

PAPER • OPEN ACCESS

Development of soft skills of teachers of Physics and Mathematics

To cite this article: L Sultanova *et al* 2021 *J. Phys.: Conf. Ser.* **1840** 012038

View the [article online](#) for updates and enhancements.

You may also like

- [Soft skills in training specialists in the sphere of standardization, metrology and quality management as a part of education for sustainable development](#)
N M Galimullina, O A Vagaeva, D E Lomakin et al.
- [Teachers' perspectives toward soft skills in science learning](#)
Susilawati, N Aznam, Paidi et al.
- [Improvement of students' soft skills \(honesty and motivation\) using edmodo by Blended Learning Method](#)
Murjainah, M A Mujib, K Aryaningrum et al.

PRIME
PACIFIC RIM MEETING
ON ELECTROCHEMICAL
AND SOLID STATE SCIENCE

HONOLULU, HI
Oct 6–11, 2024

Abstract submission deadline:
April 12, 2024

Learn more and submit!

Joint Meeting of
The Electrochemical Society
•
The Electrochemical Society of Japan
•
Korea Electrochemical Society

Development of soft skills of teachers of Physics and Mathematics

L Sultanova, V Hordienko, G Romanova and K Tsytsiura

University of Educational Management, 52-A Sichovykh Striltsiv Str., Kyiv, 04053, Ukraine

E-mail: leilasultanova22.07@gmail.com

Abstract. The article considers the problem of the development of soft skills of teachers of Physics and Mathematics in higher educational institutions in the process of certification training in the system of postgraduate pedagogical education of Ukraine. The experience of foreign countries on the relevant teachers' course training has been analyzed, the essence and significance of such soft skills as sociability, creativity, empathy for the professional development of teachers of Physics and Mathematics in higher educational institutions in the process of certification training has been characterized. The state of these skills development in teachers of Physics and Mathematics was studied, the average level of the development these skills has been stated. The possibilities of the soft skills development were determined, the four-stage process of their transition from unconscious incompetence to unconscious competence in the system of postgraduate education was substantiated. The principles, forms, methods, technologies of the development of soft skills in the system of certification training of teachers of Physics and Mathematics were discussed with the emphasis placed on the role of heuristic methods and forms, creative technologies of the soft skills development.

1. Introduction

As the modern world community entered the third millennium of information technology, global computerization and digitalization, it faced the problem of the life technological complexity developing faster than the soft skills level. At the current stage of society development, the entire education system requires significant reformation, with the focus on educational science and pedagogical practice, regardless of the direction of training, being placed on an individual with their vital interests, abilities and moral values, creativity, critical thinking, integrated problem solving, analyzing and decision-making skills.

According to [37], 70% of teachers of non-pedagogical institutions of higher education in Ukraine do not have pedagogical education. It does not allow them to perform highly professional pedagogical activities due to the constantly growing professional requirements.

Due to the imperfection of the certification training system of teachers of Physics and Mathematics (lack of psychological and pedagogical component of training; the teachers' training focused on improving knowledge in the subject area only), the issue of innovative teachers' training is becoming more and more urgent. After all, in addition to deepening the knowledge of professional subjects, the modern teacher pays great attention to the soft skills development. We use the term "soft skills" in the sense of non-specialized, intangible personal qualities that ensure the success and productivity of professional activities on the basis of such documents, as the "Glossary of Curriculum Terminology of



UNESCO International Bureau of Education” [33] and “The Future Jobs Report 2018” of the World Economic Forum [4].

The current system of training teachers of special disciplines is mainly carried out through post-graduate studies (more than 90% of post-graduate students become teachers after the thesis defense). Such system cannot be considered effective, as it is aimed at the scientific activity of teachers with the degree of Philosophy Doctor (PhD), although scientific and educational activities are quite different from each other. The quality of teaching staff is directly related to their professional competence: the continuous improvement of their professional knowledge and skills, the ability to adopt and apply innovative pedagogical technologies and methods in the practical pedagogical activities, being able to find harmony between teaching and scientific research work. The system of professional development of such teachers should take into account the issues of pedagogical skills development, psychological and pedagogical readiness for performing teaching activities, communicative competence, organization of the educational process, etc. The existing traditional system of teacher training for higher educational institutions of Ukraine is still quite old-line [2].

The problem of formation and development of soft skills is relevant, particularly for college students, as it is considered the main condition for their competitiveness in the labor market [1]. Also, it is believed that high unemployment among graduates of vocational schools arises from the fact that teachers tend to ignore the necessity of the development of soft skills, especially the so-called 4C (creativity, critical thinking, communication and collaboration) [12]. From our point of view, the ideas of the development of soft skills in the process of studying natural sciences are unique as well, due to the importance of integrating these skills in science, education and future professional activity [29].

2. Theoretical background

All over the world soft skills are in great demand for various types of professional training, including engineers [34], IT specialists [27], economists. The development of such skills involves a change in the educational process and techniques of teaching special subjects by teachers of not only the humanities but also the sciences. But the problem of unreadiness for such changes creates an insufficient level of soft skills of the teachers and, consequently, leads to the negative impact on the economy. In a study conducted by McKinsey & Company [20], which involved more than 8,000 people in eight European countries (France, Germany, Greece, Italy, Portugal, Spain, Sweden and the United Kingdom), a third of employers said that the lack of soft skills causes serious problems in the economy. In addition, qualification gaps cause the most problems in countries with the highest youth unemployment rates (e.g., Italy, Greece and Spain). With this in mind, European countries as well as the United States include soft skills development in teacher training programs.

The experience of China, which is actively moving towards a service and knowledge-oriented economy and sees the inability of teachers to acquire the necessary soft skills and knowledge to make such a transition as one of the main limitations in this way, is also of value. That is why China's higher education authorities have radically changed and keep changing their approach to the regulation of the teacher training system.

