Reforming Technical Education and STEM for Technological Advancement and Innovation

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Abstract:

This study examines the state of technical and STEM education in Pakistan, emphasizing its role in industrial growth and economic development. Using a combination of qualitative and quantitative methods, including SWOT and PESTLE analyses, the research evaluates policies, practices, and global comparisons. Key findings reveal gaps in policy frameworks, weak institutional coordination, and underutilized resources. Challenges include inadequate infrastructure, outdated curricula, and insufficient industry-academia collaboration, limiting STEM education's effectiveness. However, Pakistan's youthful population, technological advancements, and potential international partnerships offer significant opportunities to address these issues. The paper proposes actionable recommendations, including policy reforms, increased funding, and improved stakeholder collaboration, tailored to Pakistan's socio-economic context. A log frame matrix outlines short- and long-term strategies to enhance STEM education's contribution to industrial and economic development. The study underscores the need for sustainable reforms to create a more impactful and efficient education system, fostering long-term national prosperity.

Key words:

STEM Education, Technical Education, Policy Reforms, Industrial Development, Pakistan

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Problem Statement

Pakistan's economic growth depends on industrial development, which is inherently tied to technological advancement and innovation fostered through technical education and STEM. This research investigates the current ecosystem of technical and vocational education and STEM in Pakistan, focusing on the federal level and Khyber Pakhtunkhwa. The study identifies key shortcomings and proposes a practical roadmap for improvement.

Background

Technical education involves acquiring practical skills, knowledge, and competencies related to specific trades or professions (Sather et al., 2016). It typically includes hands-on training in fields like engineering, manufacturing, and IT. STEM (Science, Technology, Engineering, and Mathematics) integrates these disciplines to solve complex problems, drive innovation, and support technological development (GOI, 2021). Together, technical education and STEM are critical for workforce preparation and enhancing economic productivity, competitiveness, and prosperity (Sather et al., 2016).

Innovation, defined as the creation and implementation of transformative ideas or products (Schilling, 2020), is central to economic growth. The Global Innovation Index (GII) ranks Pakistan 88th out of 132 economies in 2023, highlighting strong innovation outputs (68th) but weak inputs (113th) (Dawn, 2023). While Pakistan outperforms many lower-middle-income economies, it significantly lags behind regional peers like India (40th) (WIPO, 2023).

Challenges in Pakistan's technical education and STEM sectors include inadequate infrastructure, outdated curricula, insufficient resources, and limited practical learning opportunities (Sather, Singh, & Thurman, 2016). Chronic underfunding further hinders teacher training, infrastructure, and curriculum reforms (Zeb, Khan, & Ahmad, 2021). These barriers limit Pakistan's capacity to develop a skilled workforce capable of meeting global economic demands (Government of Pakistan, 2021).

Recognizing these issues, Pakistan has initiated reforms to align technical education and STEM with global standards. Key initiatives include curriculum enhancements, project-based assessments, industry internships, and professional development for educators. Collaboration among academia, industry, and international stakeholders is emphasized to foster innovation-driven growth.

