

The Problems of Formation of Cognitive and Communicative Competences of Engineering Students

Dinara M. Safina*

Kazan Federal University, 420008, Kremlevskaya Street, 18, Kazan, Russia

Tatyana A. Suetina

Kazan National Research Technical University named after A.N. Tupolev-KAI, Russia

Kirill S. Smolyanitsky

Kazan Federal University, 420008, Kremlevskaya Street, 18, Kazan, Russia

Abstract

The article is devoted to the analysis of problems of engineering specialists training in Russia. The methodology for the improvement of education quality in higher educational institutions, based on the use of active forms of psychological and pedagogical support in the teaching process, is proposed. The recommendations are developed for the improvement of educational process by teaching staff. The method of psychological and pedagogical support of engineering students training is proposed. Developed methodology is intended for the formation and improvement of psychological support of educational process. Its application contributes to simultaneous formation of cognitive and communicative competences of engineering specialists. An individual approach, with the use of proposed methodology, helps to identify the students' potential, to control the psychological state and to correct it in a timely manner. For the effective application of the proposed methodology, it is necessary to increase the professional level of teachers, in terms of psychological preparation, and also to involve professional psychologists in the work. The qualitative level of training of modern engineers can be enhanced through the active use in teaching the individual forms of education, taking into account the psychological characteristics of the student's personality.

Keywords: Engineer; Self-Development; Psychology; Communicative ability; Thinking; Cognitive abilities.



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1. Introduction

The qualitative development of the country and satisfaction of the needs of the entire population are largely determined by the quantity and quality of engineering inventions. A number of surveys and information, including the Ministry of Education and Science, confirm the demand for engineers in the Russian market. According to the surveys, the demand for engineers has increased by 19.6% over the past 3 years, and has a tendency to further increase. In industry, there is already an acute shortage of competent engineering personnel. The quality of engineering education in Russia has always been at a high level, but now it is far from perfect: some young engineers underperform even in basic knowledge, and that indicates a low level of training.

It is possible to raise the level of training of engineering personnel not only with the help of direct educational technologies, but also through the creation of a special psychological and pedagogical support of educational process in universities.

The main vector of changes in the educational system of the Russian Federation over the past 10-15 years has been aimed at the restructuring of the content of education and its management. In our opinion, the main problems for the training of engineering personnel today are the following:

- low level of students' motivation for receiving the education;
- low level of educational process;
- lack of information and educational data;
- fatigue, absent-mindedness of students and teachers;
- out-dated irrelevant information in a number of disciplines.

One of the main factors for the development of a highly skilled specialist is the quality of teaching, the ability to convey of information to the students. Only taking into account the general cultural, personal and cognitive development of students, it is possible to expect that all information will be mastered by them in full. The main educational results are the subject and personal competences. In order to assess them, it is necessary to create a system for diagnosing the results of educational process. And the technologies of forming and assessment of these competencies are the main fields of psychologists' activities.

Thus, in the educational process, not only the physical, but also the mental health of students is important. It is a key factor in the development of an engineer. More attention should be paid to the individualization of teaching methods and the creation of a comfortable and psychologically safe educational environment.

2. Literature Review

Nowadays, instead of paying attention to the deterrent factors of effectiveness in the organization, there are some factors that increase positive business behaviours. One of these factors is the emphasis on the development of positive relationships in work, which means that communication has taken place between people in the workplace and is beneficial to them. Positive relationships in the workplace are very important results for the organization, because it can lead to well-being, happiness, physical and mental health, reduce job crawling, and employees' interest in managers and organizations, and ultimately boost their productivity (Madden *et al.*, 2015). That's why for many professionals who work on a daily basis with people or organizations, one important thing is, what are the qualities that lead to the development of positive relationships and how individuals can be trained? So that they can create and maintain effective and proximity communications. About a decade ago, Ryff and Singer (2000), emphasized further research on processes and factors encouraging the development of positive and effective relationships, and until recently most research has focused on the negative aspects of developing relationships. In their opinion, it's time for researchers to emphasize the positive and encouraging aspects of relationships. A similar conclusion was made by Snyder and Lopez (2007), in their book *Positive Psychology* in this regard.