The modern policy of Chinese higher educational institutions provides for the formation of not only hard skills which are very well developed by specialists in science, engineering and other fields, but also soft skills represented by innovation, creativity, management skills, high foreign language proficiency in international communication, teamwork. For example, teachers of Mathematics at Chinese universities have the opportunity to access the nationally accredited open seminars and trainings, organized and funded by the Ministry of Education and Science, and get trained in a range of subjects that are being actively implemented in the curricula. Mathematics ranks third in popularity among all subjects of accredited courses. Important courses aimed at the training of teachers of Physics and Mathematics also include management skills courses, foreign language courses, psychology courses, which allow forming the individual educational trajectory and successfully modernizing the content of education by means of combining the tasks to develop both hard and soft skills. More than 8,000 online or offline courses have been introduced in China, and more than 52,000 teachers have already been

trained. Considering the population of the country and the developmental stage of massive open online courses (MOOC), this number may seem not high enough, however it keeps growing, even though MOOC may face some problems of the interaction between the academics and listeners as well as the difficulties of assessment, materials evaluation and accreditation. Nevertheless, by the end of 2020 the Ministry of Education and Science of China is planning to have 3,000 nationally accredited MOOC [18]. The expansion of the MOOC is happening together with the development of their quality – the courses are conducted by the professional and experienced instructors in a wide range of comprehensive subjects and areas of informal education. The importance of such changes has been emphasized by Qianli Xiong. The researcher believes that the teaching based on MOOCs can be successfully combined with traditional forms of learning [38]. One more scholar Bo Gao suggests that the new teaching model based on the combination of traditional teaching model and MOOC teaching resources can be applied. This approach can significantly improve the abilities of deep analysis of the subject, awareness of the importance of self-learning, enthusiasm and initiative in cooperation with others, thus developing the soft skills [8]. American researchers can also see the perspective in MOOC. Some leading international universities like Stanford, Harvard and Massachusetts Institute of Technology have already launched MOOC platforms such as Stanford eCorner, edX, Udacity, Coursera, MIT Open Courseware [21].

In the context of ensuring student-centered higher education, we studied the levels of development of such soft skills as sociability, creativity and empathy in teachers of Physics and Mathematics, that are necessary for modern teaching.

The effectiveness of the educational process in a higher educational institution is largely determined by the nature of the teacher-student interaction, which includes a set of various connections, relationships and emotional manifestations in the process of such interaction.

As interpersonal relationships arise and develop in the process of communication, it seems obvious that successful and effective interaction between the subjects of the educational process is impossible without practical communication skills. To solve this problem, it is necessary to develop the ability to correctly interpret particular manifestations of communicative behaviour in different situations and, accordingly, to develop practical skills and abilities. It also should be noted that the main prerequisite for successful communication is the linguistic commonness of communicators, i.e., a common language of communication for both. For example, in the United States a teacher should master the second language in order to remove the language barrier.

Depending on the nature of the roles in communication, Tetiana V. Yatsula differentiates it by levels (actual, informational and personal level). The scholar notes: “The personality level of communication is characterized by the interaction, which provides subjects with the opportunity of the deepest self-disclosure and understanding of the essence of another person, themselves and the world around them. This level of interaction occurs in special situations and under certain conditions, when a person develops inspiration, enlightenment, feelings of love, a sense of unity with the world, a sense of happiness, etc. These are special situations of spiritual upturn and development of personality, so this level can still be determined as spiritual. The personal level is deeply moral: it removes any restrictions on interaction precisely because they become superfluous. The personality level of communication is largely determined by the identity of the value orientations of the interacting subjects and the ability of communicants to comprehend the essence of the phenomena of the world through enlightenment (insight) in the process of interaction” [40]. The process of communication is, however, often complicated by the emotional tension of communicants, so another important component of interpersonal interaction is the skills of behaviour in emotionally stressful situations. Irina B. Dermanova and Elena V. Sidorenko proposed a number of training materials and exercises to be used by teachers aimed at improving effective communication skills [5]. For instance, they include techniques for reducing emotional stress, which enable the transition of the interaction into another form.

Communication skills are not limited by the emotional component, but the teachers' modulation of their emotions and positive attitudes contribute to interpersonal interaction. Interpersonal interaction has a complex structure, it integrates many psychological properties of an individual and permeates different levels of organization of the personality. Nataliia V. Yaksa notes that in the humanities, attention to

interaction as a basis, a method of cognition of processes and phenomena occurring around us often leads to the interpretation of human interaction mainly through their influence on each other. And this does not mean that the impact is extremely aggressive and oppressive. It should be built on the basis of respect, esteem, approval, when one party consciously accepts a certain dominant of another one. Thus, the interaction is interpersonal in nature, when its content is primarily a dialogue of individuals [39].

The modern educational process requires the development of the teachers' creativity. Creativity is an ability of an individual, which is manifested in the realization of his/her creative origin to develop a particular product. It is about both the quality of the latter and the process of its development [26]. In modern science, the creativity is understood as a process that has certain specific characteristics and leads to the creation of the new, and the interpretation of creativity as a potential, an internal resource of an individual [25]. The pedagogical creativity phenomenon is important in our study context. Svitlana O. Sysoieva defines teacher's pedagogical creativity as a personality-oriented developmental interaction of subjects of educational process (a teacher and a pupil/student) caused by specifics of psychological and pedagogical relations between them and aimed at the development of creative personality of a student and the increase of the level of teacher's creative pedagogical activity [30]. At the same time, the teacher's pedagogical creativity is a condition for the formation of the students' creative personality, and the educational technologies designed by the teacher are the appropriate means.

The concept of "creativity" in the context of psychological and pedagogical knowledge became significant only in the early 1950s. In fact, the concept of creativity as a universal cognitive creative ability of an individual became popular after the publication of the works of the Joy Paul Guilford [10]. This type of thinking allows varying the ways to solve the problem, leads to unexpected decisions and results [14].

