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PSYCHOLOGICAL AND PEDAGOGICAL MODEL FOR DEVELOPING PROFESSIONAL COMMUNICATIVE COMPETENCE OF TECHNICAL ENGINEERS

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Abstract.
The rapid development of science, technology, and digital transformation has significantly increased the demand for engineers who possess not only technical expertise but also advanced communication skills. Professional communicative competence has become an essential component of engineering practice, enabling specialists to collaborate effectively, solve complex problems, and participate in interdisciplinary projects. This article aims to develop and substantiate a psychological and pedagogical model for enhancing the professional communicative competence of technical engineers. The proposed model integrates cognitive, motivational, emotional, behavioral, and technological components that contribute to effective professional communication. The study highlights the importance of psychological factors such as self-efficacy, emotional intelligence, motivation, and reflective thinking, alongside pedagogical strategies based on interactive learning technologies. The findings suggest that a systematic integration of psychological and pedagogical approaches can significantly improve engineers' communicative competence and professional effectiveness.

Keywords:
professional communicative competence, technical engineers, psychological factors, pedagogical model, communication skills, engineering education, emotional intelligence, professional development.

INTRODUCTION

The contemporary labor market requires engineers who can communicate effectively in multidisciplinary and multicultural environments. Advances in digital technologies, globalization, and the increasing complexity of engineering projects have transformed communication into one of the most important professional competencies. Modern engineers are expected not only to possess technical knowledge but also to negotiate, present ideas, collaborate with teams, and engage in professional discussions.

Research indicates that communication failures are among the leading causes of project inefficiencies, workplace conflicts, and engineering errors. Therefore, the development of professional communicative competence has become a strategic objective in engineering education. Despite the growing recognition of communication skills in technical professions, educational programs often prioritize technical content while paying insufficient attention to psychological and communicative aspects of professional development.

The purpose of this study is to develop a psychological and pedagogical model that facilitates the systematic development of professional communicative competence among technical engineers and to identify the key psychological and educational factors influencing this process.

LITERATURE REVIEW

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In Uzbek pedagogical and psychological research, scholars such as E.G‘. G‘oziyev, B.R. Qodirov, G‘.B. Shoumarov, M.G. Davletshin, and V.M. Karimova have emphasized the significance of communication, social interaction, and personality development in professional training. Their studies suggest that effective communication is closely related to self-awareness, emotional regulation, and social competence, all of which contribute to professional success.

Researchers from the CIS countries, including L.S. Vygotsky, A.N. Leontiev, S.L. Rubinstein, B.G. Ananyev, and V.A. Kan-Kalik have explored communication as a socially mediated activity that develops through interaction, reflection, and collaborative learning. Their theoretical frameworks emphasize the role of communication in cognitive development and professional formation.

Foreign scholars have extensively investigated communicative competence and professional communication. The communicative competence theory proposed by Dell Hymes laid the foundation for understanding communication as a combination of linguistic, social, and contextual skills. The works of Albert Bandura highlight the importance of self-efficacy in communication performance, while Daniel Goleman demonstrated the role of emotional intelligence in interpersonal effectiveness. Furthermore, David Kolb and Donald Schön emphasized experiential learning and reflective practice as essential mechanisms for developing professional competencies.

METHODOLOGY

The present study employed a mixed-method research design that integrated theoretical analysis with empirical investigation to develop and substantiate a psychological and pedagogical model for enhancing the professional communicative competence of technical engineers. At the theoretical stage, a comprehensive review of psychological, pedagogical, and engineering education literature was conducted to identify the conceptual foundations, structural components, and developmental mechanisms of communicative competence in technical professions. Particular attention was given to contemporary theories of professional communication, social interaction, emotional intelligence, self-efficacy, motivation, and reflective learning, which served as the theoretical basis for constructing the proposed model.

The empirical phase of the research was aimed at determining the psychological and pedagogical factors influencing the development of professional communicative competence among technical engineers. The study involved engineering students and practicing engineers from higher educational institutions and industrial enterprises. Participants represented various engineering disciplines, allowing for a comprehensive examination of communication competencies within diverse professional contexts. The selection of participants was based on purposive sampling to ensure that respondents possessed sufficient educational and professional experience relevant to engineering communication activities.

