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Non-Technical Engineering Skills in Technical Vocational Education: Literature Review and Systematization the Non-Tech Skills in Congruence with the Professional Field with Some Examples

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ABSTRACT: The article reviews and emphasizes the significance of non-technical skills in Technical and Vocational Education and Training (TVET) to improve the employability of graduates. It identifies communication, problem-solving, teamwork, self-management, and adaptability as crucial competencies that are integral to technical field programs, rather than as supplementary parergon skills in the technical field programs. The post-pandemic landscape, local war conflicts has heightened intensively the importance of emotional intelligence and professionalism in the workplace. Employers prioritize these transferable skills alongside technical abilities when achieving quality standards and measure efficiency. The article advocates for integrating non-technical skills into the curricula of TVET institutions in broad a scale thus enhancing and transforming educational methods, and assessments to better prepare students for competitive and changing industries. It also highlights the relevance of Professional Ethics in engineering education, suggesting that ethical considerations should be woven into academic programs.

KEYWORDS: Communication teamwork, Engineering soft skills, Emotional intelligence, non- technical skills.

INTRODUCTION

Literature review on the topic

Recent studies mention the critical importance of non-technical skills for TVET graduates' employability. Communication skills are consistently ranked as the most crucial employability skill (*Nayan & Nayan, 2024; Bakare Shola et al., 2019, Yamada & Otchia, 2020*). Other essential skills include problem-solving, teamwork, self-management, and adaptability (*Nayan & Nayan, 2024; Paryono, 2014; Dzia-Uddin et al., 2024*). The post-pandemic environment has emphasized the need for emotional intelligence, professionalism, and workplace health and safety skills (*Dzia-Uddin et al., 2024*). Employers often view these transferable skills as equally or more important than technical skills (Paryono, 2014). To enhance graduates' employability, it is recommended that TVET institutions integrate these non-technical skills into their curricula, teaching methods, and assessments. This integration would better prepare students for the competitive and evolving job market, particularly in industries like hospitality and metalwork technology.
Abdul-Rahman et al. (2011) discusses the necessity of Professional Ethics as a soft skill for engineers, emphasizing its role in engineering education. *Bairaktarova & Woodcock (2015)* explores the integration of Professional Ethics into engineering curricula and its impact on student learning. *De Campos et al.* (2020) in "The Importance of Soft Skills for Engineering" provide a systematic literature review that identifies and presents social skills required for engineers, including Professional Ethics. In "Soft Skills by Engineering Employers," they compare the expectations of engineering employers regarding social skills with the actual skills possessed by graduates. Their work "Fuzzy Model for Diagnosing Soft Skills in Engineering Training" proposes a fuzzy logic model for evaluating and diagnosing soft skills in engineering education. *Chand et al*. (2016) highlights the importance of initiative and emotional intelligence as critical soft skills for engineers. *Cheruvalath* (2019) affirms that training in Professional Ethics is a *predictor of metamoral cognitive ability* in engineering students, showing significant differences in skills between those who studied ethics and those who did not. *De Campos et al.* (2020a, 2020b, 2020c) emphasizes the need for soft skills, particularly Professional Ethics, in the engineering profession. *Fernández-Sanz et al.* (2017) discusses the relevance of self-confidence and initiative in the engineering skill set. Fischer et al. (2019) addresses the importance of organization and emotional intelligence in engineering practice. *Gopi Krishna et al*. (2019) explores the role of emotional intelligence in enhancing engineering competencies. *Jafari-*

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Marandi et al. (2019) investigates the significance of initiative as a soft skill in engineering education. *Kist & Brodie* (2011) discusses the application of knowledge in the work environment as a critical skill for engineers. *Knobbs & Grayson* (2012) highlights the need to reconcile soft skills with technical skills in engineering education. *Matturro et al*. (2019) provides a comprehensive overview of various soft skills required in engineering, including multitasking capability, persistence, and self-confidence. *Michaud* (2016) examines the role of emotional intelligence in the engineering profession. *Ogunsanmi* (2016) discusses the importance of organization as a key skill for engineers. *Redoli et al.* (2013) emphasizes the integration of soft skills, including Professional Ethics, into engineering education. *Soares et al.* (2013) highlights the importance of initiative in the engineering skill set. *Sunthara & Vishnu* (2019) discuss the significance of multitasking capability and the application of knowledge in the work environment. *Verbic et al*. (2017) discuss the evolving labor market and the need for engineers to adapt through skill development. *Vu& Le* (2019) emphasizes the importance of education and training in developing necessary skills for employability. *Zhu & Jesiek* (2017) investigates the relationship between ethics and engineering skills, emphasizing the need for ethical training in engineering education.