2.1. Cognitive and Communicative Competences

One of the factors that has highlighted today is the shift in the number of employees from the blue collar to the white collar, the increase in the number of temporary staff and conditional employment, globalization, and the use of new technologies. That is why the positive and effective communication is on the list of skills that employers are looking for. Employers expect employees to be effective in communicating and assessing them accordingly (Keyton *et al.*, 2013). Clearly, the starting point of any kind of communication is to communicate with oneself. For positive and effective communication with others, one must first be able to connect himself (Oberholzer, 2013). Self and communication are closely related; therefore, in recent decades have become important subjects in individual and social psychology. According to psychologists, the role of communication itself is very important and complex because it affects communication dynamics. How it relates to others depends on how it sees itself and how it communicates with itself. (Finkel and Vohs, 2006).

One of the features of happy employees is having a good relationship with your colleagues and with others. Despite the positive effect of positive communication on this joy and good relationship, many organizational researchers ignore this type of relationship. Positive internal communication can help resolve conflicts and help individuals face challenging organizational and welfare conditions. Therefore, learning and practicing interpersonal communication is important for all employees and at all organizational levels (Honeycutt *et al.*, 2013).

Communication-focused theories look at social phenomena, including organizations, with an interconnected magnitude, because communication is the basis of all social structures. For example, organizations, leadership, emotions, etc. all have been created from communication processes. Structural communication has many definitions. Communications have been studied since the 5th century BC and hundreds of definitions have been presented so far. Nevertheless, despite the diversity and variety of definitions, there are three important areas in which there is a great deal of agreement among the researchers in relation to things: communication, process, exchange, and symbolism. Communication is the process of sharing ideas, information, and messages with others at a specific time and place; it includes writing and speaking, as well as verbal and non-verbal communication (Macik-Frey, 2007).

2.2. Levels of Cognitive and Communicative Competences

In general, people communicate with each other at the three levels of interpersonal, interpersonal and general. An interpersonal relationship is the same as your own. This kind of communication involves activities such as cultivating thoughts, decision making, listening, and self-help. Interpersonal communication refers to communication and communication between two people. This kind of communication involves dialogue, interviews, and group talks. In general, the person sends a message to a crowd of audiences (Pearson *et al.*, 2011). Although one of the strongest claims repeatedly is that interpersonal communication is the basis of other communications, it is itself the least developed and the youngest concept among all types of communication in academic and organizational studies. Although the term interpersonal communication may seem new and relevant in recent years, and even some have suggested that such a connection lacks theoretical foundations, the idea of interpersonal communication has a lot of historical backgrounds, and even more than 2,300 The year before, Plato writes thoughts and thinking as an internal and hidden conversation, dating back to 360 BC. In recent years, this has attracted the attention of many writers; in the second half of the twentieth century, university publications, and even some interpretive models of this level of communication have increased (Eldredge *et al.*, 2015). Interpersonal communication is a kind of relationship with which individuals analyze their behaviors, attitudes and messages in order to give meaning to an event. Interpersonal communication involves all communication elements (such as sender, receiver, and transmitter) that have other levels of communication; except that in such a relationship, the person himself is the sender and the receiver of the message and sometimes provides feedback for himself (Berko *et al.*, 2010). Introspection, subjective acts of the human self-consciousness such as thinking, computing and evaluating oneself and others, and the relationships between oneself and others, planning, imagining and reminding, as well as unconscious mental acts, such as dreaming (Paniagua and Oseda, 2017). In the interpersonal communication, the message is created from the thinking and feeling of the person whose mind is processed and interpreted. Feedback when someone speaks with himself and decides to set aside some ideas or to replace them with other ideas. Since

humans are constantly planning, imagining, thinking, and worrying about things that are happening in the world around them, they are always communicating with themselves (Steinberg, 2007),