To assess the key psychological variables associated with professional communicative competence, a set of standardized psychodiagnostic instruments was administered. Communicative competence was evaluated using the Communication Skills Inventory, which measures verbal, non-verbal, and interpersonal communication abilities. Self-efficacy was assessed through the General Self-Efficacy Scale developed by Ralf Schwarzer and Matthias Jerusalem, while emotional intelligence was measured using an Emotional Intelligence Questionnaire based on the theoretical framework proposed by Daniel Goleman. Professional motivation was assessed through a Professional Motivation Scale designed to identify achievement motivation, professional aspirations, and commitment to occupational growth. In addition, reflective thinking was examined using a Reflective Thinking Assessment instrument aimed at evaluating participants’ capacity for self-analysis, critical reflection, and professional self-improvement.

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The collected data were processed using both descriptive and inferential statistical methods. Descriptive statistics were employed to determine the general characteristics of the sample and the distribution of psychological indicators. Pearson correlation analysis was conducted to identify the strength and direction of relationships between communicative competence and the examined psychological variables. Furthermore, multiple regression analysis was utilized to determine the predictive contribution of self-efficacy, emotional intelligence, professional motivation, and reflective thinking to the development of professional communicative competence. The integration of quantitative findings with theoretical analysis provided a scientific basis for the construction of a comprehensive psychological and pedagogical model aimed at improving communication effectiveness among technical engineers in modern professional environments.

RESULTS

The study revealed significant relationships between psychological characteristics and professional communicative competence among technical engineers.

Table 1

Correlation between psychological factors and professional communicative competence

Psychological Factors	r	p
Self-Efficacy	0.74	<0.001
Emotional Intelligence	0.69	<0.001
Professional Motivation	0.66	<0.001
Reflective Thinking	0.61	<0.01
Teamwork Orientation	0.58	<0.01

Interpretation of Table 1. The results indicate strong positive correlations between communicative competence and all investigated psychological factors. Self-efficacy demonstrated the strongest relationship, suggesting that engineers who believe in their professional capabilities communicate more effectively. Emotional intelligence and motivation were also found to significantly contribute to communication quality and interpersonal effectiveness.

Table 2

Regression analysis predicting professional communicative competence

Predictor Variables	β	t	p
Self-Efficacy	0.38	6.84	<0.001
Emotional Intelligence	0.32	5.72	<0.001
Professional Motivation	0.27	4.86	<0.01
Reflective Thinking	0.21	3.91	<0.05

$R^2 = 0.71$

Interpretation of Table 2. The model explains 71% of the variance in professional communicative competence. Self-efficacy emerged as the strongest predictor, followed by emotional intelligence and professional motivation. These findings indicate that psychological factors play a decisive role in shaping engineers' communication effectiveness.

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Psychological and pedagogical model for developing professional communicative competence

Table 3

Structural components of the proposed model

Components	Content
Goal Component	Development of professional communicative competence
Motivational Component	Professional values, communication motivation, career aspirations
Cognitive Component	Communication knowledge, professional terminology, digital communication literacy
Emotional Component	Emotional intelligence, empathy, emotional self-regulation
Behavioral Component	Verbal and non-verbal communication skills, teamwork, conflict management
Reflective Component	Self-analysis, feedback processing, professional reflection
Technological Component	ICT tools, virtual collaboration platforms, digital communication technologies
Outcome Component	High level of professional communicative competence

Interpretation of Table 3. The proposed model integrates psychological and pedagogical dimensions into a unified framework. The model assumes that communicative competence develops through the interaction of motivational, cognitive, emotional, behavioral, and technological components. Each component contributes to the formation of professional communication skills necessary for effective engineering practice.

