



KAPITEL 7 / CHAPTER 7⁷
MATHEMATICAL MODEL OF THE FUTURE TEACHERS'
PROFESSIONAL DEVELOPMENT RESEARCH

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Introduction

The relevance of the research is connected to the global changes taking place in society and being reflected in the democratization of various spheres, increased activity and personal responsibility of each member of society. On the other hand, in materials of the Bologna Declaration, the emphasis is pointed out on one of the priority directions of educational policy, the essence of which is to achieve a new quality of the professional level of a modern teacher who implements professional activities in the conditions of radical socio-economic transformations. This influenced the public need for modernization of education, the result of which is the «New Ukrainian School» project, which represents providing of opportunities for choice and self-determination of each pedagogical process participant, subject-subject relationships between teachers and students, the introduction of games and information technologies, etc. Obviously, only a highly qualified, creative, socially active teacher, who is focused on humanistic values, will be able to provide such education. Therefore, the investigation of the future teachers' professional development, their preparation for professional activities in today's conditions does not raise doubts.

Various aspects of teacher's professional activity and preparation for it were considered by such domestic scientists as: I. Bohdanova, A. Bohush, M. Chepel, R. Hurevich, N. Huziy, E. Karpova, R. Khmelyuk, N. Kichuk, L. Kondrashova, A. Kuzminskyi, N. Morze, V. Radul, O. Semenoh, V. Shakhov, I. Sharabura, M. Smitanskyi, M. Soldatenko, O. Tsokur, M. Yevtukh, I. Zyazyun, and others. The search for new approaches in determining the goals of education and ways of achieving them in the context of cultural relevance is highlighted in the works of: V. Andrushchenko, H. Ball, I. Bekh, E. Bondarevska, O. Hazman, B. Hershunskyi, V. Hrynyova, L. Khomych, A. Kolomiets, N. Nychkalo, O. Sukhomlynska, S. Sysoeva, and others. The problem of the future teachers' professional development was studied by a number of researchers: T. Alekseeva, O. Kokun, V. Orlov, etc.

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However, scientists mostly investigate the process and the result of this phenomenon, and from the point of view of its modeling with the use of mathematical apparatus, not enough research has been done up to date, which also proves the relevance of the mentioned problem.

The purpose of the study is to scientifically substantiate the phenomenon of professional development in the psychological and pedagogical literature and to construct and approve a mathematical model of the future teachers' professional development. In order to achieve the goal of the research, it was necessary to solve such tasks as: determine the content and essence of the phenomenon «professional development» in the psychological and pedagogical literature; experimentally verify the mathematical model of the future teachers' professional development. When solving the outlined tasks and achieving the goal, general scientific methods were used: study and analysis of philosophical, psychological and pedagogical literature on the object and subject of research; calculation of empirical values; construction of the level of multiple linear regression and qualitative analysis of the model of the future teachers' professional formation.

7.1. Theoretical aspects of the future teachers' professional development

Determining the logic of the research into the phenomenon of the future teachers' professional development, it was established that the current state of scientific research in the field of modern pedagogy is determined by the growing attention of scientists to it, which is reflected in both applied and fundamental research. The review of studying the essence of the phenomenon under research deserves attention, and is presented in Table 1.

As we can see from Table 1, professional development, firstly, is not a new concept; secondly, it is related to the categories of didactics, various activity-based aspects of the educational process subjects, personal and professional qualities, internal potential, etc.

The conducted theoretical work made it possible to determine that professional development can be characterized by content, activity and process directions of self-realization, which contributes to the development of motivation for learning, the future teacher's internal and external self-organization, the ability to build a trajectory of self-learning, thanks to which he / she becomes the subject and product of his / her own future activity constructing.