2.3. Competences and Effectiveness

Communication competence, which is the same communicative effect, has attracted significant attention in communication literature. Communication competence has been studied from the perspective of many scholars, and since 1970, attention has grown. Researchers each separately examine the linguistic roots, social factors, behavioral criteria, and spoken features as factors associated with these competencies. However, there is still no single definition of it, and awareness of features that are recognized as communicative competence is incomplete (Keyton *et al.*, 2013). The concept of merit is widely used in various disciplines and fields; it is a problematic concept, because it has different meanings and interpretations, and its interpretation depends on cultural, linguistic and national contexts. Merit is not limited to skills acquisition, and the ability to manage challenges that occur in a particular situation is in the right direction.

Effectiveness in interpersonal communication requires the acquisition of competence and understanding of the communication process. Intrapersonal competence is rooted in the concept of intrapersonal intelligence, which was first introduced by Gardner in 1983 with the introduction of multiple intelligence theory. Gardner categorized intelligence into eight categories, and one of them called "intelligence" (Nangle *et al.*, 2010). According to Singh (2013), the inner competence of a person rooted in inward intelligence is the ability to learn from oneself, to understand his weaknesses and strengths, and to express his feelings and thoughts in a non-destructive way. Nelson and Low (2011), defined the in-person communication competence to be able to manage the internal and external emotions, self-regulation, as well as individual awareness of their values as a person.

The evaluation of interpersonal competencies due to the complexity of the process is difficult. However, each of the communication researchers has referred to one or more of its dimensions in its own right. For example, Rodriguez-Cadena (2017), dimensions of individual communication competencies are self-management; time management; self-development; self-regulation; adaptability; executive performance; purposefulness; delays in satisfaction (or delaying short-term goals and immediate rewards); Pursuing long-term goals that are temporary but more valuable); the ability to cope with distraction; and the ability to adjust its strategy and vision as needed. Each individual possesses a series of internal merits, which are unique to the fingerprint. In his opinion, people who use a broad range of in-person competencies show a high level of self-esteem. According to Aldana-Rivera *et al.* (2018), self-esteem and proper stress management are skills that directly relate to interpersonal competencies. This type of self-control relies on a cognitive adaptive approach to maintain a balanced level of emotional state.

Oliver *et al.* (2010), have shown that interpersonal communication can affect one's thoughts, feelings, and behaviors in stressful situations; and that interpersonal communication is in the form of thoughts and feelings that authority Improves personal competence and is associated with emotional well-being. Individuals in interpersonal communication, like an open dialogue, discuss the meanings within themselves, and recall the negative desires and conflicts of the past as well as positive emotions. They have also shown that self-concept that refers to a person's overall assessment of one's own understanding and others is one of the factors that affects communication competence.

Although correction of person's behavior is of great importance, but in terms of semantic expansion and its value among the total human communication behaviors and its impact and impact, less research has been done; Hidalgo-Arango and Pérez-Caballero (2018), and Finkel and Vohs (2006), point out that they have "self" in communication. However, interpersonal communication among research on other levels of communication has been relatively new and less attention has been paid to this issue, and there has been little initial enthusiasm among academic subjects about this issue. Therefore, this research tries to examine it and discuss individual competencies; thus, managers, staff, and organizational researchers are aware of this issue and can fill some of the research vacuum in this area. Considering that the purpose of this research is to use the method of interpretive structural modeling, which is an effective and effective way for subjects in which qualitative variables have different effects on different levels of importance, one can interact with them using dependencies Detected and analyzed the qualitative variables of the problem (Rodríguez, 2018). Identification of interpersonal competencies encouraging positive and effective organizational communication and examining how communications are the internal dimensions affect it with one another.

3. Methods

The main methods of scientific knowledge, such as analysis, synthesis, classification, generalization is used in this paper. They allowed to formulate the problem of forming of cognitive-communicative competences of students, and to develop a possible solution to it.