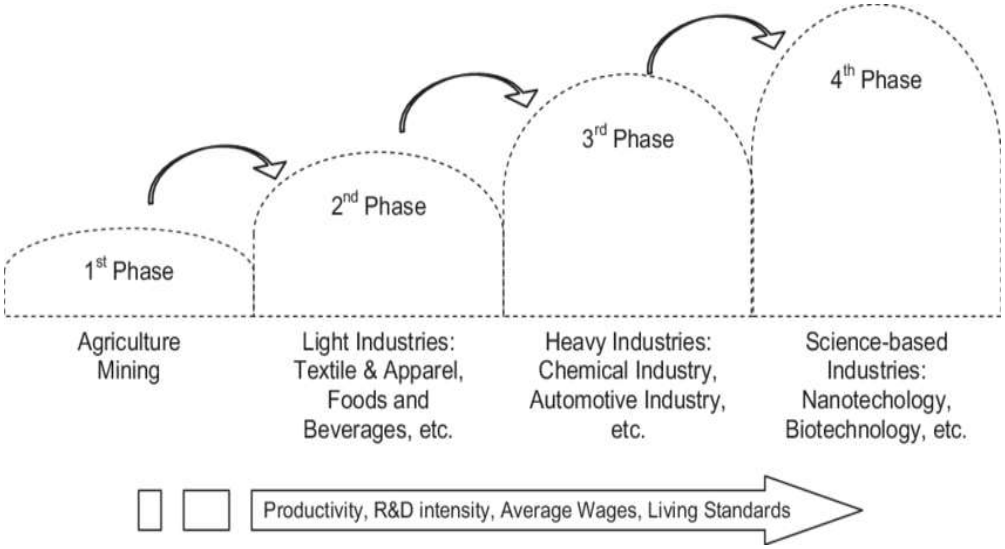
Research methodology

A mixed-method approach combining qualitative and quantitative methods employed. The methodology designed to comprehensively explore the current state of technical education and STEM fields in Pakistan, identify challenges and opportunities, and develop evidence-based policy recommendations. The study carried out situational analysis of current policies, initiatives, practices, and contributions, literature review, analysis of the existing legal and institutional framework, comparative analysis with global best practices, examining successful models from other countries will allow for a comparative analysis, highlighting best practices that can be adapted to Pakistan's context. Additionally, SWOT Analysis of Technical Education and STEM Institutions and stakeholders' interviews. PESTLE/GAP Analysis, practical plan using Log Framework Matrix to organize and present the recommended actionable plan.

Theoretical Underpinnings

Endogenous Growth Theory

In the context of Pakistan's industrial development, the **Endogenous Growth Theory**, proposed by Romer (1986), emphasizes the pivotal role of technological innovation, human capital, and knowledge spillovers in achieving sustained economic growth. For Pakistan to advance its industrial sector, substantial investments in education, technology, and research and development (R&D) are imperative. By cultivating a skilled workforce equipped with modern technological expertise and fostering innovative practices, Pakistan can enhance productivity and drive industrial progress. Furthermore, promoting knowledge spillovers through robust industry-academia partnerships and international collaborations can accelerate technological advancements and economic growth. Prioritizing these areas will enable Pakistan to establish a resilient and competitive industrial



foundation, consistent with the principles of Endogenous Growth Theory.

Analysis of Issues and Challenges

Situational Analysis of current Policies and Practices

Federal Government has introduced a number of policies, initiatives and practices for technological advancement, innovation and STEM in the country. A brief situational analysis is as under:

1. National Education Policy Framework 2018

The framework emphasizes improving education quality at all levels, with a strong focus on STEM education. It aims to enhance students' critical thinking and problem-solving skills.

2. Technical and Vocational Education and Training (TVET) Policy 2018

This policy focuses on developing a skilled workforce through vocational and technical education. It addresses skills gaps by introducing competency-based training programs, enhancing industry-academia linkages, and promoting public-private partnerships.

3. National Skills for All Strategy 2021

This strategy ensures accessible, high-quality technical and vocational training for all. It involves expanding vocational training centers, integrating technology into training programs, and providing financial support to students.

4. National Science, Technology, and Innovation Policy 2022

This policy provides a comprehensive plan to foster innovation and technological development. It includes increased funding for R&D, the establishment of innovation hubs, and the promotion of STEM education.

5. STEAM Pakistan Initiative

Led by the Ministry of Federal Education and Professional Training, this initiative promotes holistic education to develop critical thinking, problem-solving, and collaboration skills.

6. TVET Reform Initiative

Supported by international partners, this initiative enhances equitable access to quality training and boosts employability.

7. Prime Minister's Youth Skill Development Program (PMYSDP)

This program empowers youth with skills, including high-tech training, conventional skill development for underprivileged areas, and apprenticeships.

8. Partnerships with International Organizations
Collaborations with entities such as the European Union, German Cooperation, and the Norwegian Embassy have improved vocational training through resource sharing, curriculum development, and best practices.

9. Hands-On Practical Learning
Vocational schools emphasize practical learning in fields like dental assistance, hardware repair, agriculture, and IT. Short-duration programs equip students with job-ready skills.

10. Accessible and Inclusive Training
Many government-funded and non-profit-led vocational programs are accessible to economically disadvantaged groups and include training for disabled individuals.

11. Demand-Driven Skills
Vocational training aligns with market demands, equipping students with high-demand skills, reducing the skills gap, and enhancing employability.

Critical Review

Vocational Training: Significant in industrial development through workforce skill enhancement, youth employment, and entrepreneurship (NAVTTC, 2023; TEVTA, 2023).

National Education Policy Framework 2018: Lacks practical application and industry integration (Government of Pakistan, 2018).

