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Advancing Technology Education in Uzbekistan's Secondary Schools

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In the evolving global economy, integrating technology into education is essential for workforce readiness and innovation. Uzbekistan's "Technology" curriculum in secondary education bridges theory and practice across nine subfields, including robotics, electronics, and traditional crafts. However, gaps remain in practical training, teacher development, accessibility, entrepreneurship, and sustainability. This study aims to evaluate the curriculum's alignment with global best practices and propose targeted enhancements. Results highlight the need for improved industry partnerships, teacher training, equitable access, and sustainability-focused modules. The novelty lies in actionable strategies to modernize the curriculum, ensuring it fosters skills for the 21st-century labor market. Implications suggest the curriculum's potential to drive workforce readiness, economic growth, and cultural preservation in Uzbekistan.

Keywords: Technology Curriculum, Vocational Education, Workforce Readiness, Practical Training

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INTRODUCTION

Education is the foundation of societal advancement, and the inclusion of practical and technical subjects like «Technology» in secondary education ensures that students acquire skills that are both relevant and transformative. In Uzbekistan, the subject "Technology" bridges theoretical learning and hands-on application, equipping students with skills critical for the 21st-century workforce. Uzbekistan's curriculum stands out for its comprehensive approach, encompassing practical, technical, and cultural dimensions. It encompasses nine diverse subfields, ranging from robotics and electronics to culinary arts and traditional crafts, creating a holistic educational experience. This paper will highlight the curriculum's current state, the essence of these nine subfields, analyze their impact on education, and evaluates its alignment with market demands, comparing global practices that reinforce the significance of such curricula.

LITERATURE REVIEW

Technical and vocational education (TVE) in secondary schools plays a critical role in preparing students for the labor market. It equips them with skills essential for industrial, technological, and entrepreneurial activities. Scholars have emphasized the importance of such curricula in bridging the gap between education and employment, fostering national economic growth (Wheelahan et al., 2009).

Renowned educationist Sir Ken Robinson argued that creative subjects bridge the gap between theoretical knowledge and practical application, enhancing student engagement (Robinson, 2015). Similarly, Andreas Schleicher, OECD's education director, emphasized that skills-oriented learning prepares students for a dynamic workforce (Schleicher, 2018). Globally, Finland, South Korea, and Germany exemplify the benefits of integrating technical and practical education. Their models demonstrate improved student engagement, higher employability rates, and greater innovation, outcomes Uzbekistan can achieve through its "Technology" subject.

Technical and vocational education (TVE) is designed to equip students with practical skills and competencies that align with industry demands and societal needs. Across the globe, countries have tailored TVE programs to address specific economic and developmental goals, from reducing unemployment to fostering innovation and sustainability. Now, we try to highlight 5 key focus areas within TVE, drawing on exemplary practices from Germany, South Korea, Singapore, Finland, India, and Kenya, to showcase how strategic education initiatives can transform both individual lives and national economies:

1. Vocational Preparation and Apprenticeships

   The German dual education system serves as a global benchmark for integrating practical and academic learning. Students alternate between classroom instruction and hands-on apprenticeships in industries such as automotive, healthcare, and engineering. This system has been credited with maintaining one of the lowest youth unemployment rates in Europe (Deissinger, 2015),(Kennedy & Frady, 2024).

2. STEM-Focused Education

   South Korea's robotics and coding curricula, integrated into secondary education, prepare students for careers in technology-driven sectors. Similarly, Singapore's focus on high-tech industries ensures that its workforce is aligned with global market trends (Lim & Lee, 2019),(El Khoury, 2024)

3. Sustainability and Green Technologies

   Finland's sustainability education introduces students to renewable energy and environmental technologies. This approach has not only prepared students for green economy careers but also fostered national innovation in sustainable practices (Kumpulainen & Lipponen, 2012),(El Khoury, 2024)

4. Entrepreneurship Education

   India integrates entrepreneurial skills into TVE, empowering students to launch small businesses in rural and urban areas. Similarly, Kenya's focus on agricultural education equips students to contribute to food security and agribusiness development (Kumar, 2017),(Muthamia et al., 2020)