4. Results and Discussion

The shift of attention to the psychological aspects of educational process significantly changes the entire situation in educational institutions, determining the exact place for the forms and types of application of psychological knowledge, in the content and organization of educational environment of universities and colleges. This makes the activity of a psychologist mandatory, specific and observable, as a full participant in the educational process.

The purpose of the proposed psychological support is the creation of socio-psychological conditions for the development of personality of students and their successful learning, as well as for laying the foundations of the present and future mental health. The main tasks of psychological and pedagogical support are the following:

- observing the psychological and pedagogical status of students and the dynamics of their psychological development in the process of training;
- formation of the abilities for self-knowledge, self-development and self-determination.

The main forms of psychological and pedagogical support of educational process include: counselling, diagnostics, developmental and correctional work, examination.

Counselling refers to psychological assistance in matters of development, upbringing and education through psychological counselling. Psychological counselling helps to understand oneself correctly, properly evaluate own thoughts and actions, to recognize and use own strengths and weaknesses for the benefit, to make the right decisions and take responsibility for them, to develop and implement things, which allow to manage the life and make it better.

The methods of psychological counselling include various kinds of training, discussion methods, which allow to intensify the mental abilities, to expand the possibilities of understanding.

The purpose of the diagnostics is to identify individual psychological characteristics of the students, and to assess the level of their personal and intellectual development (Basistaya *et al.*, 2014; Sapagina, 2016).

Psychological correction is an active influence on the process of personality formation and the preservation of its individuality, carried out on the basis of joint activities of teachers, psychologists and other specialists. The goal of correctional and developmental work is to organize systematic work with students, experiencing learning and adaptation difficulties. Developmental work includes the improvement of students' cognitive sphere: attention, imagination, thinking, memory; removing the anxiety and the formation of adequate self-esteem; development of self-organization and self-control skills.

The purpose of examination is to study the non-pathological phenomena of the psyche and to reveal the influence of peculiarities of the mental state of individual on the behaviour of person at the moment of interest; psychological analysis of personality of the interested participants in the process.

On the basis of psychological and pedagogical forms of influence, we have developed the methodology for the assessment of cognitive-communicative level of engineers training. The essence of methodology is to form an understanding of the dependence of engineer on the psychological culture, which is defined as the ability to conscious mastering of scientific information, communication in groups, to purposeful self-organization of behaviour, to be creative in carrying out of own official duties, based on legal, moral and ethical attitudes. The methodology is performed in two stages, which are repeated on various courses of study.

It is known that psychological culture is formed at the process levels of mental activity: cognitive and communicative. The cognitive substructure of engineer's mental activity includes cognitive processes, which provides the digestion and processing of perceived information: social, teaching, scientific, and production. Communicative abilities of the individual ensure the effectiveness of interpersonal communication, and psychological compatibility of activity. Communication skills are the mandatory component of organizational skills and leadership abilities. All this determines the importance of development of students' communicative abilities, which play a significant role in the formation of psychological culture of the future engineer (Antimonov, 2009; Evplova, 2014; Johnson and Johnson, 2007; Koroleva, 2014; Kozlov, 2017; Zotova, 2014).

The proposed methodology includes the elements of formation of cognitive characteristics of personality and the elements of communication skills formation. In addition, more time and efforts should be given to communicative abilities, because the engineering students often lack this trait of character. One of the most important methods of formation of communicative competences is trainings, as well as individual and group conversations with psychologists. Also an important role is played by psychological tests, for example, the Leary test "Interpersonal Diagnosis of Personality" (Anastazi, 1982; Leary, 2004). Aimed at defining the interpersonal relations and personality characteristics, which are important when interacting with other people (Agranovich and Puente, 2007; McMichael, 2013; Rosselli and Ardila, 2003).