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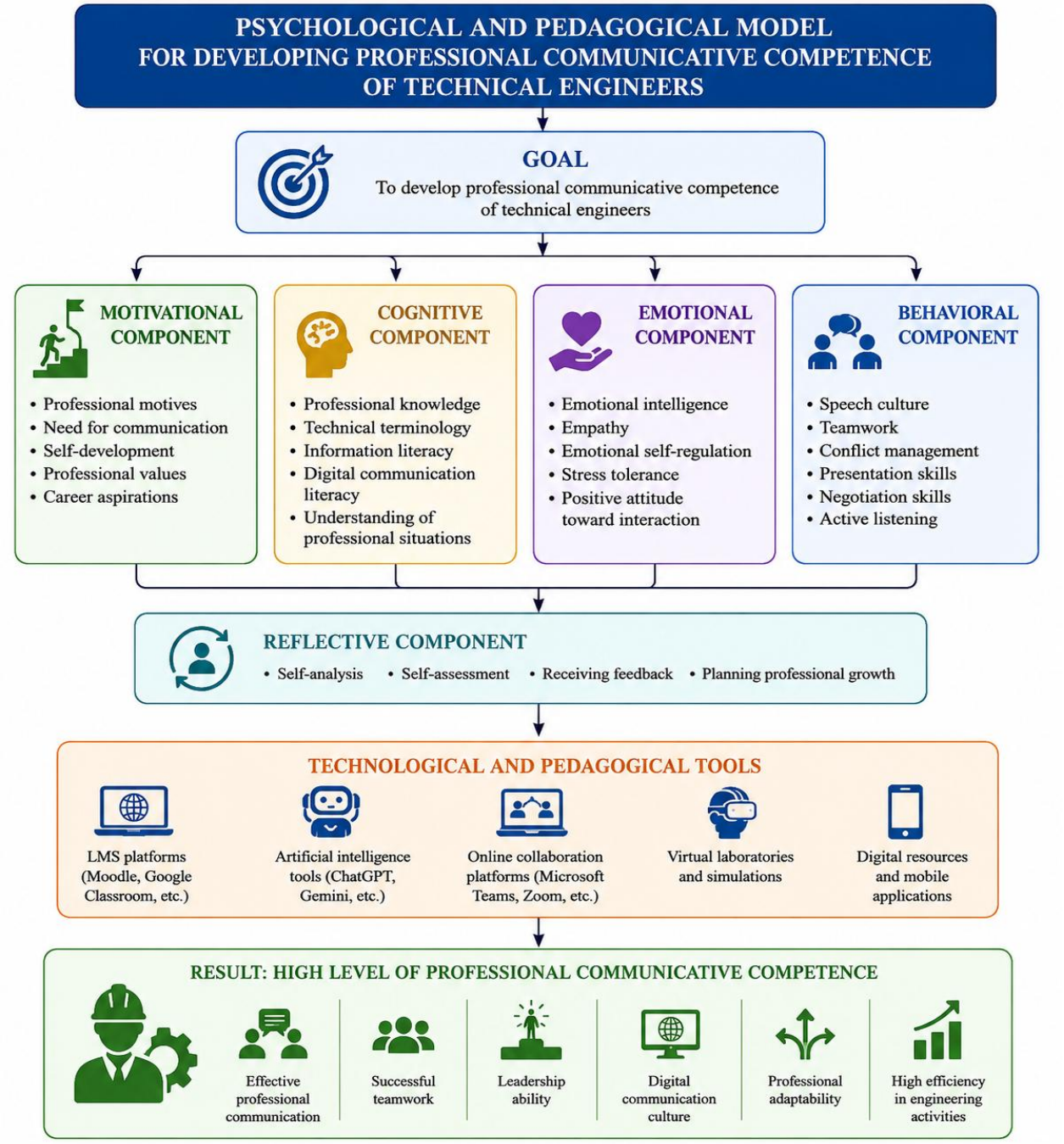


Figure 1. Psychological and Pedagogical Model

Figure 1 presents a psychological and pedagogical model for developing the professional communicative competence of technical engineers. The proposed model is based on the integration of psychological and pedagogical factors that ensure effective professional communication in modern engineering practice. The primary objective of the model is to develop engineers' ability to communicate effectively in professional settings, collaborate successfully within teams, exchange technical information accurately, and utilize digital communication technologies efficiently.

The first component of the model is the motivational component, which includes professional motivation, communication needs, self-development aspirations, career goals, and professional values.

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Motivation serves as the driving force behind the development of communicative competence, encouraging engineers to actively engage in professional interactions and continuously improve their communication abilities. The stronger the engineer's motivation toward professional growth and communication, the higher the level of communicative competence achieved.