5. Economic and Labor Market Impact

   Several researchers have highlighted economic and labor market impact of the subjects that combine both theoretical knowledge and practical skills in real-life settings, and underscored the direct benefits of TVE for national economies. For instance, in terms of (1) employment generation, programs such as Australia's TAFE reduce skill shortages in trades like construction and hospitality (Wheelahan et al., 2009). Regarding (2) economic diversification, countries like Poland and Denmark align vocational training with national priorities such as manufacturing and renewable energy (Kennedy & Frady, 2024),(Vierke, 2024). We must also consider another critical matter, (3) youth empowerment. Entrepreneurship education in India and agricultural education in Kenya have empowered students to create self-sustaining ventures, contributing to grassroots economic development (Muthamia et al., 2020)

[Figure 1. About here]

METHOD

This study adopts a descriptive-qualitative approach to analyze the relevance, challenges, and potential improvements of the "Technology" curriculum in Uzbekistan's secondary education system. Data collection involved literature review, comparative analysis of global best practices, and examination of national curriculum and

education policy documents. The methodology aims to identify strengths and weaknesses in the current curriculum while proposing strategic recommendations based on global trends and local needs.

A comprehensive literature review was conducted to explore the role of technical and vocational education (TVE) in workforce readiness and national economic growth. Prior studies from countries such as Germany, South Korea, Finland, and Kenya were analyzed to identify best practices that could be adapted to Uzbekistan’s context. Additionally, the current "Technology" curriculum in Uzbekistan was examined to understand its structure, scope, and implementation. Official documents from the Ministry of Education were reviewed to evaluate the alignment of its subfields with modern labor market demands.

The study also utilized a comparative analysis to draw insights from countries that have successfully integrated TVE into their education systems. For instance, Germany's dual education system, South Korea's focus on robotics and STEM, and Finland’s emphasis on sustainability provided valuable models for potential improvements. This analysis aimed to highlight opportunities for Uzbekistan to enhance its curriculum by aligning with global standards while addressing local priorities.

Based on this analysis, five key focus areas for improvement were identified: enhancing practical training, improving teacher competency, increasing educational accessibility, promoting entrepreneurship, and emphasizing sustainability. Each focus area was assessed for its applicability to Uzbekistan’s unique socio-economic context and its potential to foster workforce readiness.

Finally, strategic recommendations were formulated using an evidence-based approach, integrating findings from the literature review, comparative studies, and policy analysis. These recommendations are designed to optimize the curriculum's impact, preparing students for modern labor market demands while contributing to sustainable national economic growth. This methodology ensures a comprehensive understanding of the "Technology" subject's current state and provides actionable insights for its future development.

RESULTS AND DISCUSSION

Jahan The diversity of technical and vocational education (TVE) programs worldwide highlights how education systems address unique national priorities and socio-economic contexts. These programs not only prepare students for careers in specific industries but also align educational goals with broader national strategies, such as reducing unemployment, fostering innovation, and preserving cultural heritage. This section explores various TVE approaches across countries, offering valuable insights for Uzbekistan’s “Technology” curriculum and its potential evolution.

In the last few decades, global education systems have developed various subjects and programs in secondary education to impart technical and vocational skills. These subjects reflect diverse national priorities and unique socio-economic contexts, offering valuable insights for the subject curriculum. Now, we discuss ten practices in this field, incorporated by numerous leading countries in the world into their national curricula, and benefited for national growth at societal and economic levels:

1. Design and Technology (United Kingdom)

   Design and Technology combines design principles with practical problem-solving skills. Students explore modules in product design, engineering, textiles, and food technology, utilizing Computer-Aided Design (CAD) tools to develop sustainability-focused projects. This subject prepares students for careers in engineering, manufacturing, and design industries (Eggleston, 2001)
2. Berufsvorbereitungsjahr.

   Germany's Berufsvorbereitungsjahr (Vocational Preparation Year) integrates vocational training into general education, focusing on fields like automotive engineering, carpentry, and healthcare. This program prepares students for apprenticeships or entry-level jobs through Germany’s dual education system, which combines part-time work placements with classroom instruction. It has been hailed as a model for reducing youth unemployment (Deissinger, 2015)
3. Family and Consumer Sciences (United States).