Grouping nuclei of non-tech skills with the professional field of TVET: Systematizing the sector

In the context of Technical and Vocational Education and Training (TVET), non-technical skills can be categorized into several key areas that align with the demands of the professional field. These categories include communication skills, teamwork and collaboration, problem-solving abilities, and professional ethics, all of which are vital for effective performance in the engineering profession.

Communication Skills are essential for engineers as they often serve as a bridge between technical teams and stakeholders. Effective communication encompasses not only the ability to articulate ideas clearly but also the capacity to listen actively and engage in constructive discussions. In a professional setting, engineers must convey complex concepts in an understandable manner to both technical and non-technical audiences.

Teamwork and Collaboration are crucial in the engineering field, where projects typically involve multiple stakeholders, including engineers, designers, project managers, and clients. The ability to work collaboratively enhances team dynamics, cultivates innovation, and ensures that diverse perspectives are integrated into problem-solving processes. Training that emphasizes group projects and interdisciplinary work can help students develop these skills effectively.

Problem-Solving Abilities require engineers to approach challenges with critical and analytical thinking. Non-technical skills related to problem-solving include creativity, adaptability, and decision-making capabilities. Engineering professionals must be able to analyse situations, weigh options, and implement effective solutions in a timely manner, particularly in fast-paced work environments.

Professional Ethics are foundational to the integrity and reliability of engineers. An understanding of ethical principles and the ability to navigate ethical dilemmas is indispensable in the field. Training in professional ethics not only prepares students to make informed decisions but also reinforces their responsibility to society, emphasizing the importance of engineering solutions that are socially and environmentally sustainable.

As engineering education evolves to meet the challenges of the modern workforce, it is increasingly crucial to integrate these non-technical skills into the curriculum. By doing so, TVET institutions can cultivate well-rounded engineering professionals who are not only technically proficient but also equipped with the interpersonal, analytical, and ethical skills necessary for success in their careers. This holistic approach to skill development ultimately enhances employability and prepares students to contribute meaningfully to their fields and communities.

When it comes to enhancing the employability of graduates through non-technical skills in Technical and Vocational Education and Training (TVET), several strategies can be employed. One effective approach is to create an engaging learning environment that prioritizes practical experience. This includes implementing project-based learning where students collaborate on real-world projects that require communication and problem-solving. Such experiences help students understand the importance of teamwork and provide them with opportunities to practice critical soft skills in a controlled setting.

Institutions should also consider embedding workshops and seminars focusing on essential soft skills within their curricula. Topics could include emotional intelligence, leadership, conflict resolution, and professional ethics. By bringing in industry experts, students can gain insights and practical tips that enhance their understanding and application of these skills in a professional context. Role-playing and simulation exercises further allow students to navigate hypothetical situations, thereby strengthening their

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decision-making and negotiation skills in realistic scenarios. Interdisciplinary collaboration can significantly benefit the development of non-technical skills. By encouraging engineering students to work alongside peers from other fields, such as business or environmental studies, institutions promote a rich exchange of ideas and perspectives. This collaboration nurtures flexibility, adaptability, and a deeper appreciation for the diverse viewpoints necessary in today's workplace. Active integrating community service opportunities into the educational framework cultivates a sense of social responsibility among students. As they apply their engineering skills to solve community issues, they not only contribute positively to society but also enhance their ethical awareness and organizational skills.

Peer mentoring programs can also be advantageous. When senior students mentor juniors, they not only solidify their own knowledge but develop leadership and communication skills crucial for their future careers. This supportive network can help cultivate a sense of community within the institution, making the learning process more enriching. Basically, integrating non-technical skills into TVET education is a multifaceted approach that requires commitment from educational institutions. It would include hands-on learning, interdisciplinary collaboration, and community engagement, TVET programs can produce graduates who are not only technically proficient but also equipped with the critical soft skills demanded in the modern workplace. This alignment between education and employer expectations will ultimately enhance graduates' chances of success in their chosen careers, contributing positively to their fields and society as a whole. Of extreme importance is TVET institutions to recognize the value of these skills and take proactive steps to include them in their curricula, cultivating well-rounded professionals ready to meet the challenges and opportunities of the 21st-century workplace. A diagram of the core non-technical skills grouping in nests is presented in ***Figure.1.***