Table 1 – Content analysis of the substance of «professional development» concept

№	Author, year of publication	Essence	Source
1	T. Alekseeva, 2013	psychological category that reflects the process of self-development of a person throughout life, within which the formation of specific types of subject activity of an individual takes place on the basis of the development and structuring of a set of professionally oriented characteristics, which provide realization of the functions of cognition, communication and regulation in specific types of activities and at the stages of the professional way	Access mode: http://nbuv.gov.ua/UJRN/Vn_adps_2013_4_18 .
2	O. Kokun, 2012	new qualitative change of the teacher, which gives him / her the opportunity to become a professional in the new rapidly changing conditions of the education system	Psykhohohiya profesiynoho stanovlennya suchasnoho fakhivtsya [Psychology of professional development of a modern specialist] : monohrafiya. K. : DP «Inform.-analit. ahentstvo», 2012. 200 s.
3	V. Orlov, 2003	complex and multidimensional phenomenon of the individual, which is the process of emergence of the individual's professional qualities that he / she did not have and which meet the essential requirements of the profession.	Orlov V. F. Profesiynne stanovlennya vchyteliv mystets'kykh dystsyplin [Professional formation of artistic disciplines teachers] : monohrafiya. K. : Naukova dumka, 2003. 262 s.

The works of I. Beh, O. Kokun, O. Pehota, I. Pidlasiy, I. Zyazyun are of particular importance for the conducted research, in which we find that the key to the successful future teachers' professional development is the formation of valuable attitude to the future professional activity, which occurs in stages: from getting acquainted with the features of the future profession, creating a clear and conscious idea about it, about the requirements for the professionalism of a specialist – to the formation of value ideas and the creation of the image «Self-professional» [1].

At the same time, the analysis of scientific literature confirmed that today the problem of the future teachers' professional development has its actuality and requires systematization and generalization of considering this phenomenon.

In general, investigating theoretical problems of the future teachers' professional development implies that their training in the conditions of educational and



professional activity, firstly, is aimed at the formation of stable positive motives, socially significant and professionally important qualities, readiness for constant professional growth, finding optimal techniques and methods of high-quality and creative performance of professional activities; secondly, it depends on the continuous process of purposeful personality modification due to social influences and one's own activity (according to E. Zeyer and E. Klimov).

Let us emphasize that the present encourages teachers to constantly improve themselves, to realize the prospects of their own professional development, to make the most of their personal intellectual abilities, to evaluate their own professional activity and its effectiveness, which, in turn, is closely related to their professional worldview, the level of formation of which has an external manifestation in motivation, communication, activity, behavior and emotions. Therefore, the research is based on the assumption that future teachers' professional development depends on the state and quality of pedagogical thinking, communicative skills and abilities, professional and pedagogical value orientations, motivational, emotional and mental states.

Thus, studying the essence and content of pedagogical thinking it was found out that scientists characterize it as the ability to consciously use pedagogical ideas, knowledge and skills in specific situations of professional activity, to see in certain phenomena of activity the pedagogical essence, which will further determine the activity and striving of an individual for the future profession achievements. It is necessary to emphasize that pedagogical thinking is characterized by visual-active, visual-figurative and verbal-conceptual forms. Visual-active thinking is performed with the help of existent transformation of the situation, observation of a real motional act, event, action. Visual-figurative thinking functions through imaginary representation of what should happen as a result of the subject's activity. Figurative thinking allows to present the unusual, non-standard combinations of qualities, connections and relationships. Verbal-conceptual thinking is performed with the help of logical operations with concepts. Depending on the spheres of functioning and the type of tasks to be solved, theoretical and practical pedagogical thinking are distinguished. Theoretical pedagogical thinking is aimed at the discovery of new laws, principles, rules of education and upbringing. Practical pedagogical thinking functions in the process of activity, its main task is the transformation of reality [8]. Therefore, the formation of the future teachers' pedagogical thinking during their training affects the quality of their acceptance, awareness and understanding of pedagogical phenomena in professional and pedagogical activities.



The actuality of the formation of communicative abilities and skills is determined by professional and pedagogical communication of information exchange in the systems «person – person», «person – computer», «person – computer – person», the success of which provides competence in implementing communication – integral personal forming of the communicative activity value by the teacher, theoretical and practical readiness for its qualified implementation [11]. Despite the sufficient number of psychological-pedagogical studies on the professional development and readiness of the future teacher for communicative activities (I. Beh, N. Bibik, N. Volkova, etc.), the question of forming the future teachers' communicative abilities and skills remains open.