TVET Policy 2018: Identifies skills gaps and promotes linkages but has limited reach (Government of Pakistan, 2018).

National Skills for All Strategy 2021: Broadens vocational training access but faces quality assurance challenges (Government of Pakistan, 2021).

National Science, Technology, and Innovation Policy 2022: Provides a solid foundation for innovation but requires increased funding and robust implementation (Government of Pakistan, 2022).

Analysis of the Existing Legal and Institutional Framework

Technical Education and Vocational Training Authority (TEVTA)
TEVTA operates in the provinces, focusing on curriculum development, teacher training, and industry linkage programs.

National Vocational and Technical Training Commission (NAVTTC)
NAVTTC plays a pivotal role in overseeing and coordinating the TVET sector

in Pakistan. It develops national policies, standards, and frameworks to ensure alignment of technical education with industry requirements.

Higher Education Commission (HEC)

The Higher Education Commission (HEC) of Pakistan regulates and accredits higher education institutions offering STEM programs. It provides essential funding for research and development, promotes quality assurance through accreditation and ranking systems, and encourages international collaborations to enhance STEM education.

HEC's initiatives include establishing research centers and technology parks within universities, promoting startup incubation, and funding technological research projects, which significantly contribute to technological advancement and innovation. Additionally, HEC supports digital learning through the Pakistan Education and Research Network (PERN), connecting academic institutions to digital libraries and high-speed internet (Tribune, 2022).

Despite these efforts, HEC's impact is constrained by bureaucratic challenges and inconsistent funding, hindering seamless implementation and program sustainability. Faculty development initiatives are beneficial, but retaining trained educators is challenging due to better opportunities abroad. There is limited funding for establishing reverse engineering programs, and the integration of reverse engineering concepts into engineering curricula is unclear. Faculty training workshops may lack standardization, leading to inconsistency. Furthermore, financial support for university-industry projects focused on reverse engineering is lacking, highlighting the need for targeted and sustained funding and support (HEC, 2023; Dawn, 2021; Tribune, 2022).

Pakistan Science Foundation (PSF)

PSF supports scientific research and innovation in Pakistan by providing grants for research projects, organizing science competitions, and promoting STEM education through outreach programs. It aims to create a scientific culture and encourage young people to pursue STEM careers.

Provincial Education Departments

Provincial education departments implement national education policies at the local level and oversee technical and vocational training institutions.

Comparative Analysis

United States and South Korea

These countries excel through substantial funding, strong industry-academia partnerships, and curricula emphasizing critical thinking. Institutions like the National Science Foundation (NSF) and robust government policies bolster advancements (NSF, 2023; Ministry of Education, South Korea, 2023).

Germany and Finland

Germany's dual education system integrates vocational training with classroom instruction, producing a highly skilled workforce. Finland emphasizes creativity, collaboration, and technology integration, preparing students for the modern workforce (Federal Ministry of Education and Research, Germany, 2023; Ministry of Education and Culture, Finland, 2023).

United States, Finland, and South Korea

The U.S. STEM Education Coalition advocates for policy changes and increased investment in STEM education. Finland integrates technology across curricula to foster creativity and critical thinking. South Korea promotes collaboration between educational institutions and industries, resulting in rapid technological advancements and a high number of STEM graduates (Ministry of Education and Culture, Finland, 2023; Ministry of Education, South Korea, 2023).

SWOT Analysis of Education and STEM Related Institutions

SWOT for Federal Government

Category	**Strengths**	**Weaknesses**
Internal Factors	1. Establishment of bodies like TEVTA and NAVTTC to regulate and promote technical education.	1. Many institutions lack modern laboratories and equipment necessary for hands-on learning.
	2. Partnerships with international organizations like the EU enhance resources and training quality.	2. Insufficient programs for continuous professional development of educators.
	3. A large, young population provides a significant pool of potential students for STEM fields.	3. Limited financial resources hamper the development and implementation of advanced educational programs.
	4. Ongoing efforts to update and align curricula with global standards and industry needs.	4. Persistent mismatch between industry requirements and the skills of graduates.
Category	**Opportunities**	**Threats**
External Factors	1. Potential for more collaborations with international educational and industry partners to enhance curriculum and training.	1. High inflation and economic challenges can limit funding and investment in education.
	2. Adoption of emerging technologies can modernize educational practices and improve learning outcomes.	2. Frequent changes in government and policies can disrupt long-term educational planning and initiatives.