   This subject focuses on life skills such as nutrition, cooking, family dynamics, and financial literacy. By equipping students to manage households or pursue careers in hospitality and service industries, it also includes entrepreneurship components to foster small business creation. It emphasizes practical skills for independence and employability (Stewart, 2016)
4. Technika.

   Poland’s Technika (Technology) offers basic technical education in mechanics, electronics, and crafting. Early exposure to industrial tools and manufacturing practices prepares students for vocational trades. This subject builds a strong foundation for Poland’s manufacturing-driven economy (Szczepaniak, 2019)
5. Praktisk-estetiske fag (Norway).

   Praktisk-estetiske fag (Practical-Aesthetic Subjects) include arts and crafts, woodworking, and textile design. These courses foster creativity, manual dexterity, and pathways to vocational training. They are often tied to traditional crafts, such as Norwegian folk art, supporting cultural preservation and niche industries (Opheim, 2020)
6. Études professionnelles.

   France’s Études professionnelles (Professional Studies) provide technical skills in agriculture, mechanics, and culinary arts. By emphasizing regional specialties like wine-making and cheese production, the curriculum bridges secondary education and vocational careers, addressing both local and national industry needs (Duranton, 2018)

7. Work Studies.

Australia's Work Studies subject introduces students to workplace practices, career planning, and technical skills. Collaboration with local businesses enables students to gain hands-on experience and prepare for part-time work or vocational pathways post-graduation (Billett, 2007)

8. STEM-Focused Technology Education.

South Korea integrates robotics, AI, and programming into secondary education. These STEM-focused programs prepare students for careers in technology and innovation-driven fields. Students frequently participate in national robotics and coding competitions, reflecting the country's commitment to technological advancement (Lim & Lee, 2019)

9. Agriculture and Land Use (Kenya).

This subject emphasizes modern farming techniques, irrigation, and sustainability, addressing food security and promoting agribusiness skills. It is tailored to Kenya's reliance on agriculture as a key economic sector, equipping students to drive innovations in this critical industry (Muthamia et al., 2020)

10. Teknologifag.

Denmark's Teknologifag (Technology Subjects) includes mechanical engineering, energy systems, and environmental technology. The curriculum fosters sustainable innovation and prepares students for technical roles. Integration of green energy solutions into project-based learning aligns education with Denmark's green economy goals (Vierke, 2024)

The subject "Technology" in Uzbekistan's secondary education curriculum reflects a deliberate effort to provide students with a balanced education that integrates practical life skills, vocational training, and cultural preservation. The division of the curriculum into nine subfields, covering diverse areas such as food processing, robotics, and vocational guidance, ensures students receive both foundational knowledge and specialized training. Below, we discuss the following nine core subfields in the subject scope, and their relevance in global practice:

1. Food Processing Technology.

Students learn the nutritional value of food, preparation techniques, and traditional recipes. This module enhances practical life skills and emphasizes health and cultural identity. Globally, countries like Japan incorporate traditional cooking lessons to foster cultural appreciation and life skills from an early age.

2. Textile and Garment Technology.

Students engage with design, tailoring, and pattern creation, which link directly to Uzbekistan's rich history in textiles. Similar programs in Italy focus on fashion design, combining tradition with modern techniques, preparing students for careers in creative industries.

3. Energy Production and Utilization.

This module introduces renewable energy and power systems. Sweden's secondary schools emphasize sustainability education, which aligns with this subfield, preparing students for global challenges like climate change and energy efficiency.

4. Mechatronics and Robotics.

Hands-on learning in robotics equips students with 21st-century skills. South Korea's STEAM programs are exemplary, integrating robotics into education to foster critical thinking and technological literacy, key to thriving in the digital economy.

5. Social and Economic Technology.

Focusing on family economics and project management, this module encourages entrepreneurship. Finland's educational system mirrors this by emphasizing project-based learning, which enhances problem-solving skills and innovation.

6. Folk Art and Craftsmanship.

Preserving traditional crafts fosters cultural identity. India includes handicrafts in its curriculum, empowering students with creative and entrepreneurial skills while preserving cultural heritage.

7. Household and Life Skills.

Practical lessons in organization and appliance management address essential life skills. Germany's vocational schools offer similar curricula, ensuring students transition smoothly into adulthood.