The pedagogical meaning of the concept «communicative skills» lies in the fact that they mean individual psychological features of a person that provide the effectiveness of his / her communication and coexistence with other people. Communicative skills include such ones as: initiating openness to contacts, response to the initiative of others; express your readiness to communicate with words and facial expressions; the ability to exchange information, to listen without interrupting others, to establish joint interaction; the ability to value relationships, to reveal available age features, loyalty, reliability, compliance [25].

We find it significant to figure out that the success of pedagogical communication depends on whether the teacher knows how to establish the contact with the audience, on the systematicity of its presentation, logic, argumentation, the ability to stimulate students for further activities, encourage, direct their attention, anticipate conflicts, disagreements, remove emotional tensions in communication and eliminate barriers, prevent the emergence of conflict situations [2].

In terms of research, the conclusions are correct that the formation of communicative skills will be the more effective, the deeper the personality of the future teacher acquires communicative knowledge and relevant skills – automated conscious actions that contribute to quick and accurate reflection of communicative situations at the lessons. Based on the investigations of the above-mentioned scientists, a list of teacher's communicative skills was established, which are basic for the formation of the future teachers' professional and pedagogical intercourse: communication with people and directing them; operational orientation in the conditions of the communication being carried out; planning and implementation of communication system, in particular its important link – speech influence; sense and maintain feedback



in communication [30].

The peculiarity of our research is studying the problem of the development of the future teacher's Self-concept during his / her preparation for professional activity. Psychological and pedagogical aspects of teacher training and professional activity were considered by the following scientists: O. Abdullina, I. Bohdanova, R. Hurevich, E. Karpova, R. Khmelyuk, N. Kichuk, M. Yevtukh, I. Zyazyun, etc. Various aspects of studying Self-concept were highlighted in the works of V. Ahapov, R. Burns, A. Derkach, N. Kuzmina, L. Mitina, A. Rean, K. Rogers, S. Rubinstein, V. Shadrykov, and others. On the other hand, despite the above-mentioned scientific developments, the problem of the future teachers' Self-concept formation has not been sufficiently investigated up to date.

The term Self-concept appeared in scientific circulation at the turn of the 19th and 20th centuries in the works of the American psychologist W. Gemma, who determined that Self-concept includes self-awareness from the four perspectives: the spiritual «Self», the material «Self», the social «Self» and the physical «Self». It should be emphasized that the profession of a teacher presupposes the presence of the future teacher's certain professional and psychological qualities, which are revealed in his / her Self-concept: «real Self» (self-assessment of one's personal qualities); «ideal Self» (ideas about the qualities inherent in the ideal of a teacher); «anti-ideal Self» (ideas about qualities undesirable for a teacher); «professional Self» (assessment of one's professional qualities, motives, value orientations, etc.). During the investigation of the specified problem, it was established that scientists observe the essential importance of a positive Self-concept as productive for the further self-improvement of a teacher, which contributes to the manifestation of the feelings of satisfaction from pedagogical work, self-respect, self-confidence and the sense of success in the work as a whole, which is achieved by the harmonization of the components of the Self-formations of teacher's Self-concept.

We adhere to the opinion that teacher's positive Self-concept, providing high self-esteem and self-confidence as a teacher, prevents the emergence of the desire to assert oneself, humiliate the learner's dignity, abuse one's power. On the other hand, positive Self-concept has a beneficial effect on the trainees' self-esteem, assuring them of their own significance. A teacher with such a concept is optimistic about the learner's personality, believes in the possibility of developing his / her abilities, creates conditions for their development, which is manifested in an unconditional positive attitude towards the trainee [13].



Therefore, the development of teacher's positive Self-concept, as an integral characteristic of his / her professionalism, adds constancy, provides progressive stimulating influence on the future teachers' professional development not only as subjects of pedagogical activity, but also as subjects of their own development, creators of their own life and professional path.