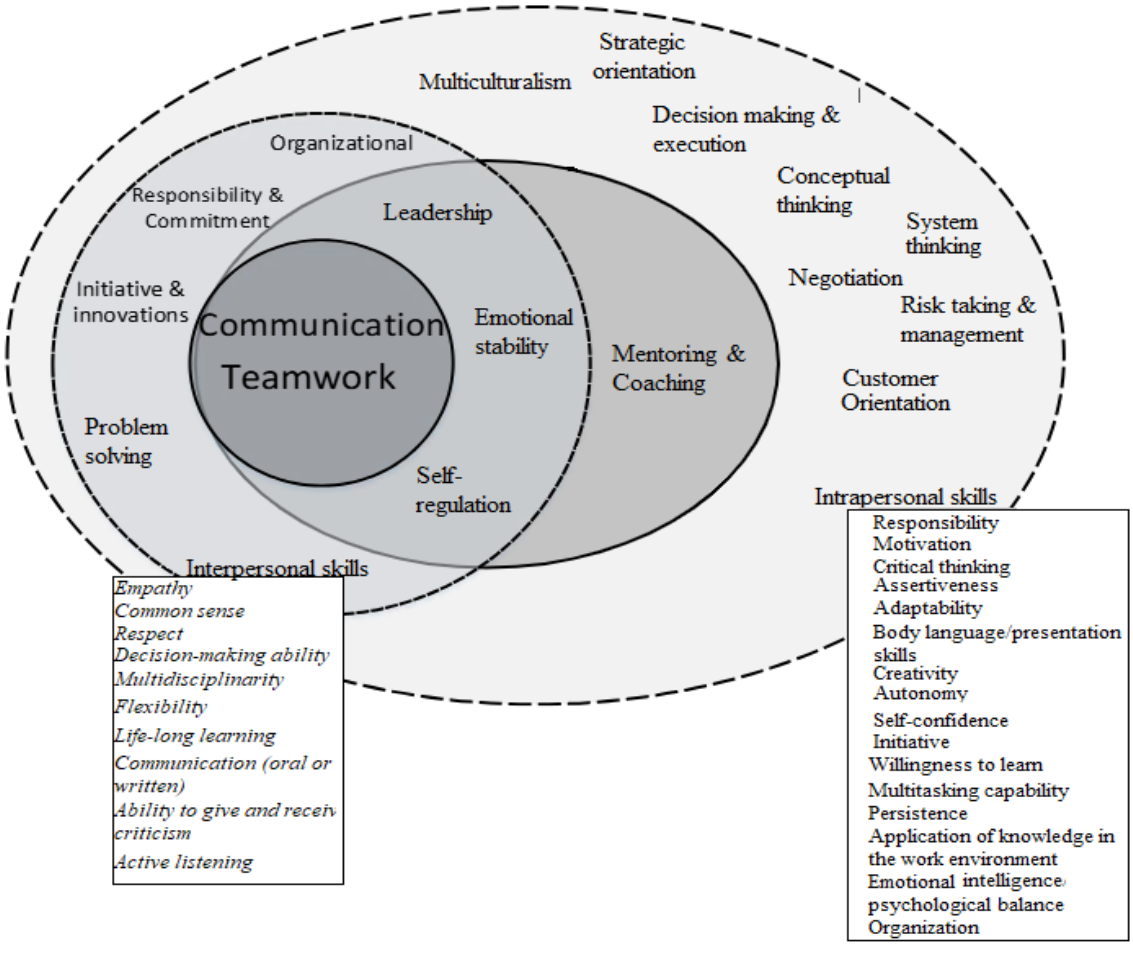

Figure 1. Social non-technical skills core grouping
[source: author's]

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Table 1. summarizes the **engineering non- technical skills** along with the corresponding articles referenced in the systematic review.