8. Fundamentals of Electronics.

Introducing basic electronics prepares students for STEM careers. The U.S. integrates electronics projects into middle and high school curricula, inspiring interest in engineering and technology.

9. Vocational Guidance.

Career planning modules provide a roadmap for students' futures. Australia's career education programs help students explore pathways, ensuring informed decisions about their academic and professional journeys. (Education, 2022)

While this curriculum integrates traditional skills like folk art and modern disciplines such as robotics, reflecting a blend of heritage and innovation, and prepares students for both local crafts-based industries and global technological careers, there are still some useful insights that we can learn from global best practices to ensure the subject "Technology" remains relevant and impactful in Uzbekistan's secondary education system. Among them, we would like to highlight the following 5 key directions for improvement and enhancement that can be identified below. These focus areas aim to align the curriculum with global trends, address local challenges, and maximize its contributions to workforce readiness and economic growth.

1. Expanding Practical Training.

Strengthening the practical training component of the curriculum is vital to bridging the gap between classroom learning and industry requirements. Establishing partnerships with industries can provide students with internships and apprenticeships, offering real-world exposure and hands-on experience. Moreover,

equipping schools with advanced tools for robotics, electronics, and green technology would enhance the technical competency of students and prepare them for high-demand sectors such as automation and renewable energy. Countries around the world emphasize the importance of practical, hands-on learning experiences to connect students with real-world applications of their education:

- Germany: The dual education system pairs classroom-based theoretical instruction with industry-based apprenticeships, giving students direct exposure to the labor market while they learn. This model has significantly reduced youth unemployment in Germany.
- Australia: Through Technical and Further Education (TAFE) programs, students gain vocational qualifications that are highly valued by employers. Partnerships with industries ensure that students graduate with skills that align with market needs.

2. Teacher Training and Development.

The effectiveness of the "Technology" curriculum largely depends on the expertise of educators. Developing specialized training programs for teachers in robotics, electronics, and entrepreneurship would ensure they are well-equipped to deliver modern, skill-oriented instruction. Additionally, continuous professional development initiatives are necessary to keep educators abreast of the latest industry trends, enabling them to adapt their teaching methods to evolving technological advancements. Investing in teacher expertise is a common strategy to improve the quality of education delivery, particularly in technical and vocational fields:

- Finland: Teacher training programs include project-based methodologies and STEM-specific skills. Regular professional development sessions ensure educators stay updated with technological advances and pedagogical innovations.
- Singapore: The Ministry of Education offers specialized training for teachers in fields such as artificial intelligence, robotics, and sustainability to prepare them for delivering high-tech curricula.

3. Enhancing Accessibility.

Ensuring equitable access to quality education is crucial for national development. Rural schools must be provided with resources comparable to those available in urban areas, bridging the gap in educational opportunities. Furthermore, offering online and hybrid learning modules can reach underserved regions, allowing students from remote areas to benefit from the same level of instruction and exposure to modern technology. Addressing geographical and socio-economic disparities in access to education is a priority for many nations:

- India: The government's Digital India initiative promotes online education platforms to reach students in remote areas. Programs like SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) provide free digital content for vocational training.
- United States: Hybrid learning models, particularly in community colleges, offer flexible access to vocational programs, benefiting students who cannot attend traditional classes due to geographical or economic constraints.

4. Promoting Entrepreneurship.

To cultivate a spirit of innovation and self-reliance among students, the curriculum should embed stronger entrepreneurial components. These modules would prepare students for self-employment by equipping them with the skills to identify and seize business opportunities. Collaborations with local businesses can provide practical, problem-solving experiences, ensuring that students develop the mindset and abilities required to thrive in entrepreneurial ventures. Many countries include entrepreneurship education in their TVE curricula to foster innovation and self-employment:

- Kenya: Agricultural education programs embed entrepreneurial components, encouraging students to start small businesses in farming and agribusiness. This strategy addresses food security challenges while boosting economic activity.
- South Korea: Entrepreneurship is integrated into STEM education, encouraging students to create startups, particularly in high-tech industries like AI and robotics. These initiatives are supported by government funding and mentorship programs.