However, based on the purpose of the research, it would be quite appropriate to determine the essence of the characteristics of the future teacher's positive Self-concept, such as: motivation to achieve success, the ability of self-assessment, developed reflection.

The analysis of psychological and pedagogical literature made it possible to establish that the future teachers' professional development will be successful under the condition of his / her purposeful motivational activity. The professional activity of a modern teacher is determined by a complex of motives, such as internal (indicator of internal responsibility, formation of the motivational sphere), as well as incentives of social nature, manifested in the form of demands, condemnation, encouragement, approval or disapproval of actions, etc. In this regard, the motivational sphere of professional activity determines the interest in the content of pedagogical activity itself, its results and consequences. Motivation, or the need for achievement, is one of the varieties of labor motivation, related to the need of an individual to achieve success and to a lesser extent to avoid failure. It is success that reflects objective indicators of the activities effectiveness, subjective attitude towards oneself, which affects future teachers' awareness of themselves as subjects of pedagogical activity (according to A. Derkach and V. Zazykin, 2000).

It should be emphasized that motives of pedagogical activity are the motivation associated with its implementation, whether it is the internal need to work in the field of a given subject or the need to work with people, based on awareness of one's pedagogical abilities [31]. By educational and professional motivation scientists understand the system of motives, goals, needs, and incentives that determine the manifestations of educational activity and intensive actions related to mastering a profession, including teaching profession. This makes it possible to assert that during the formation of the future teachers' motivation there is a desire for continuous professional development, continuous achievement of the high level of pedagogical mastery [22].

The development of motivation to study is influenced by both the internal state of the individual and the external conditions and environment. Motivation to study is a



complex system in which the system of factors affecting its formation and development is reflected. Motivation to study is defined as a system of personal and external factors that encourage applicants of higher education to join the learning process. That is, according to I. Shalimova, is a combination of not only individual strivings, but also external motivations that determine and stimulate his / her educational and cognitive activity [29].

Note that future teachers' awareness of pedagogical activity during training is closely related to the ability of reflection and self-assessment. It is known that a teacher, feeling calm and confident, friendly and equal in relations with the learners, understanding the weak sides of his / her work, intending to correct them, does not destroy the overall positive self-esteem, and vice versa, teachers with low professional self-esteem negatively perceive pedagogical reality through the prism of their stress and anxiety, often turning to an authoritarian style as a means of psychological self-defense (according to A. Markova, 2000). On the basis of self-respect and adequate ideas about one's own professional status, the effect of normative self-regulation is strengthened. In this aspect, self-regulation, which covers the intellectual and speech, emotional, volitional activity of the future teacher's personality performs acts of self-analysis, self-control and self-evaluation related to reflection. On the other hand, reflection is self-knowledge, self-analysis and awareness of one's activities and relationships through the eyes of other people (according to V. Ahapov). The study of O. Myroshnyk is relevant, in which the author defines professional pedagogical reflection as a holistic, systemic professional property that can be formed thanks to reflective processes that allow to simultaneously create and systematically integrate mental representations of the objective basis of professional activity in teacher's mind [16].

Investigating the formation of the future teacher's positive Self-concept, Z. Kurlyand emphasizes such definitions of reflection as: self-analysis, comprehension, assessment of prerequisites, conditions and the course of one's own activity, inner life; the process of getting to know himself / herself as a professional, one's inner world, the analysis of his / her own thoughts and experiences in connection with professional and pedagogical activities, reflection on oneself as a person, awareness of how one is perceived and evaluated by students, colleagues, and others around. Reflection includes such phenomena as self-awareness, reconceiving, checking one's opinion about oneself, about other people and what, according to the subject, people think about him / her, how they evaluate and treat him / her [13].



We share the author's point of view and believe that the future teachers' striving for achieving success, the ability of self-assessment, the development of reflection, which is manifested in their formed positive Self-concept, affects further professional upgrowth.