Serhii D. Maksymenko offers the following definition: "Creativity is a natural property of an individual that has existed since the human life began; this is the highest form of individual's activity. Creativity is an activity that is embodied in the products of creative work. Thanks to creativity, individuals can express themselves, their inner world, while changing it. It creates not only the external world, but also their own (internal) one" [19].

According to Ellis Paul Torrance, creativity means the ability to "dig deeper, focus better, correct mistakes, talk to a cat, dive into the depths, go through walls, light the sun, build a castle on the sand, welcome the future" [32]. As Erich Fromm states, creativity is the ability to be surprised, to find solutions in an unusual situation, to focus on something new, the ability to deeply understand one's own experience. The scholar identifies the potential and current "incarnations" at the centre of the phenomenon of creativity. This happens due to the processes of assimilating a particular (new) type of activity that has social significance by the carrier of potential creativity [7]. From the standpoint of acmeology, Nataliia F. Vishniakova defines creativity as a process inherent in many individuals and a set of intellectual and personality characteristics of an individual, which contributes to the ability to raise problems independently, generate more original ideas and find unconventional solutions [36].

Thus, creativity is the ability to find and develop new original ideas, successfully solve problems in a non-standard way, as well as the ability to solve problems that arise within static systems. This is the ability to see problems from a different angle and find unique ways to solve them.

The basic means of creativity development for the teacher of Physics and Mathematics include:

- Comprehensive erudition. The knowledge of physical and mathematical sciences today can be obtained in many ways (online courses, webinars, educational resources, etc.). The knowledge in other areas (humanities, art) and the ability to combine them with the knowledge of physics and mathematics are a component of the teacher's ingenuity and comprehensive erudition.
- Constant connection (communication) with other teachers. Communication with like-minded people on Facebook and other social networks, on educational platforms stimulates the development of their own creative teaching system.
- Abreaction, deliverance from bondage. A teacher who is confident in their own creative potential is never afraid to make experiments. If there is a feeling of fear, insecurity, it is worth

working on self-esteem. As practice shows, only the teachers who are interesting for themselves, are creative and interesting for students.

- Developing creativity. The teacher of Physics and Mathematics can reach the higher level of creativity through constant work, because developing creativity has recently been compared with athletes' work on their physical shape.
- Constant analysis of own teaching. Awareness of one's own mistakes and accomplishments forms a clear idea of effective teaching methods and helps to avoid the uniformity of the methodology.
- Creativity as an everyday goal. Creativity helps to solve methodical problems. It is important that creativity becomes a part of the daily work for a teacher of Physics and Mathematics, because creativity is a solution for the problems in a completely new extraordinary way.

In order for the creativity of a teacher of Physics and Mathematics to develop as a deep (personality) ability, not only a behavioural (situational) one, the development should take place under the environment influence. Various methods of developing creativity, which involve local influence (for example, non-standard creative tasks), mostly stimulate the individual to understand the tasks given and find some solution technology for them [6]. Creativity should be a constant, not a situational characteristic of a teacher, creative behaviour should rely on a stable motivational basis. Such statements lead us to the conclusion that the process of the development of creativity includes several stages and is accompanied by the mastery of socially significant activities.

According to modern researchers, empathy is a key component in the emotional intelligence structure, as well as one of the soft skills most sought after by employers. It is a factor in professional success, effective relationships and trust between people. Vadim A. Petrovskii defines empathy in the professional reflection structure, including pedagogical empathy [24]. Empathy gives teachers of Physics and Mathematics the opportunity to design the assimilation of educational material by students, taking into account their individual features. As we know, empathy is an ability to feel another person, their psychological condition and needs, to sympathize with them. There are several scientific approaches to understanding this phenomenon, which, however, are united by the recognition of its emotional nature. Larisa A. Petrovskaia defines empathic ability as the ability to emotionally penetrate into the world of another person's experiences and the ability to respond to them emotionally [23]. Tatiana P. Gavrilova considers empathy as the ability to share the problems of other people, experiencing them with a sign of the emotional state to which the object responds [9]. According to Iuvenalii N. Kuliutkin and Galina S. Sukhobskaia, empathy is the ability to understand the world of other people and even penetrate into their feelings, respond to them and feel empathy to these people [17]. Vladimir D. Shadrikov attributes empathy to spiritual abilities, in which the individual rises above the ordinary abilities: "A person knows himself, his spiritual world through another person, while a spiritually rich person cognizes another person better than himself". He distinguishes between emotional, cognitive and predicative forms of empathy [16].

Artur E. Shteinmetc emphasizes that empathy should not only be considered as an emotional phenomenon, pointing out the gnostic component in its structure [28]. Kristina V. Verbova states that there is a cognitive and emotional empathy [35]. In the context of considering empathy as the basis of emotional intelligence and reflexive abilities, the study of Svetlana B. Borisenko is interesting for us; according to him, empathy includes the following components: emotional identification processes, personal reflection, the moral consciousness level [3].

Thus, the scientific resources analysis gives grounds to state that the authors, recognizing the reflection and empathy of the teachers' professional abilities, consider the relationship between these concepts differently: they are identified, included as the part of one or the other, or distinguished. In this research, the empathy of teachers is considered as the basis of pedagogical reflection, supporting the ideas of those researchers who interpret reflection as a generic concept regarding empathy.

3. Results and discussion

The teachers of Physics and Mathematics of such higher education institutions as Kyiv National Economic University named after Vadym Hetman, National Pedagogical Dragomanov University, Kyiv National University of Trade and Economics, National Transport University, State Institution of Higher Education “University of Educational Management” took part in the survey. The study involved 138 teachers of Physics and Mathematics who were in the process of certification training in higher education institutions.

The following methods were used to determine the soft skills levels of teachers of Physics and Mathematics:

- “Sociability Level Test” by V. F. Riakhovskii;
- “Manifestation of Creativity” method by A. Lazukin and N. Kalin;
- “Ability to Empathize” questionnaire by I. Yusupov.