Table 1. Non-technical skills: a summary of literature review group nuclei

SKILL	*REFERENCES*
INTERPERSONAL SKILLS	
Empathy	*Ballesteros-Sanchez et al., 2017; De Campos et al., 2020b; Chand et al., 2019; Knobbs & Grayson, 2012; Maria Gil-Martin et al., 2010; Ogunsanmi, 2016*
Common sense	*De Campos et al., 2020b; Maria Gil-Martin et al., 2010*
Respect	*Michaud, 2016; Zhu & Jesiek, 2017*
Decision-making ability	*Bero & Kuhlman, 2011; Burnik & Košir, 2017; Itani & Srour, 2016; Martin-Lara et al., 2019; Miñano et al., 2017; Sunthara Valli & Vishnu Priya, 2019*
Multidisciplinarity	*De Campos et al., 2020b, 2020c; Kist & Brodie, 2011; Krueger-Ziolek et al., 2013; Miñano et al., 2017; Monteiro et al., 2017; Ogunsanmi, 2016; Staniškis & Katiliute, 2016; Verbic et al., 2017; Vu Anh & Le Quoc, 2019*
Flexibility	*Ballesteros-Sanchez et al., 2017; De Campos et al., 2020b, 2020c; Fernández-Sanz et al., 2017; Kist & Brodie, 2011; Masoud & Al Muhtaseb, 2019; Matturro et al., 2019; Michaud, 2016*
Life-long learning	*Burnik & Košir, 2017; Kist & Brodie, 2011; Krueger-Ziolek et al., 2013; Sunthara Valli & Vishnu Priya, 2019*
Communication (oral or written)	*Ballesteros-Sanchez et al., 2017; Burnik & Košir, 2017; De Campos et al., 2020a, 2020b, 2020c; Caratozzolo et al., 2019; Chand et al., 2019; Jafari-Marandi et al., 2019; Ogunsanmi, 2016; Pons, 2016; Soares et al., 2013*
Ability to give and receive criticism	*Matturro et al., 2019; Sunthara Valli & Vishnu Priya, 2019*
Active listening	*De Campos et al., 2020a, 2020b; Sunthara Valli & Vishnu Priya, 2019*
INTRAPERSONAL SKILLS	
Responsibility	*Abdul-Rahman et al., 2011; De Campos et al., 2020a, 2020b, 2020c; Custovic, 2015; Matturro et al., 2019; Michaud, 2016; Monteiro et al., 2017; Sunthara Valli & Vishnu Priya, 2019b; Verbic et al., 2017*
Motivation	*De Campos et al., 2020a, 2020b; Fischer et al., 2019; Gopi Krishna et al., 2019; Maria Gil-Martin et al., 2010; Matturro et al., 2019; Ogunsanmi, 2016; Pinkus et al., 2015*
Critical thinking	*De Campos et al., 2020a, 2020b; Caratozzolo et al., 2019; Monteiro et al., 2017; Redoli et al., 2013; Sunthara Valli & Vishnu Priya, 2019b; Vu Anh & Le Quoc, 2019*
Assertiveness	*Ecklund & Di, 2017; Knobbs & Grayson, 2012; Matturro et al., 2019; Ogunsanmi, 2016*
Adaptability	*Ballesteros-Sanchez et al., 2017; Chand et al., 2016; Gopi Krishna et al., 2019; Karmis, 2017; Michaud, 2016; Ogunsanmi, 2016; Sunthara Valli & Vishnu Priya, 2019*
Body language/presentation skills	*Fischer et al., 2019; Krueger-Ziolek et al., 2013; Masoud & Al Muhtaseb, 2019; Matturro et al., 2019*
Creativity	*Ballesteros-Sanchez et al., 2017; De Campos et al., 2020a, 2020b, 2020c; Fernández-Sanz et al., 2017; Fischer et al., 2019; Jafari-Marandi et al., 2019; Matturro et al., 2019; Monteiro et al., 2017*
Autonomy	*Chand et al., 2016; Matturro et al., 2019; Soares et al., 2013*
Willingness to learn	*Jafari-Marandi et al., 2019; Matturro et al., 2019*
Multitasking capability	*Matturro et al., 2019; Sunthara Valli & Vishnu Priya, 2019*
Persistence	*Martin-Lara et al., 2019; Matturro et al., 2019*