	3. Increasing focus on promoting entrepreneurship amongst STEM students can drive innovation.	3. Societal norms may hinder the participation of women and underrepresented groups in STEM fields.
	4. New policies aimed at boosting vocational and technical education can improve the overall education landscape.	4. Rapid advancements in STEM education in other countries can leave Pakistan lagging behind if it doe

SWOT for Higher Education Commission (HEC) of Pakistan

Strengths	Weaknesses	Opportunities	Threats
Established authority for higher education.	Limited funding compared to global standards.	Attract international funding and partnerships.	Economic instability affecting funding and policy implementation.
Supports research and innovation through funding and policies.	Bureaucratic delays can hinder initiatives.	Leverage global focus on STEM education for development.	Political changes leading to policy discontinuity.
Facilitates international collaborations.	Inconsistent education quality across institutions.	Integrate advanced technologies in curricula.	Competition from private institutions with better resources.

Pakistan Science Foundation (PSF)

Strengths	Weaknesses	Opportunities	Threats
Promotes scientific research and STEM education.	Limited funding and resources compared to global standards.	Potential for international collaborations and funding.	Economic constraints limiting funding and resources.
Provides grants and funding for research projects.	Inadequate infrastructure for advanced scientific research.	Growing interest in STEM fields can drive program expansion.	Political instability affecting policy continuity.
Organizes science competitions and outreach programs.	Lack of coordination with other educational institutions.	Opportunities to integrate new technologies and methodologies in science education.	Brain drain with talented researchers and students moving abroad.

National Vocational & Technical Training Commission (NAVTTC)

Strengths	Weaknesses	Opportunities	Threats
Central authority for vocational and technical training. Develops national standards and policies.	Limited reach and accessibility, especially in rural areas. Insufficient practical training infrastructure.	Potential for public private partnerships to enhance programs. Growing demand for skilled labor can drive program expansion.	Rapid technological changes requiring constant updates to programs. Economic challenges reducing funding and support.
Focuses on aligning training programs with industry needs.	Dependence on limited government funding.	Increasing global emphasis on technical skills attracting international support.	Competition from advanced international vocational training programs.

Technical Education and Vocational Training Authority (TEVTA)

Strengths	Weaknesses	Opportunities	Threats
Focuses on practical skills and competency-based training.	Limited infrastructure and resources for advanced training.	Potential for increased collaboration with industry partners.	Economic instability affecting funding and resource allocation.
Offers a variety of diploma and certification courses.	Inconsistent quality of training across different regions.	Growing demand for skilled labor in various sectors.	Rapid technological advancements requiring continuous updates to training programs.
Aims to develop a globally competitive workforce.	Challenges in keeping curricula up to date with industry needs.	International partnerships and funding opportunities.	Competition from private vocational training institutes with better facilities.

Provincial Education Departments

Strengths	Weaknesses	Opportunities	Threats
Implement national education policies at the local level.	Variability in policy implementation and educational quality across provinces.	Leverage local industry partnerships for vocational training.	Regional disparities in funding and resource allocation.
Manage funding and oversee the operation of training institutions.	Limited resources and infrastructure, especially in rural areas.	Address regional educational needs with tailored programs.	Political and administrative changes affecting policy continuity.
Play a crucial role in regional education development.	Bureaucratic challenges and inefficiencies.	Potential for increased funding and support from federal initiatives.	Economic challenges impacting the implementation of educational programs.

Industry

Strengths	Weaknesses	Opportunities	Threats
Provide UpToDate industry relevant training.	May prioritize profit over educational quality.	Growing demand for skilled labor can drive private sector investment in education.	Economic downturns affecting private sector investment in education.
Flexibility to adapt quickly to changing industry needs.	Limited focus on broader educational outcomes beyond immediate industry needs.	Opportunities for public private partnerships to enhance vocational training.	Competition from public institutions and international vocational training programs.
Resources to invest in advanced training infrastructure.	Potential disconnects with national education policies.	Potential to set industry standards for technical education.	Regulatory challenges and changes in education policy.

Nongovernmental Organizations (NGOs)

Strengths	Weaknesses	Opportunities	Threats
Focus on improving access to quality education and vocational training.	Dependence on donor funding, which can be unstable.	Potential to form partnerships with government and private sector.	Economic instability affecting donor funding.
Ability to reach underserved and marginalized communities.	Limited scale and reach compared to government programs.	Growing recognition of the importance of vocational training and STEM education.	Political changes impacting NGO operations and support.
Flexibility to innovate and adapt to local needs.	Challenges in sustaining longterm projects without consistent funding.	Opportunities to pilot innovative educational approaches.	Competition for limited funding resources from other NGOs.