These methods allowed analyzing the formation of soft skills levels, characterizing the state of the problem and justifying the relevant stages of these skills development in postgraduate education. To overcome the subjectivity in the testing process, a representative sample of subjects was formed, a formalized instruction procedure was applied, and the answers anonymity was ensured.

Communication as a means of interpersonal interaction is an important area in the professional activities of teachers of Physics and Mathematics, who interact with the subjects of the educational process. In order to determine the sociability levels, we used the “Sociability Level Test” by V. F. Riakhovskii [13].

The methodology consists of 16 questions with three possible response options: “yes”, “no”, “sometimes”. For each “yes” the respondent receives 2 points, “no” – 1 point, “sometimes” – 0. Then the total number of points is calculated (0–8 points correspond to a high sociability level; 9–24 points – medium sociability level, 25–32 points – low sociability level).

The generalized results of determining the respondents’ sociability levels are presented in figure 1.

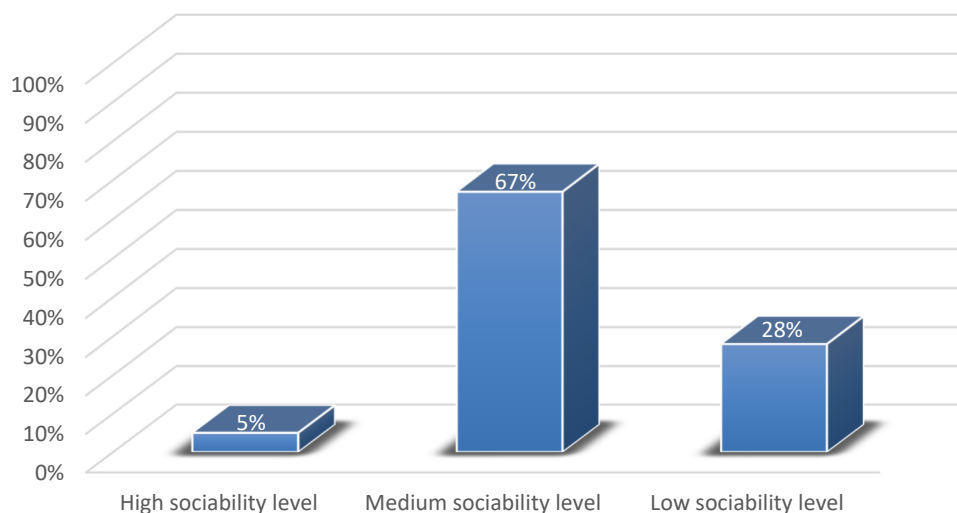


Figure 1. Sociability levels of teachers of Physics and Mathematics.

The majority of respondents – 92 people (67%) – have a medium sociability level. Teachers with an average sociability level feel quite confident in unfamiliar circumstances. We can state that they easily find common ground with other interlocutors.

The low level is typical for 39 people (28%). Such teachers are not sociable, modest, introvert, they prefer privacy and isolation but tend to suffer from it. It is difficult to communicate with such teachers. They cannot be relied upon in matters that require collective effort.

A high sociability level was stated for 7 people (5%). Such teachers feel comfortable everywhere. They take on any task, although they may not always be able to complete it, however sometimes such sociability is painful.

During the study, the creativity levels were determined using “Manifestation of Creativity” method by A. Lazukin and N. Kalin. The methodology consists of 15 questions with two statements each. The respondents had to select the one that is most acceptable to them or better consistent with their ideas, and reflects their points of view more accurately.

The level of positive attitude, desire for creativity, as well as a certain level of development of creativity as a creative potential of an individual is expressed through the selection of the answers given in a key. The greater the sum of points, the better the person’s attitude to creativity: 12–15 – high level; 4–11 – medium level; 0–3 – low level.

The results of the study of creativity, which is manifested in the realization of creativity of an individual in the particular product development, are presented in figure 2.

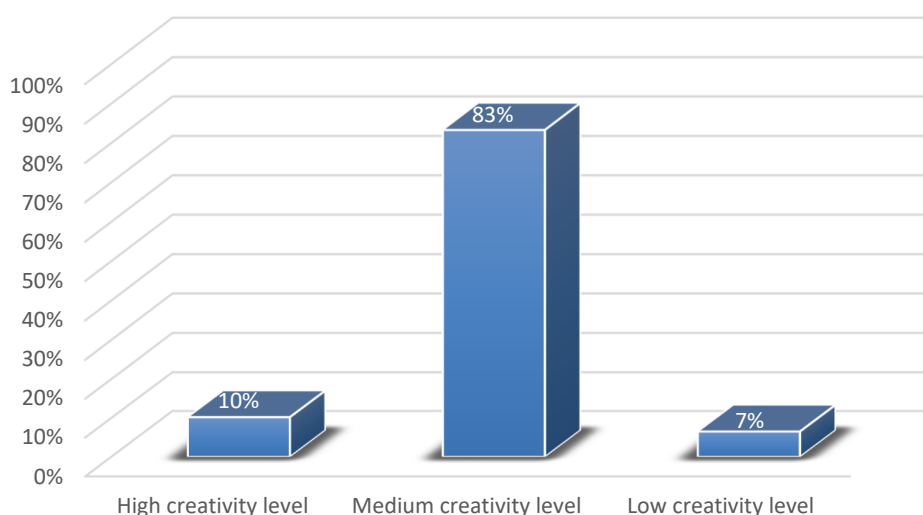


Figure 2. Creativity levels of teachers of Physics and Mathematics.

We can see that all the creativity levels are manifested among teachers, but medium level dominates – 115 people (83%), high level of manifestation ranks second – 14 people (10%), and low level is the least manifested – 9 people (7%).