At the first stage, preliminary testing of students is carried out, in order to define their cognitive-communicative aptitudes or difficulties. Further work should be organized in groups, to which the students can be attributed, according to the test results. For example, four groups can be formed, as a result of the identified strengths and weaknesses in cognitive competencies and communication skills (Table 1).

Table-1. Groups of students, defined in accordance with cognitive-communicative inclinations and difficulties.

Cognitive-communicative factors		Cognitive abilities	
		Strong	Weak
Communication skills	Strong	Group A	Group B
	Weak	Group C	Group D

The formation of a larger number of groups, with the assessment of strength and weakness of one factor or another, as well as the application of individual approach to the students, require much more attention of psychologists. Thus, in our opinion, it is appropriate to use an individual approach only in the most difficult cases. According to the results of the first stage, corrective measures should be developed, for the elimination of cognitive-communication difficulties.

The second stage of the methodology includes the application of corrective measures, in order to form the missing competencies and skills, as well as to maintain the natural inclinations, shown by students in the field of education, science and public communications.

As can be seen from the table above, group A is the strongest and most promising, i.e. these are the students, who have good cognitive abilities and a high level of adaptability, and communicative activity. The individuals from group A are the leaders and can assist in working with students from other groups. If the students of this group remain outside the framework of psychological work, there is a risk of getting the opposite effect, manifested in their gradual shift to one of the following groups. It can be due to the fact that their sincere interest and motivation for cognitive and social activities will not be in demand.

Persons from group B have some problems in the cognitive sphere, but they are interested in social activities, and they are extroverts by their nature. This group is in fact not too problematic. Most often, they need support in additional interaction with the teacher in the field of academic workload, as well as the measures for increase the motivation and self-control in educational activities. They need active participation in the public activities of the university, with simultaneous implementation of control measures in educational activities and the avoidance of educational debts. A good incentive for them is public recognition in the form of certificates of commendation and special prizes.

The portrait of a typical representative of group C is a quiet and reticent student, who shows no interest in social activities, but has quite serious educational achievements. If the interest in social activities of such a student does not manifest at all, then there is no point in occupying him with a social burden, or offering him collective forms of work. In this case, it may be much more effective to involve him in scientific work and in participation in scientific conferences and symposia. This can help the student to adapt to public activity and to form certain communication skills.

The greatest attention of psychologists should be paid to the students from group D. This group consists of students, who need an individual approach. It is extremely difficult to transfer such students from group D immediately to group A. Therefore, it is necessary to evaluate their individual inclinations and motivational characteristics by conducting additional research and analytical measures, which will allow us to determine which group is easier to make the transition: to group B or group C.

5. Summary

The result of application of developed methodology and timely psychological correction is the gradual transition of students from groups B, C and D to group A, or at least, the progressive movement within these groups, with the fixation of improvements in a particular area. The work on the application of developed methodology should not be one-time. We need a cyclical repetition of two stages: psychological and pedagogical testing, and psychological and pedagogical correction. Both these stages should be repeated on different courses of study, starting from the first course, with observation of its dynamics.

6. Conclusions

In terms of further measures for the implementation of the proposed methodology, we consider it expedient to begin its application on the basis of one of the universities within the pilot group. The size of pilot group should allow to draw the conclusions, which will be statistically significant, and the composition of pilot group should be representative. This work can be organized under the control of deputy directors for educational work, with appropriate support of the involved psychologists.

The application of this methodology is possible only with the active participation of teaching staff, and under the condition, that they are ready to adjust their approaches to working with students.

The application of developed methodology requires the involvement of professional psychologists in the staff of universities. The return on this kind of investment can be high, since the improvement of the quality level of graduates and their abilities not only in the field of cognitive skills, but also in the communication sphere, can be a serious incentive for the development of country's economy as a whole. The consideration of psychological characteristics of a student's personality can become a tool, which will be able to significantly raise the quality level of training of a modern engineer. In the conditions of a lack of psychological support, it is advisable to initiate the training of teachers in the field of psychology.

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