The analysis of scientific psychological-pedagogical and methodical literature convinces that the attention of many scientists and practicing teachers is attracted by the problem of studying various aspects of the concepts «values» and «value orientations» within the limits of philosophical, sociological, psychological and pedagogical directions (Sh. Amonashvili, N. Chepeleva, V. Isaev, H. Lyaluk, S. Maksymenko, V. Myasishchev, V. Semichenko, R. Skulskyi, O. Sukhomlynska, V. Yadov, etc.). However, the issue of future teachers' awareness of professional and pedagogical value orientations remains open.

At the psychological level, as stated in the large explanatory dictionary, value is understood as: 1) quality or property of an object that makes it useful, desirable or valuable; 2) an abstract and general principle regarding the model of behavior within the framework of a certain culture or society, which, as a result of the socialization process, the members of this society consider very important [3].

The analysis of psychological and pedagogical literature made it possible to assert the absence of a unified approach to the problem of values. However, different definitions, classifications of value orientations and values do not, in general, contradict each other, but complement each other and allow to consider them from different positions.

In terms of research, attention should be paid to the classification of professional and pedagogical value orientations, which reflects the specificity of the teaching profession (according to V. Denysenko): general pedagogical orientations aimed at the civilian and social values of the teaching profession (the ability to benefit people, raising those who study, communicating with them, etc.); personal developmental orientations related to the development of the learners's personality as the main pedagogical value (development of the trainees's intellectual abilities, creative abilities, etc.); subject-activity orientations aimed at the teacher's subject-teaching activity (self-development, teacher's self-education); personal orientations aimed at the teacher's self-expression in professional activities (proper professional characteristics); professional and pragmatic orientations related to the prestige of the teaching profession, salary, long vacation, etc. [9].

The ideas of N. Maksymchuk are particularly significant for our research, in



which we find that the structure of value orientations is a complex socio-psychological formation that has a dynamic character, as a result of which it is possible to influence its formation. Summarizing the results of the research of prioritised for the future teachers value orientations, the scientist established that their content, represented by all groups of values, belongs to professional and status orientations (reflecting the strivings of higher education applicants to master the chosen profession and occupy a worthy place in society) and traditional values (personal, universal, material) [14].

Continuing to study the essence of the future teachers' professional development, there is a need to focus on the study of the problem of emotional intelligence, which is associated with a huge arsenal of accumulated knowledge about it and its connections with various socio-psychological factors, such as: academic success, bullying, social networks, risks of nervous breakdowns, emotional burnout in particular.

Analysis of psychological and pedagogical literature (M. Kuznetsov, D. Lyusin, O. Sannikova, O. Vlasova, H. Yusupov, etc.) made it possible to establish that emotional intelligence is interpreted differently by scientists, and namely as: all non-cognitive abilities, knowledge and competence that gives a person the opportunity to successfully cope with various life situations (according to Bar-On R.,_1997); the ability to understand personal relationships, represented in emotions, and manage the emotional sphere on the basis of intellectual analysis and synthesis (according to H. Harskova, 2013); as an integral property of a person and a component of his / her inner world, as «a form of revealing a positive attitude of a person to himself / herself, to the others, to the world, which reflects the value of emotional intelligence (according to E. Nosenko, 2002) [17].

A brief review of the interpretations of the concept «emotional intelligence» showed that researchers, revealing the meaning of this concept, referred, first of all, to the distinction between the constructs «emotion» and «intelligence», which were considered to be opposite to each other until now. On the other hand, in the modern psychology of emotional intelligence, there is a tendency to use such categorical concepts to reflect the content of this concept as «emotional self-awareness» (O. Vlasova, 2005), «emotional intelligence» (E. Nosenko, 2003), «emotional erudition» (O. Pryimachenko, 2006), «emotional literacy» (K. Steiner, 2001). In general, the disclosure of the content of emotional intelligence takes place through the use of the concepts «ability», «skills», «capability», with an emphasis on the valuable essence of emotional intelligence, on its functional property of reflecting the inner world of the individual.