The ability to empathize is directly related to the teachers’ individual approach to students in the educational process, their individual educational trajectory. Levels of empathy of teachers of Physics and Mathematics were determined with the use of the questionnaire “Ability to Empathize” by I. Yusupov. The methodology contains 18 questions with the following response options: “I don’t know”, “never”, “sometimes”, “often”, “almost always”, “always”. All points for responses are summed according to the answers: “I don't know” – 0, “never” – 1, “sometimes” – 2, “often” – 3, “almost always” – 4, “always” – 5. The level of empathy is determined by the following norms: 82–90 – very high level, 63–81 – high level, 37–62 – normal (optimal) level, 12–36 – low level, 11 and less – very low level.

The generalized results of determining the respondents’ empathy levels are presented in figure 3.

As the respondents did not show extremely high and low empathy levels, it was considered inexpedient to graphically represent the zero indicator in Figure 3.

Medium (optimal) empathy level, which dominates among the respondents, is typical for the majority of respondents – 109 people (“79%). High empathy level has a slight manifestation in the sample – 9 people (“7%), which means sensitivity to the needs of others, generosity, emotionality, but such people find it difficult to be accurate in painstaking work. Low empathy level stated for 20 people (“14%) indicates some difficulties in establishing contacts with people and sensitivity to their needs.

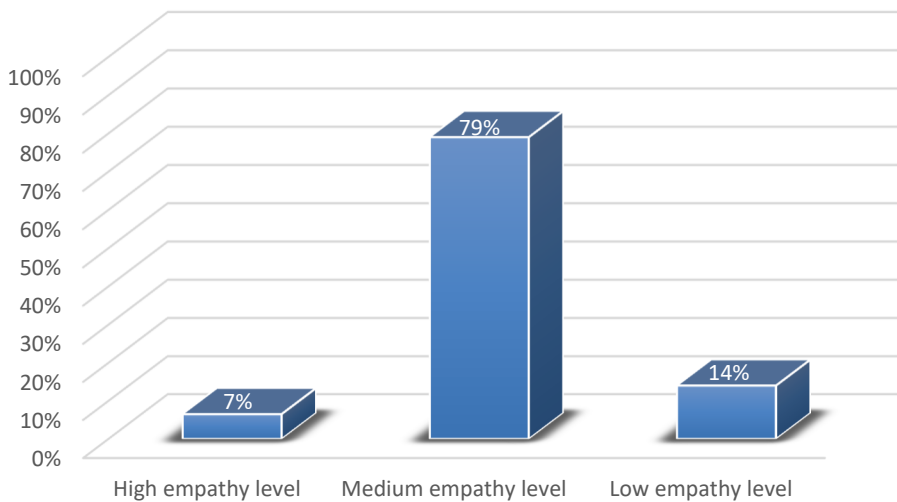


Figure 3. Empathy levels of teachers of Physics and Mathematics.

The results of diagnosing the levels of the studied soft skills of teachers of Physics and Mathematics are presented in table 1.

Table 1. Levels of the studied soft skills of teachers of Physics and Mathematics.

| Item No. | Levels of soft skills | Sociability | | Creativity | | Empathy | |
|---------------|-----------------------|-------------|------|------------|------|---------|------|
| | | number | % | number | % | number | % |
| 1. | High level | 7 | 5 | 14 | 10 | 9 | 7 |
| 2. | Medium level | 92 | 67 | 115 | 83 | 109 | 79 |
| 3. | Low level | 39 | 28 | 9 | 7 | 20 | 14 |
| Total: | | 138 | 100% | 138 | 100% | 138 | 100% |

Since the soft skills acquisition involves certain stages, it is worth paying attention to the development as a field of personality theory. Explaining the development of an individual and individual differences are some of the most serious objectives that psychologists are facing [22]. The individual development determinants are usually divided into genetic and environmental ones.

Different views on what is more important for the individual – genes (nature) or environment (education) – dominated at different points of the science development. Lawrence A. Pervin and Oliver P. John wrote that in recent years, there has been a growing attention to genetic factors, but even proponents of this view sometimes admit that the pendulum towards increasing natural determinants was swung too much [22].

Personal growth is due to many external and internal factors. External factors, or the environment determinants, include: the individual’s belonging to a particular culture, socio-economic class and the environment which is unique for each family.

According to Larry L. Hjellev and Danuel J. Ziegler, scholar’s controversy over the issue on what has the greatest impact on development – genetic factors or environment – has given impetus to the development of new theoretical ideas to explain how these factors should interact to lead to the emergence of certain characteristics of behaviour [11]. This is an interactionist position (interactionism is a direction in modern social psychology, which is characterized by consideration of the development and life of an individual in the context of social interaction). According to this position, heredity imposes restrictions on the range of development of certain characteristics, but, nevertheless, within this range, the further development of characteristics is determined by environmental factors. Igor S. Kon wrote

the following in this regard: “All these possible predictions are statistical in nature, they relate to the psyche and behaviour of the average person, with a given type of nervous system, with a given self-awareness or with a given social status. But it is impossible to deduce particular features and actions of the given particular person on their basis because all these regular relationships (genotype – phenotype; biography – individuality; social system – specific social role) are in different planes, and their intersection in a given individual is random in relation to each of them separately. A specific, original, unique result, which emerges from their intersection, cannot be predicted in advance. The same life experience gives different results in combination with different psychophysiological features and social conditions” [15].

We believe that the environment is of great importance in the teachers’ personality development, particularly in the soft skills development. However, it is difficult to exactly predict how these factors affect teachers. The only fact that remains indisputable is that such influence is inherent in the process of socialization.

Thus, soft skills are being acquired in the process of establishment and development of personality of the teacher of Physics and Mathematics under the purposeful and/or spontaneous influence of external and/or internal factors. Such development is a process of the teachers’ mental and moral growth, it covers all quantitative and qualitative changes of innate and acquired traits. We emphasize the importance of the teachers’ sociability, creativity and empathy among their personality traits.