The second component is the cognitive component, which encompasses professional knowledge, technical terminology, information literacy, digital communication literacy, and understanding of professional situations. This component reflects the intellectual foundation of communication competence, enabling engineers to express technical ideas clearly, interpret professional information accurately, and participate effectively in technical discussions. In contemporary engineering environments, the ability to communicate specialized knowledge has become as important as possessing technical expertise itself.

The third component is the emotional component, which includes emotional intelligence, empathy, emotional self-regulation, stress tolerance, and positive attitudes toward interaction. Engineering professionals frequently encounter complex workplace situations that require emotional stability and interpersonal sensitivity. Therefore, emotional competence plays a crucial role in maintaining constructive communication, preventing conflicts, and fostering productive professional relationships.

The fourth component is the behavioral component, which represents the practical manifestation of communicative competence. It includes speech culture, teamwork skills, conflict management, presentation abilities, negotiation skills, and active listening. Through these behavioral skills, engineers can effectively participate in collaborative projects, present technical solutions, engage in professional discussions, and build successful working relationships with colleagues and stakeholders.

An essential element of the model is the reflective component, which focuses on self-analysis, self-assessment, feedback acceptance, and professional growth planning. Reflection enables engineers to evaluate their communication experiences, identify strengths and weaknesses, and continuously improve their professional performance. Reflective thinking serves as a mechanism for lifelong learning and self-development, which are indispensable in modern engineering professions.

The development of these components is supported by technological and pedagogical tools, including learning management systems (LMS), artificial intelligence technologies, online collaboration platforms, virtual laboratories, simulations, and digital educational resources. Platforms such as Moodle, Google Classroom, Microsoft Teams, Zoom, ChatGPT, and Gemini provide opportunities for interactive learning, collaborative communication, and professional skill development. These technologies create an educational environment that facilitates the practical application of communication skills in authentic professional contexts.

As a result of the interaction among the motivational, cognitive, emotional, behavioral, reflective, and technological components, a high level of professional communicative competence is achieved. Engineers possessing such competence are capable of effective professional communication, successful teamwork, leadership, digital communication literacy, and professional adaptability. These qualities contribute significantly to their professional effectiveness, innovative capacity, and competitiveness in the modern labor market.

Thus, the proposed psychological and pedagogical model represents a comprehensive and integrated framework for developing the professional communicative competence of technical engineers. By combining psychological resources with pedagogical strategies and digital technologies, the model provides a systematic approach to preparing engineers for successful professional communication in contemporary technological and industrial environments.

DISCUSSION

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The findings demonstrate that professional communicative competence cannot be developed solely through technical instruction. Psychological factors such as self-efficacy, emotional intelligence, motivation, and reflection significantly influence communication effectiveness. Engineers who possess higher emotional awareness and stronger confidence in their abilities are more capable of participating in professional discussions, presenting technical information, and collaborating within interdisciplinary teams.

The proposed psychological and pedagogical model provides a systematic framework for integrating communication training into engineering education. Interactive teaching methods, project-based learning, collaborative problem-solving, digital simulations, and reflective practices create favorable conditions for the development of communication competencies. The integration of information and communication technologies further enhances opportunities for professional interaction in modern engineering contexts.

The results are consistent with the theoretical perspectives of Bandura, Goleman, Kolb, and Schön, whose works emphasize the importance of experiential learning, emotional competence, self-efficacy, and reflective practice in professional development.

CONCLUSION

The study confirms that professional communicative competence is a critical component of engineering professionalism and is significantly influenced by psychological and pedagogical factors. Self-efficacy, emotional intelligence, professional motivation, and reflective thinking emerged as the most influential determinants of communication effectiveness.

The proposed psychological and pedagogical model offers a comprehensive framework for developing professional communicative competence among technical engineers. The model integrates motivational, cognitive, emotional, behavioral, reflective, and technological components, ensuring a holistic approach to professional development.

The implementation of this model in engineering education can enhance communication quality, teamwork effectiveness, professional adaptability, and overall engineering performance. Future research should focus on experimental validation of the model and its application in various engineering specializations and educational contexts.

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