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Application of knowledge in the work environment	*Kist & Brodie, 2011; Matturro et al., 2019; Sunthara Valli & Vishnu Priya, 2019*
Emotional intelligence/psychological balance	*De Campos et al., 2020a, 2020b, 2020c; Chand et al., 2016; Fischer et al., 2019; Gopi Krishna et al., 2019; Michaud, 2016*
Organization	*Fischer et al., 2019; Ogunsanmi, 2016*
Self-confidence	*Fernández-Sanz et al., 2017; Matturro et al., 2019*
Initiative	*Chand et al., 2016; Fernández-Sanz et al., 2017; Jafari-Marandi et al., 2019; Matturro et al., 2019; Soares et al., 2013*
SOCIAL JUSTICE	
Gender equality in the professional field / feminist ethics	*Ecklund & Di, 2017; Zhu & Jesiek, 2017*
Multiculturalism	*De Campos et al., 2020a, 2020b; Staniškis & Katiliute, 2016; Zhu & Jesiek, 2019*
Awareness	*Donaldson, 2017; Knobbs & Grayson, 2012; Maria Gil-Martin et al., 2010; Matturro et al., 2019*
Morality	*De Campos et al., 2020b; Cheruvalath, 2019; Gelfand, 2016; Gupta, 2015; Maria Gil-Martin et al., 2010; Miñano et al., 2017*
MANAGEMENT WITH PROFESSIONAL ETHICS	
Formal and informal rules compliance	*Ecklund & Di, 2017; Hojem & Lagesen, 2011; Lurie & Mark, 2016; Maria Gil-Martin et al., 2010; Miñano et al., 2017; Ogunsanmi, 2016; Zhu & Jesiek, 2019*
Professionalism	*Abdul-Rahman et al., 2011; Ballesteros-Sanchez et al., 2017; Burnik & Košir, 2017; De Campos et al., 2020a, 2020b, 2020c; Fischer et al., 2019; Lurie & Mark, 2016; Monteiro et al., 2017; Ogunsanmi, 2016; Trope & Ressler, 2016; Zhu & Jesiek, 2017*
Teamwork	*Ballesteros-Sanchez et al., 2017; Burnik & Košir, 2017; De Campos et al., 2020a, 2020b, 2020c; Fernández-Sanz et al., 2017; Fischer et al., 2019; Itani & Srour, 2016; Jafari-Marandi et al., 2019; Knobbs & Grayson, 2012; Masoud & Al Muhtaseb, 2019; Matturro et al., 2019*
Leadership	*Ballesteros-Sanchez et al., 2017; Burnik & Košir, 2017; De Campos et al., 2020a, 2020b, 2020c; Custovic, 2015; Fischer et al., 2019; Karmis, 2017; Knobbs & Grayson, 2012; Matturro et al., 2019; Monteiro et al., 2017; Ogunsanmi, 2016; Pons, 2016; Stovall, 2011*
Problem-solving capability	*Ballesteros-Sanchez et al., 2017; Burnik & Košir, 2017; De Campos et al., 2020a, 2020b, 2020c; Gopi Krishna et al., 2019; Jafari-Marandi et al., 2019; Karmis, 2017; Kist & Brodie, 2011; Knobbs & Grayson, 2012*
Mentoring and coaching	*Custovic, 2015; Fischer et al., 2019; Matturro et al., 2019; Michaud, 2016*

DISCUSSION

The literature review suggests that the integration of Professional Ethics into Engineering education is crucial as it prepares students to confront ethical dilemmas they may face in their careers in the age of AI and Transhumanistic ideas in multivious context. It needs to cultivate critical thinking and encourages students to understand the wider implications of their engineering decisions on society, the environment, and the economy. The key soft skills essential for engineers derived from the grouped nuclei above are:

[1] Decision-making ability
[2] Multidisciplinary and innovative reasoning
[3] Flexibility
[4] Life-long learning
[5] Communication skills (oral and written)
[6] Creativity and dianoetic reasoning
[7] Autonomy
[8] Willingness to learn

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[9] Multitasking capability
[10] Persistence
[11] Application of knowledge in the work environment
[12] Emotional intelligence/psychological balance

Emotional intelligence, even not firstly reviewed, is pivotal in enhancing engineering competencies, as it relates to an engineer's ability to understand and manage their own emotions, as well as to empathize with others. This skill contributes to improved teamwork, effective communication, and a better ability to handle stress and conflict in the workplace. Studies suggest that engineers with high emotional intelligence can navigate professional relationships effectively, leading to more successful project outcomes and a more cohesive work environment.

For effective development of non-technical skills in engineering TVET, a variety of practical strategies can be implemented. One approach is the incorporation of project-based learning with real cases where ethical dilemmas appear and scientifical approaches and metage should be made; where students engage in hands-on projects that necessitate teamwork, problem-solving, and communication. For example, students could collaborate on a community project to design and construct a sustainable solution, such as a solar energy system for a local organization, but taking account the social impact of the installation and the ecological impact. This type of experiential learning not only cultivates collaboration but also promotes initiative and real-world application of engineering concepts.

Additionally, organizing workshops and seminars focused on essential soft skills can prove beneficial. These sessions could cover topics such as leadership, negotiation, emotional intelligence, and professional ethics, with industry experts invited to lead discussions that provide students with strategies to enhance these competencies. Another effective method is the use of role-playing and simulation exercises, in which students navigate ethical dilemmas or work-related challenges. For instance, a simulated project meeting could allow students to present their ideas while handling objections, thereby developing their communication and negotiation skills.