The teachers of Physics and Mathematics were developing the soft skills within the four stages proposed. Using the concept of “stage” in the sense of a particular moment, period, stage in the development, stages of the soft skills development are understood as certain periods in the personality development of the teacher of Physics and Mathematics, which aim at the consistent activities to achieve high level of soft skills. The staged formation of an integral process of the soft skills development allows ensuring the most effective dynamics of their development in teachers of Physics and Mathematics.

The management coaches Sara Thorpe and Jackie Clifford clearly demonstrated how education can influence the process of competence development in “The Coaching handbook: An Action Kit for Trainers & Managers” [31]. The scholars compared some of the theories that underlie modern ideas about learning and development. According to this theory, learning is a four-stage process that involves the transition from unconscious incompetence to unconscious competence (see figure 4): unconscious incompetence; conscious incompetence; conscious competence; unconscious competence.



Figure 4. The process of competence development according to Sara Thorpe and Jackie Clifford.

Unconscious incompetence. With unconscious incompetence, a person is not aware that he does not know anything (or does not know how to do it). He is at the level of “*I don’t know what I don’t know*”. It is possible that a person has almost no need to acquire this skill or knowledge and therefore has not yet realized the lack of his competence.

Conscious incompetence. With conscious incompetence, a person acquires knowledge about his “ignorance”. This is usually due to the need or desire to take an action. This is the “*I know what I don’t know*” stage.

Conscious competence. In order to become consciously competent, a person needs to go through training (formal or informal). At this stage, a student of higher educational institution often copies the teacher’s actions. At every moment of time, a student realizes what he is doing, because he is at the stage of “*I know what I know*”.

Unconscious competence. In unconscious competence, knowledge and skills are used so often that they become “habits”. Performing particular actions, the person no longer feels the need to think through each step, because the algorithm of the action is embedded in the unconscious (or subconscious). Then a person can state: “*I don't know what I know*”.

Thus, unconscious competence (automatic application of acquired knowledge, skills and abilities) is the highest competence level. Achieving this level is one of the main goals of education.

The process of the soft skills development in teachers of Physics and Mathematics can be correlated with the approach to understanding the process of competence development proposed by Sara Thorpe and Jackie Clifford (see figure 5).

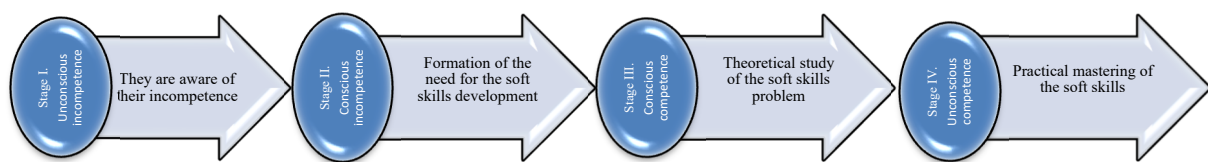


Figure 5. The process of the soft skills development.

The authors proposed four stages of development of soft skills of teachers of Physics and Mathematics, each having a specific purpose, determined in accordance with the purpose, objective, content, as well as forms and methods of implementation of the stage.

Thus, *the first stage of the soft skills development* corresponds to “*unconscious incompetence*”, because teachers of Physics and Mathematics, having not enough practical professional experience, may not be aware of the lack of their soft skills. Therefore, the purpose of this stage is making them aware of their incompetence.

The objectives of the stage:

1. Diagnose the level of sociability, creativity and empathy of teachers of Physics and Mathematics.
2. Analyze the results of input diagnosis.
3. Let teachers of Physics and Mathematics get acquainted with the stages of development of soft skills.

The content of the stage implementation:

1. Input diagnosis of sociability, creativity and empathy levels of teachers of Physics and Mathematics.
2. Analysis of the results, discussing them with respondents.
3. Delivering information lecture/seminar entitled “Soft Skills – Competencies of the 21st Century”.

The purpose of the *second stage of conscious incompetence*, when teachers of Physics and Mathematics have already realized their incompetence, is the formation of the need for the development of soft skills.

The objectives of the stage:

1. Motivate teachers of Physics and Mathematics to increase the level of sociability, creativity and empathy.
2. Understand the importance of developing soft skills as a necessary competence of a modern teacher.

The content of the stage implementation:

1. Conducting a business game to develop motivation.
2. Holding a meeting of the Discussion club on the topic “Soft Skills of Teachers of Physics and Mathematics: Realities and Prospects”.

Forms and methods of the stage implementation:

1. Business game “Motivator”.
2. Discussion club with the use of media teaching aids.

At *the next stage of “conscious competence”* teachers of Physics and Mathematics begin to theoretically study this problem.

The objectives of the stage:

1. Systematize knowledge about soft skills obtained in the process of studying related topics of other subjects.

2. Study a special course “Soft Skills of Teachers of Higher Educational Institutions”.

The content of the stage implementation:

1. Generalization of knowledge about soft skills obtained in the process of studying related topics of other subjects by teachers of Physics and Mathematics.

2. Introduction of content modules of the special course “Soft Skills of Teachers of Higher Educational Institutions” into the educational system of higher educational institutions.

The special course highlights the conceptual principles of soft skills development in teachers, substantiates their essence and structure, offers interactive forms and methods of development of these skills, including communication, creativity, empathy as the basis of emotional intelligence. The course has been designed for 30 academic hours, which corresponds to one ECTS credit. Mastering the discipline involves the study of three thematic modules, each of them includes 10 academic hours. The structure of each module provides 6 hours of in-class work (one lecture, one seminar and one practical class), 2 hours of independent work, 2 hours of control and evaluation activities. In order to check the knowledge acquired during the lectures and independent work, a list of tasks for self-assessment, continuous and modular assessment is proposed, at the end of the course it is planned to conduct a summative assessment. The first thematic module is devoted to the communicative competence of the teacher, the second one – to the creative potential of the teacher, the third one – to the emotional intelligence of the teacher, led by empathy.