GAP Analysis for Technical and STEM Education in Pakistan

Aspect	Current State	Gap	Desired State
Curriculum and Training	Outdated curricula not aligned with industry needs	Modernized curriculum incorporating emerging technologies and global standards	Updated curricula aligned with industry and global standards, including practical learning experiences
Infrastructure	Educational institutions lack modern laboratories and equipment	Significant investment needed in infrastructure	Well-equipped laboratories and research facilities with modern teaching tools
Teacher Training	Insufficient training programs for educators	Comprehensive training programs for continuous professional development	Skilled educators with UpToDate pedagogical skills and subject knowledge
Research and Development (R&D)	Limited funding and resources for R&D activities	Increased funding and resources for R&D	Enhanced R&D capabilities with strong international and private sector partnerships
Industry Academia Collaboration	Weak collaboration between educational institutions and industry	Strengthening partnerships and collaborative research projects	Robust industry academia partnerships with practical internship programs and joint research initiatives

PESTLE Analysis of Technical and STEM Education in Pakistan

Political Factors

Frequent government changes in Pakistan lead to inconsistent education policies, hindering long-term planning and development. Stable and consistent policies are essential.

Economic Factors

High inflation and funding constraints limit investments in education infrastructure and programs, widening the gap between the current and desired state of education.

Social Factors

Cultural barriers and a lack of awareness restrict participation in STEM fields, particularly for women and minorities. Policies and outreach programs promoting diversity and raising awareness about the benefits of STEM are needed to create an inclusive educational environment.

Technological Factors

Limited integration of modern technologies into the curriculum hinders students' ability to acquire necessary skills for today's technology-driven world. Updating educational technologies and incorporating cutting-edge tools and methodologies are crucial for preparing students for the modern workforce.

Legal Factors

Weak enforcement of existing legal frameworks results in variations in educational standards and quality. Strengthening these frameworks and enhancing enforcement mechanisms are necessary to ensure high standards in education.

Environmental Factors

Inadequate infrastructure and resource limitations affect the sustainability of education programs. Developing sustainable infrastructure and integrating environmental education into the curriculum are vital to addressing these challenges.

Challenges for Pakistan

Outdated Infrastructure and Limited Funding

- Pakistan's technological and educational infrastructure is significantly outdated, impeding effective learning and innovation.
- Expenditure on R&D is only 0.22% of GDP, compared to India's 0.66% and Bangladesh's 0.39% (World Bank, 2023).
- Limited financial resources hinder the sustainability of technological initiatives and the development of advanced research facilities.

Policy and Implementation Issues

- Bureaucratic delays and inefficiencies obstruct the smooth implementation of technological policies and programs.
- Frequent political changes result in inconsistent policies, disrupting long-term planning and stability in technological and educational sectors.

Weak Industry-Academia Collaboration

- Pakistan faces weak collaboration between educational institutions and industry, unlike India, which has robust partnerships facilitating innovation and practical learning.
- Financial support for university-industry projects is often lacking, limiting collaborative innovation opportunities.

Human Capital and Training Challenges

- Pakistan allocated only 2.4% of GDP to education in 2022, compared to 3.1% in India and 2.8% in Bangladesh (UNESCO, 2023).
- Insufficient training programs for educators and significant brain drain as many trained professionals leave for better opportunities abroad.

Slow Technology Integration

- Slow integration of modern technologies into the educational system affects education quality and research capabilities.
- Initiatives like the Pakistan Education and Research Network (PERN) aim to improve digital connectivity, but broader access to high-speed internet and digital libraries remains limited.

Economic and Social Barriers

- Economic instability, including high inflation rates (21.3% in 2022), restricts investment in technological and educational infrastructure.
- Cultural barriers hinder the participation of women and underrepresented groups in STEM fields, with women making up only 18% of the STEM workforce in Pakistan compared to 30% in India and 25% in Bangladesh (World Economic Forum, 2023).

