechanisms of action, and potential health implications are discussed. The review also highlights emerging extraction techniques and future research needs in spice phyto-chemistry.
Keywords: Indian Spices, Biological Activities, Bioactive molecules.

Introduction - Spices have shaped global cuisines and traditional medicine systems such as Ayurveda and Unani for thousands of years. Aside from flavor and aroma, spices contribute significant chemical complexity, comprising primary and secondary metabolites with diverse biological functions. Secondary metabolites such as phenolics, terpenoids, alkaloids, and essential oils not only influence sensory attributes but also exhibit medicinal properties.

The present paper reviews the chemical constituents and bioactive molecules found in major Indian spices, emphasizing the relationship between phytochemistry and health benefits. It also covers analytical approaches used in their characterization.

Phytochemistry of Indian Spices

- **Turmeric (Curcuma longa)**

Turmeric is widely known for its yellow pigment and health effects.

Major Compounds:

Curcuminoids – Curcumin, demethoxycurcumin, bisdemethoxycurcumin

Volatile oils – Turmerone, atlantone, zingiberene

Curcumin is the most studied compound; it exhibits antioxidant, anti-inflammatory, and anticancer properties. Its polyphenolic structure allows free-radical scavenging and modulation of cellular signaling pathways.

Biological Activity and Mechanism:

Curcumin affects multiple molecular targets including COX-2 and cytokines. Its low solubility and bioavailability have led to studies on nanoparticle delivery systems.

- **Black Pepper (Piper nigrum)**

Black pepper is valued for pungency and digestive properties.

Major Chemical Constituents

Piperine – A piperidine alkaloid responsible for pungency

Essential oil – Sabinene, limonene, â-caryophyllene

Biological Activities

Piperine enhances nutrient absorption and exhibits anti-inflammatory effects. It may influence drug metabolism by inhibiting CYP450 enzymes, increasing bioavailability of co-administered compounds.

- **Clove (Syzygium aromaticum)**

Clove is rich in aromatic compounds.

Major Constituents

Eugenol – Phenolic compound

β-Caryophyllene – Sesquiterpene

Acetyl eugenol

Biological Effects

Eugenol shows strong antioxidant, antimicrobial, and analgesic effects. Its phenolic group allows it to donate hydrogen, neutralizing free radicals.

- **Ginger (Zingiber officinale)**

Ginger is widely used in Indian cooking and medicine.

Active Molecules

Gingerols – 6-gingerol, 8-gingerol

Shogaols – Formed by dehydration of gingerols

Zingerone

Activities

Gingerols and shogaols exhibit anti-nausea, anti-inflammatory, and antioxidant activities. 6-gingerol has been studied for cancer prevention.

- **Cinnamon (Cinnamomum verum)**

Cinnamon provides sweet-spicy flavor and health benefits.

Constituents
Cinnamaldehyde – Major flavor component
Functional Activities
Cinnamaldehyde affects glucose metabolism and exhibits antimicrobial action against several food pathogens.

- **Cardamom (Elettaria cardamomum)**

Cardamom has a unique aromatic chemistry.
Phytochemicals
1,8-Cineole – Major volatile compound
α-Terpinyl acetate
Bioactivity
Cardamom essential oils show digestive and antimicrobial properties. 1,8-cineole contributes to respiratory benefits in traditional usage.

Analytical Techniques for Phytochemical Profiling
Chromatography
HPLC (High Performance Liquid Chromatography) for quantifying curcuminoids, piperine, gingerols
GC–MS (Gas Chromatography–Mass Spectrometry) for volatile oils
Spectroscopy
UV-Visible Spectroscopy for polyphenolic content
NMR (Nuclear Magnetic Resonance) for structural elucidation
Mass Spectrometry
High-resolution MS provides accurate mass and fragmentation patterns, enabling identification of novel compounds.
Bioactivities and Mechanisms
Antioxidant Activity
Phenolics and terpenoids donate electrons to stabilize free radicals. Assays like DPPH, FRAP, and ABTS measure activity.
Antimicrobial Effects
Essential oils disrupt microbial cell membranes leading to bacteriostatic or bactericidal outcomes.
Health Implications and Applications
Nutraceutical Potential
Standardized spice extracts are being developed into supplements.
Food Preservation
Spice essential oils show potential as natural food preservatives.
Extraction and Sustainability
Conventional Extraction
Solvent extraction yields varied phytochemical profiles.
Green Techniques
Supercritical CO, and microwave-assisted extraction enhance yield and reduce environmental impact.
Challenges and Future Perspectives
Standardization of spice extracts
Bioavailability enhancement
Safety and regulatory studies
Discovery of novel bioactives through metabolomics
Conclusion: Traditional Indian spices are rich repositories of chemical constituents with significant bioactive properties. Understanding their phytochemistry bridges traditional knowledge with modern scientific validation, promoting therapeutic applications and innovations in food chemistry.

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