Forms of the educational process organization:

- training sessions (lectures and seminars);
- independent work;
- control (continuous, thematic and summative control);

Methods and techniques for the development of sociability, creativity and empathy of teachers of Physics and Mathematics:

- methods of organization and implementation of educational and cognitive activities;
- methods of stimulating and motivating educational and cognitive activities;
- methods of control and self-control of the effectiveness of educational and cognitive activities.

Finally, *the stage of unconscious competence* involves practical skills and communication skills, the ability to apply different strategies in solving problems (creativity), the ability to empathize.

The objectives of the stage:

1. Acquire the ability to operate with theoretical knowledge about soft skills.

2. Acquire communication skills.

3. Acquire the ability to apply different strategies in solving problems.

4. Acquire the ability to empathize.

The content of the stage implementation:

1. Modelling the process of the development of soft skills.

2. Development of communication skills.

3. Development of the ability to apply different strategies in solving problems.

4. Development of the ability to empathize.

Forms and methods of the stage implementation:

1. Webinar “Modelling the Process of the Soft Skills Development”.

2. Training on the communication skills development.

3. CARUS (combination, analogy, reconstruction, universal strategy, random substitutions) training on the development of creativity developed by V. Moliako.

4. Training on empathy development.

4. Conclusion

Therefore, the problem of the soft skills development in teachers of Physics and Mathematics in the system of postgraduate pedagogical education is urgent and needs thorough research. Studies of the level of development of such soft skills as sociability, creativity, empathy, conducted with teachers of Physics and Mathematics, indicate that for most respondents their development corresponds to the medium level. The number of teachers with a low level of sociability and empathy is greater than with a high one. The opposite trend is observed for creativity, which may happen due to the technical creativity of teachers, but it has less effect on the quality of interaction with students and the feedback establishment compared to sociability and empathy.

We have determined that the soft skills development of teachers in the postgraduate education system is a four-stage process that involves the transition from unconscious incompetence to unconscious competence. The process includes diagnostics, professional development planning, its implementation, reflection, results correction of the certification training. This process should be based on andragogical principles, namely: independence of learning, joint activities, reliance on the experience of teachers, individualization and consistent learning, updating the results of educational activities, development of educational needs of every teacher. We believe that preference should be given to heuristic forms and methods of conducting classes that most contribute to the soft skills development of teachers. At the stage of presenting theoretical material, it is advisable to use active lectures with a significant role given to the students, but not to the teacher. Practice shows that theoretical material is of interest to students only when it is delivered in close cooperation with them on the basis of their pedagogical experience. Lectures should be delivered in the form of the active polemics, accompanied by discussion questions, solving various pedagogical problems, etc. In order to deepen the communicative, creative and empathic abilities of teachers of Physics and Mathematics, the preference in the postgraduate education system should be given to creative learning technologies, often conducted in simulation forms.

It is planned to further study the implementation effectiveness of the suggested stages of soft skills development in teachers of Physics and Mathematics in higher educational institutions, the possible adaptation of the suggested methodology for the teachers of other disciplines, development of such soft skills as critical thinking, decision-making, people management in teachers of other subjects and the institutions of other educational levels.

References

- [1] Azita Binti Ali, Doria Islamiah Rosli, Imam Sujadi, Budi Usodo and Fengky Adie Perdana 2017 Mastering the soft skills in the implementation of work-based learning among community college students. *Phys.: J. Conf. Ser.* **795** 012004 URL <https://doi.org/10.1088/1742-6596/795/1/012004>
- [2] Bondarenko V V and Kopytkov D 2017 The teacher of the higher vocational school as a basis of education quality *Bulletin of Kharkov national automobile and highway university* **77** 7–22
- [3] Borisenko S B 1988 Methods for the formation and diagnosis of teacher empathy (Metody formirovaniia i diagnostiki empatii uchitelei) *Thesis*
- [4] Centre for the New Economy and Society 2018 *The Future of Jobs Report 2018* (Cologne/Geneva: World Economic Forum) URL http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf
- [5] Dermanova I B and Sidorenko E V 2001 *Psychological workshop. Interpersonal relationships (Psikhologicheskii praktikum. Mezhlchnostnye otnosheniia)* (Sankt-Peterburg: Rech)
- [6] Druzhinin V 2007 *General ability psychology (Psikhologiya obshchikh sposobnostei)* (Sankt-Peterburg: Piter)
- [7] Fromm E 1999 Lichnost v sovremennoj kulture *Psikhologiya lichnosti* (Samara: Bakhrakh) vol 2 pp 233–47
- [8] Gao B 2019 Highly Efficient English MOOC Teaching Model Based on Frontline Education Analysis *International Journal of Emerging Technologies in Learning* **14** 138–46
- [9] Gavrilova T 1977 Empathy and its features in young and middle-aged children (Empatiia i ee