Comparative Performance

- India ranks 40th globally in the Global Innovation Index (GII) 2023, compared to Pakistan's 88th position and Bangladesh's 116th position (WIPO, 2023).
- India benefits from substantial funding, strong industry-academia partnerships, and a robust policy framework supporting sustained technological growth.
- Bangladesh has shown considerable progress in recent years, ranking higher than Pakistan in innovation inputs and outputs, effectively utilizing international partnerships to enhance its technological education and research sectors.

Interviews with Experts (Primary Sources)

Key points from Mr. Ijaz Khan (Vice President, Sarhad Chamber of Commerce):

i. Industrial policies aim to promote trade and employment but face challenges like energy shortages and high costs.
ii. Development of industrial and economic zones under CPEC has seen limited progress.
iii. Lack of infrastructure, investors, and security hinders job opportunities and industrialization in KP.

Key points from Mr. Munir Gul (Director, KP TEVTA):

i. Most industries in KP are closed or near closure, leading to reduced demand for skilled workers.
ii. TVETA trains youth in technical skills, capitalizing on the fact that 60% of the population is young.
iii. Around 107 technical institutions provide skill development, but 80% of trained manpower migrate abroad.

Conclusion

Pakistan faces significant challenges in advancing technological innovation and education, which are essential for its industrial development and economic growth. The country's technological and educational infrastructure is significantly outdated, impeding effective learning and innovation. Limited funding for Research and Development (R&D) exacerbates this issue, with Pakistan's expenditure on R&D at only 0.22% of its GDP, compared to India's 0.66% and Bangladesh's 0.39% (World Bank, 2023). This financial constraint impacts the development of advanced research facilities and the implementation of sustained technological initiatives. Bureaucratic delays and inefficiencies further hinder the smooth implementation of technological policies and programs. Frequent political changes lead to inconsistent policies, disrupting long-term planning and stability in the technological and educational sectors.

Human capital development is also hampered by inadequate training programs and significant brain drain, with many trained educators and researchers leaving for better opportunities abroad. In 2022, Pakistan allocated only 2.4% of its GDP to education, compared to 3.1% in India and 2.8% in Bangladesh (UNESCO, 2023). The integration of modern technologies into the educational system is slow, affecting education quality and research capabilities. Initiatives like the Pakistan Education and Research Network (PERN) aim to improve digital connectivity, but broader access to high-speed internet and digital libraries remains limited. Economic instability, characterized by high inflation rates (21.3% in 2022), restricts investment in technological and educational infrastructure. Cultural barriers also impede the participation of women and underrepresented groups in STEM fields,

with women constituting only 18% of the STEM workforce in Pakistan. Addressing the multifaceted challenges in infrastructure, policy implementation, human capital development, and technology integration is crucial for Pakistan to advance its technological and educational capabilities and achieve sustainable growth.

Recommendations

1. ***Policy Formulation and National Standards***
   - Develop comprehensive national policies for technical education and STEM, ensuring alignment with global best practices.
   - Establish national standards and frameworks for curricula, teacher qualifications, and student assessments in technical and STEM education.
2. ***Funding and Resource Allocation***
   - Increase budget allocations for technical education and STEM initiatives, focusing on infrastructure development, teacher training, and research facilities.
   - Provide grants and subsidies to encourage public-private partnerships (PPP) in establishing technical institutes and STEM centers.
3. ***National Research and Development***
   - Invest in national research and development (R&D) programs to drive innovation and technological advancements.
   - Create a national innovation fund to support startups and research projects in STEM fields.
4. ***Public Awareness and Outreach***
   - Launch nationwide campaigns to raise awareness about the importance of technical education and STEM careers.
   - Promote gender inclusivity and diversity in STEM through targeted scholarships and outreach programs for underrepresented groups.

Provincial Government Recommendations

1. ***Curriculum and Teacher Training***
   - Collaborate with federal authorities to adapt national standards to the provincial context, ensuring relevant and updated curricula.
   - Implement continuous professional development programs for teachers to enhance their skills and knowledge in technical and STEM subjects.

2. ***Infrastructure Development***
   - Invest in building and upgrading technical institutes, vocational training centers, and STEM-focused schools with modern facilities and equipment.

- Ensure access to high-quality internet and digital tools in educational institutions to facilitate eLearning and digital literacy.

3. ***Industry-Academia Collaboration***
   - Foster partnerships between local industries and educational institutions to align training programs with market needs.
   - Establish provincial innovation hubs and incubators to support students and researchers in developing and commercializing new technologies.
4. ***Monitoring and Evaluation***
   - Set up provincial monitoring and evaluation units to assess the effectiveness of technical education and STEM initiatives.
   - Use data-driven insights to inform policy adjustments and improvements in educational programs.