Summarizing, it should be emphasized that emotional intelligence starts with understanding one's emotions, and only by becoming aware of one's emotions can we learn to understand other people's emotions and the reasons that caused them. In this regard, we can state that the development of the future teachers' emotional intelligence is influenced by a set of internal and identified motives, which provide the success of educational activities, high indicators of emotional creativity, self-efficacy as a belief in one's own productivity, general intelligence and low indicators of educational anxiety, in particular feelings of anger, actual anxiety, restlessness and excessive emotionality during knowledge testing [6].

Increasing attention to the issue of the future teachers' moral and volitional qualities formation during their professional development is directly related to the problem of cultural development in the context of humanizing, democratizing, differentiating and integrating processes in education. Despite a sufficient number of scientific studies devoted to pedagogical culture (V. Andrushchenko, E. Bondarevska, V. Hrynyova, N. Huziy, R. Khmelyuk, E. Karpova, O. Sukhomlynska, M. Yevtukh, I. Zyazyun, etc.) the issue of considering the formation of the future teachers' moral and volitional qualities during their professional development remains open. The basis for this is the research of N. Semchenko, in which it is proven that only a teacher who has well-formed emotional and moral-volitional qualities can teach and educate, and morality covers not only the relationships of people, but also their moral views, beliefs, habits, feelings, people's behavior, etc. We believe that future teachers should have at a sufficient level such moral and volitional qualities as: humanity (perception of the learner as the highest value, respectful treatment of him / her as a unique individual); social responsibility, sense of duty (the need to randomly take responsibility for the results of one's behavior in front of oneself, the surrounding people, and society as a whole); the ability to consider the consequences of one's actions; a sense of responsibility for other people; altruism (sufficiently expressed priority of the group interests over individual interests, the ability to partially sacrifice one's welfare for the sake of achieving social goals); integrity, conscientiousness, thoroughness, self-criticism (striving to act in accordance with one's own life principles, solid implementing of each fragment of work, desire to adequately perceive oneself and one's behavior); discipline (strict adherence to the daily routine, clear allocation of work and time for its performing); ambition (the teacher has a strong motive for self-assertion, social recognition, leadership); dignity (positive attitude towards oneself, understanding one's own significance as of an individual); diligence (tendency,



willingness to work voluntarily to achieve certain goals, general positive attitude to work); bravery, determination, courage, resistance (ability to take justified risks, lack of fear when defending one's ideals, ideas, etc.) [23].

The conducted theoretical work made it possible to establish that, taking into account the spiritual and moral-volitional development of an individual through physical culture or sports training, the problem of its development and the interaction of the volitional sphere and moral growth acquires high social significance. Accordingly, when characterizing a person engaged in physical culture, it is necessary, first of all, to bear in mind the maturity of his / her consciousness, stability of character and high moral qualities [12].

In the aspect of the last assumption, regarding the future teachers' professional development, there is a highlighting of the ability to overcome barriers in professional and pedagogical activities. Analysis of psychological and pedagogical literature (V. Bratus (1988), L. Bozhovich (1995), O. Chaplina (2006), E. Ilyin (2002), V. Kazanska (2005), A. Massanov (2010), N. Miloradova (2002), R. Nemov (1999), A. Petrovskyi (1985), O. Pylypenko (1995), R. Shakurov (2001), V. Stolin (1983), T. Verbytska (2003), etc.) regarding the concept «barrier» (from the French «barriere», which means an obstruction, an obstacle to something [15]) made it possible to claim that anti-innovation barriers are understood as external or internal obstacles that prevent the implementation of innovative activities [10]. It should be emphasized that external barriers include: social (incompatibility of the new with existing experience and values accepted in society; stereotypes of the pedagogical community thinking); organizational (resistance of the governing authorities of education to the implementation of innovations; lack of coordination centers for the development and implementation of pedagogical innovations); methodical (lack of methodological support for innovation, lack of awareness in the field of pedagogical innovation); material and technical (teacher workload, living conditions, salary level).

Internal barriers include psychological (personal) barriers that hide deep personal and professional problems. Psychological barriers arise due to the need to go beyond the usual ways of solving a professional task, to give preference to another point of view. They appear as internal obstacles (reluctance, fear, uncertainty, etc.) that prevent a person from performing a certain action.