Encouraging interdisciplinary collaboration can further support the development of non-technical skills. By cultivating projects that require engineering students to work alongside peers from other fields, such as business or environmental science, institutions can promote interpersonal skills, flexibility, and an appreciation for diverse perspectives. Integrating service-learning opportunities allows students to apply their engineering skills in community service projects, thereby enhancing their sense of social responsibility and ethical awareness while improving their organizational and leadership abilities.

Establishing peer mentoring programs can create a supportive learning environment in which senior students guide junior counterparts through their educational journeys. This kind of interaction nurtures leadership skills in mentors and enhances communication and social skills for both parties involved. Furthermore, partnering with local industries to provide internship or apprenticeship opportunities exposes students to workplace dynamics and expectations while allowing them to practice and refine their soft skills in a real-world context.

Encouraging reflective practice is another significant aspect of skill development. Students could be asked to maintain journals or portfolios that document their learning experiences and personal growth throughout their studies, emphasizing the importance of self-evaluation and lifelong learning. Lastly, organizing discussions and debates on contemporary issues in engineering and ethical dilemmas faced by professionals stimulates critical thinking and improves public speaking abilities, cultivating a deeper understanding of the role of soft skills in the engineering field.

Implementing these strategies within TVET education, institutions can significantly contribute to the development of essential non-technical skills in students, enhancing their prospects for success in the engineering profession and improving their overall employability.

The future of non-technical skills is set to become increasingly crucial within the evolving and interconnected domains of work, education, and ecology. As automation and artificial intelligence (AI) continue to reshape industries, research suggests that the demand for uniquely human cognitive and socio-emotional abilities—such as emotional intelligence, critical thinking, creativity, and interpersonal communication—will rise significantly. Unlike algorithmic problem-solving and rule-based decision-making, these complex cognitive and affective processes are deeply rooted in neurobiological and socio-cultural mechanisms that are not easily replicable by artificial systems. Studies in organizational psychology and behavioural economics further indicate that human-centric skills enhance adaptability, innovation, and cooperative problem-solving, thereby increasing their indispensability in an AI-

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augmented workforce. Consequently, as technological advancements automate routine and analytical tasks, non-technical skills will play a pivotal role in sustaining human agency and enhancing productivity in future professional environments

In various sectors, employers are beginning to prioritize non-technical skills as essential attributes that contribute to an individual's overall effectiveness. As teams become more diverse and collaborative, the ability to communicate clearly, work well with others, and engage in constructive problem-solving will be key differentiators in job performance and career advancement. Another aspect is the globalization of the workforce necessitates cultural competence and adaptability. Professionals will increasingly need to navigate multicultural environments and work collaboratively with colleagues from different backgrounds. This calls for a strong foundation in negotiation, empathy, and flexibility—skills that will become crucial as remote and hybrid work models continue to dominate.

As education systems worldwide recognize the importance of holistic development, there is a growing trend to incorporate non-technical skills training into curricula. Beyond traditional academic subjects, programs focusing on leadership, ethics, and social responsibility are expected to gain traction. This shift will better prepare future generations to tackle complex challenges and adapt to rapid changes in the job market. The rise of lifelong learning and professional development will emphasize the need for individuals to continually refine and expand their non-technical skill sets throughout their careers. As the nature of work evolves, professionals will be expected to remain adaptable and proactively seek opportunities to develop skills that enhance their interpersonal relationships and problem-solving abilities.

CONCLUSION

The integration of a large plethora of non-technical skills into TVET education is essential for preparing graduates to meet the demands of a dynamic job market. By focusing on skills such as communication, emotional intelligence, and ethical practices, educational institutions will align their programs in congruence with employer expectations. This holistic approach enables students to develop the necessary competencies to thrive in diverse professional settings. One aspect in concern, prioritizing non-technical skills alongside technical knowledge will cultivate well-rounded and profound graduates who are equipped to face the complexities of their respective fields and enhance their overall career success. The recent future of non-technical skills is bright and essential. As workplaces become more interconnected and dynamic, the ability to collaborate effectively, think critically, and navigate complex social landscapes will be inevitably necessary for success. Organizations and educational institutions that embrace and prioritize the inculcation of these skills will not only induce individual growth but also create environments conducive to innovation and resilience.

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