5. Emphasizing Sustainability.

As global priorities shift toward sustainable development, the curriculum must reflect these changes by expanding modules on renewable energy and environmental technology. These additions would prepare students to contribute to the green economy and address critical challenges such as climate change and resource management. Aligning the curriculum with global sustainability trends ensures that Uzbekistan's workforce remains competitive in an increasingly environmentally conscious world. Sustainability is a global priority, and many countries are aligning their education systems with green economy goals:

- Sweden: Sustainability is a core focus of vocational training programs, with students learning about renewable energy technologies and environmental conservation methods. Schools partner with green industries to provide hands-on experience.
- Denmark: Teknologifag (Technology Subjects) integrate green technology and sustainable engineering practices into secondary education. Students work on project-based solutions to real-world environmental challenges, preparing them for roles in the global green economy.

[Figure 2. About here]

By focusing on these areas – practical training, teacher development, accessibility, entrepreneurship, and sustainability – Uzbekistan can further enhance the subject "Technology" curriculum's impact. These initiatives will not

only prepare students for the demands of the modern labor market but also contribute to the nation’s economic resilience and sustainable growth.

CONCLUSIONS

As we have seen, countries recognize the critical role of practical training, teacher development, equitable access, entrepreneurship, and sustainability in strengthening TVE systems globally. These strategies not only enhance workforce readiness but also contribute to national economic resilience and global competitiveness. Uzbekistan’s proposed enhancements to its “Technology” curriculum align with these global trends, indicating that the nation is on the right path to modernizing its education system and preparing its youth for the challenges of the 21st century.

The inclusion of «Technology» in Uzbekistan’s secondary education curriculum is both timely and transformative. By integrating practical skills, cultural preservation, and career readiness, the subject not only addresses current educational needs but also positions Uzbekistan as a model for holistic education in the region. Adopting insights from global practices and further refining the curriculum can ensure sustained impact, empowering a new generation to thrive in a complex, interconnected world.

In conclusion, we can safely say that Uzbekistan is on a promising trajectory with its “Technology” curriculum, reflecting many global trends while addressing unique national priorities. By tackling areas such as gender inclusivity, accessibility, and industry collaboration, the country can further align its education system with international standards. With strategic enhancements, this subject can significantly contribute to workforce readiness, entrepreneurship, and sustainable economic growth.

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ConflictofInterestStatement: Theauthorsdeclarethattheresearchwasconducted in the absence of any commercial or financial relationships that could be construed as a potential conflict ofinterest.

LIST OF FIGURE

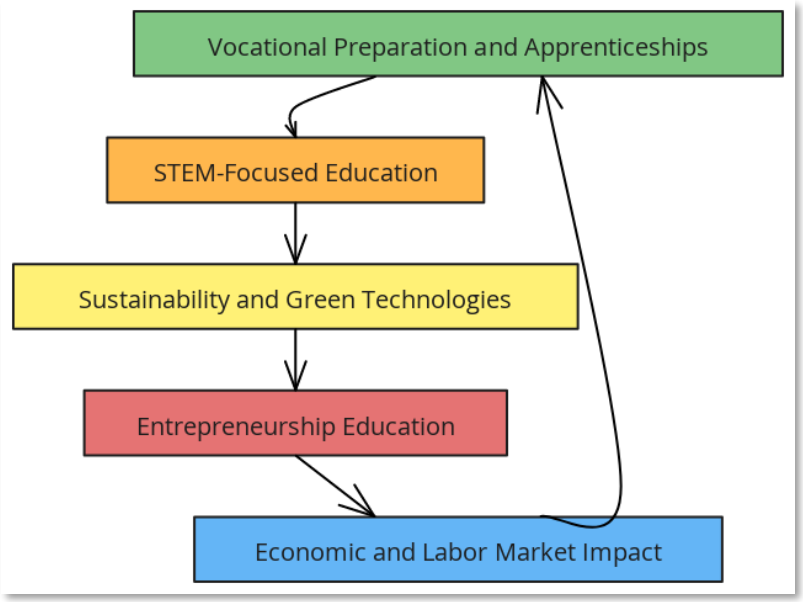

Figure 1 / Five key focus areas within TVE

Figure 2 / Mindmap for the Five Key Directions