- osobnosti u detei mladshogo i srednego vozrasta) *Thesis*
- [10] Guilford J 1962 *The nature of human intelligence* (New York: McGraw-Hill Book Company)
- [11] Hjelle L L and Ziegler D J 1992 *Personality Theories: Basic Assumptions, Research and Applications* 3rd ed (New York: McGraw-Hill Publishing Co.)
- [12] I Made Sudana, Delta Apriyani and Agus Suryanto 2019 Soft Skills evaluation management in Learning processes at Vocational school *J. Phys.: Conf. Ser.* **1387** 012075 URL <https://doi.org/10.1088/1742-6596/1387/1/012075>
- [13] Karelin A 2007 *Big Encyclopedia of Psychological Tests* (Moscow: Eksmo) p 416
- [14] Kiv A, Kolesnykova K, Koycheva T, Vinkovskaya A and Donchev I 2021 The development of creative thinking as an important task of educational process *Journal of Physics: Conference Series* In press
- [15] Kon I S 1967 *Sociology of personality (Sotciologiya lichnosti)* (Moscow: Politizdat)
- [16] Kulikov L V 2016 *Psychology of personality in the works of Russian psychologists (Psikhologiya lichnosti v trudakh otechestvennykh psikhologov)* (Sankt-Peterburg: Piter)
- [17] Kuliutkin Iu N and Sukhobskaya G S 1971 *Individual differences in the mental activity of adult students (Individualnye razlichia v myslitelnoi deiatelnoi vzroslykh uchashchikhsia)* (Moscow: Pedagogika)
- [18] Ma R 2019 The Emergence of China's Nationally-Recognized MOOCs *Class Central* URL <https://www.classcentral.com/report/china-national-moocs/>
- [19] Maksymenko S D 2007 *Psikhologiya osobystosti* (Kyiv: KMM)
- [20] Mourshed M, Patel J and Suder K 2014 Education to Employment: Getting Europe's youth into work *McKinsey & Company* URL <https://www.mckinsey.com/industries/social-sector/our-insights/converting-education-to-employment-in-europe>
- [21] Panchenko L F and Muzyka I O 2020 Analytical review of augmented reality MOOCs *CEUR Workshop Proceedings* **2547** 168–80
- [22] Pervin L A, John O P 2001 *Personality: Theory and Research* 8th ed (Hoboken: John Wiley & Sons)
- [23] Petrovskaya L A 1982 *Theoretical and methodological problems of social and psychological training (Teoreticheskie i metodicheskie problemy sotsialno-psikhologicheskogo treninga)* (Moscow: Izdatelstvo Moskovskogo universiteta)
- [24] Petrovskii V A 1996 *Personality in psychology: the paradigm of subjectivity (Lichnost v psikhologii: paradigma subektnosti)* (Rostov-na-Donu: Feniks)
- [25] Romanova H, Artiushyna M and Kotykova O 2007 *Psikhologo-pedagogichni aspekty realizatsii suchasnykh metodiv navchannia u vyshchii shkoli* (Kyiv: KNEU)
- [26] Romanova H, Kozakov V, Artiushyna M and Kotykova O 2003 *Psikhologiya diialnosti ta navchalnyi menedzhment* (Kyiv: KNEU)
- [27] Semerikov S, Striuk A, Striuk L, Striuk M and Shalatska H 2020 Sustainability in Software Engineering Education: a case of general professional competencies *E3S Web of Conferences* **166** 10036 URL <https://doi.org/10.1051/e3sconf/202016610036>
- [28] Shteinmetc A E 1983 Development of empathy in psychological training of the teacher (from work experience) (Razvitie empatii v psikhologicheskoi podgotovke uchitelia (iz opyta raboty)) *Voprosy psikhologii* **2** 79–83 URL <http://www.voppsy.ru/issues/1983/832/832079.htm>
- [29] Susilawati, Aznam N, Paidi and Ngadimin 2020 Teachers' perspectives toward soft skills in science learning. *J. Phys.: Conf. Ser.* **1460** 012111 URL <https://doi.org/10.1088/1742-6596/1460/1/012111>
- [30] Sysoieva S O 1998 *Pedagogichna tvorchist* (Kharkiv, Kyiv: Karavela)
- [31] Thorpe S and Clifford J 2003 *The Coaching handbook: an Action Kit for Trainers & Managers* (London: Kogan Page)
- [32] Torrance E P 1988 The nature of creativity as manifest in its testing *The nature of creativity: Contemporary psychological perspectives* ed Sternberg R J (Cambridge: Cambridge

- University Press) pp 43–75
- [33] UNESCO International Bureau of Education 2013 *IBE Glossary of Curriculum Terminology* pp 53–4 URL <http://www.ibe.unesco.org/sites/default/files/resources/ibe-glossary-curriculum.pdf>
- [34] Vakaliuk T, Kontsedailo V, Antoniuk D, Korotun O, Semerikov S and Mintii I 2020 Using Game Dev Tycoon to Develop Professional Soft Competencies for Future Engineers-Programmers *CEUR Workshop Proceedings* **2732** 808–22
- [35] Verbova K V 1971 The problem of forming the life plans of high school students (Problema formirovaniia zhiznennykh planov starsheklassnikov) *Thesis*
- [36] Vishniakova N F 1996 Psychological foundations of the development of creativity in professional acmeology (Psikhologicheskie osnovy razvitiia kreativnosti v professionalnoi akmeologii) *Thesis*
- [37] Vozniuk O and Dubaseniuk O 2020 Perspektyvni napriamy pidgotovky maibutnikh uchyteliv do innovatsiinoi pedahohichnoi diialnosti *Innovatsiinyi rozvytok vyshchoi osvity: globalnyi, yevropeyskyi ta natsionalnyi vymiry zmin: materialy VI Mizhnarodnoi naukovo-praktychnoi konferentsii (23-24 kvitnia 2020 roku, m. Sumy)* vol 1 pp 217–22
- [38] Xiong Q 2018 College English MOOC Teaching on SWOT Analysis *Educational Sciences: Theory & Practice* **18** 3529–35 URL <http://doi.org/10.12738/estp.2018.6.263>
- [39] Yaksa N V 2009 Professional preparation of future teachers for interaction of subjects of educational process in the conditions of polyculturality of the Crimean region (Profesiina pidhotovka maibutnikh uchyteliv do vzaiemodii subiektiv osvithnoho protsesu v umovakh polikulturnosti Krymskoho rehionu) *Thesis*
- [40] Yatsula T V 2015 Theoretical approaches to determining the essence of personal interaction of a teacher as his pedagogical competence (Teoretychni pidkhody do vyznachennia sutnosti osobystisnoi vzaiemodii vchytelia yak yoho pedahohichnoi kompetentnosti) *Zbirnyk naukovykh prats Khersonskoho derzhavnoho universytetu. Pedahohichni nauky* **67** 285–9