District Level Recommendations

1. ***Local Implementation of Programs***
   - Implement provincial policies and programs at the district level, ensuring that they are tailored to local needs and contexts.
   - Establish district education offices to oversee the administration and quality control of technical education and STEM initiatives.
2. ***Community Engagement***
   - Engage local communities, including parents, businesses, and civic organizations, in supporting and promoting technical education and STEM fields.
   - Organize local STEM fairs, competitions, and workshops to encourage student participation and interest in these areas.
3. ***Capacity Building***
   - Provide training and resources for district education officers and school administrators to effectively manage and support technical and STEM education programs.
   - Facilitate local teacher networks and professional learning communities to share best practices and resources.
4. ***Resource Mobilization***
   - Encourage local businesses and industries to contribute resources, such as equipment, internships, and scholarships, to support technical and STEM education.
   - Leverage district-level funds and grants to address specific local needs and gaps in educational infrastructure and resources.

References

1. Dawn. (2024). PM Shehbaz orders formation of Pakistan Skill Company to train overseas Pakistanis. Retrieved from https://www.dawn.com/news/1832262
2. Federal Ministry of Education and Research (Germany). (2023). Dual education system in Germany. Berlin, Germany. Retrieved from https://www.bmbf.de/en/vocationaleducationandtraining562.html
3. Federal Ministry of Education and Research (Germany). (2023). Vocational education and training. Retrieved from https://www.bmbf.de/en/vocationaleducationandtraining562.html
4. Finnish National Agency for Education. (2023). Education system. Retrieved from https://www.oph.fi/en/educationsystem
5. Higher Education Commission (HEC). (2023). Annual report 2023. Islamabad, Pakistan.
6. Higher Education Commission (HEC). (2023). Higher Education Commission of Pakistan. Retrieved from https://www.hec.gov.pk
7. Learn at Noon. (2023). A comprehensive guide on vocational schools in Pakistan. Retrieved from https://www.learnatnoon.com/s/enpk2/vocationalschoolsinpakistan
8. Lewis, W. A. (1954). Economic development with unlimited supplies of labour. The Manchester School, 22(2), 139–191.
9. Ministry of Education and Culture, Finland. (2023). Finland's education system: Overview and innovations. Helsinki, Finland.
10. Ministry of Education Science and Technology (South Korea). (2023). Education policies. Retrieved from http://english.moe.go.kr
11. Ministry of Education, South Korea. (2023). Education in Korea: Achievements and future directions. Seoul, South Korea.
12. Ministry of Finance, Government of Pakistan. (2023). Economic survey of Pakistan 2022-23. Retrieved from https://www.finance.gov.pk/survey_2023.html
13. National Science Foundation (NSF). (2023). NSF annual report 2023. Arlington, VA, USA.
14. National Vocational & Technical Training Commission (NAVTTC). (2023). NAVTTC strategic plan 2023-2026. Islamabad, Pakistan.
15. National Vocational & Technical Training Commission (NAVTTC). (2023). National Vocational & Technical Training Commission. Retrieved from https://navttc.gov.pk
16. Pakistan Science Foundation (PSF). (2023). PSF achievements and initiatives. Islamabad, Pakistan.
17. Pakistan Science Foundation (PSF). (2023). STEM education in Pakistan. Retrieved from https://stem.psf.gov.pk
18. Romer, P. M. (1986). Increasing returns and long-run growth. Journal of Political Economy, 94(5), 1002–1037.
19. STEM Education Coalition. (2023). Advocating for STEM education.

Retrieved from https://www.stemedcoalition.org
20. STEM Education Coalition. (2023). Annual report on STEM education 2023. Washington, D.C., USA.
21. Technical Education and Vocational Training Authority (TEVTA). (2020). Khyber Pakhtunkhwa TEVTA brief. Retrieved from https://kpten.gov.pk/TEVTA_brief.pdf
22. Technical Education and Vocational Training Authority (TEVTA). (2023). Technical Education and Vocational Training Authority. Retrieved from https://tevta.punjab.gov.pk
23. Tribune. (2024). PM orders creation of Pakistan Skill Company. Retrieved from https://tribune.com.pk
24. TVET. (2023). Technical and vocational education and training reform. Retrieved from https://tvetreform.org.pk