Based on the above-mentioned scientific developments, it was established that psychological barriers exist as: a form of manifestation of the socio-psychological climate of the collective in the conditions of innovation in the form of negative mental



states of employees caused by the innovation; a set of actions, judgments, concepts, expectations and emotional experiences of employees, in which negative mental states are expressed consciously or unconsciously, hidden or not hidden [10].

The analysis of the scientific fund (I. Dychkivska, K. Levin, A. Massanov, E. Rogov, O. Sannikova, etc.) on the mentioned issues made it possible to establish that future teachers during their professional development should realize that in the pedagogical environment most often are revealed organizational-psychological, social-psychological, cognitive-psychological barriers, such as: tendency to conformism; fear of turning out to be a «white crow», to seem unreasonable and ridiculous in one's judgments; fear of seeming too extravagant in their rejection and criticism of other people opinions; inability to implement new methods and forms of performing pedagogical activity; insufficient development of personal creative potential of individual teachers; lack of need to introduce new things; fear of another person's revenge; personal anxiety, diffidence, negative self-perception («Self-concept»), characterized by individual's low self-esteem, reluctance to express one's ideas; rigidity (inflexibility) of thinking [15].

Therefore, based on the above, we come to the conclusion that when considering the future teachers' professional development, each scientist relies on a certain concept, within the framework of which he / she analyzes this concept. On the other hand, the systematization of scientific research on the subject of study made it possible to establish that the result of the future teachers' professional development is considered to be a formed pedagogical culture.

7.2. Pedagogical culture as a result of the future teachers' professional development

Theoretical analysis of the sources of scientific findings made it possible to find out that culture is a multifaceted concept, has a large number of definitions and interpretations and is characterized by researchers T. Hrytsenko (2007), M. Kagan (2001), K. Prokofieva (2005), O. Stolyarenko (2014), etc. in the following way: system of material and spiritual values; result of personality development; form of activity; system of normative orientations; system of values of the individual and society as a whole; a world filled with human content [6]. In the reference literature, culture is defined as the activity of people in the reproduction and renewal of social life, products



and results included in this activity [28].

The conducted theoretical work made it possible to define a number of concepts that characterize the notion «culture» and differ in distinctive features of the definitions of this phenomenon: ontological – considers culture as the content of social life, an artificial world created by mankind; axiological – characterizes culture as the value-meaning basis of people's activity, behavior and communication; gnosiological – distinguishes culture as a memory, experience of humanity, information space of an era; anthropological – defines culture as the embodiment of the essence of a person, his / her mentality, the originality of the attitude to the world and life [20].

In pedagogy, culture acts as a sense-forming factor and is divided into such types as: elite and mass, spiritual and material, folk and personal, national, linguistic and thinking, informational, behavioral and communicative, reading, emotional and intellectual, physical, etc. On the other hand, the characteristics of culture distinguish the following subgroups: domestic (peculiarities of the peoples of a certain territory); political (a factor determined by the socio-economic relations of different peoples at different times); legal (level of regulation of legal relations); artistic and creative (multifacetedness, multidimensionality of human artistic activity); technical (human-machine interaction); productive (ethical relations between members of productive teams). M. Kagan's position is also correct, in which the author proposes to consider the phenomenon «culture» from the perspective of three modalities: human (culture is presented as the cultural potential of a person acting as a creator of culture and its creativity); procedural and activity (culture acts as ways of human activity, objectification, deobjectification and communication of people, participants of both processes); subject (culture characterizes the multifacetedness of material, spiritual, artistic works that form the «second nature» of phenomena) [6].

Considering the essence of the mentioned phenomenon, we find it necessary to emphasize the functions and forms of revealing culture. Thus, among the important functions of culture the scientists (T. Hrytsenko, S. Hrytsenko, A. Kondratyuk, etc.) attribute: human-creating (learning the achievements of culture, a person gets to know himself / herself, determines his / her place in society, the world, the purpose of his life); informative (enriching a person with previous experience); regulatory (thanks to norms and rules, the organization of people's cohabitation takes place); axiological (establishment of value priorities); hedonistic (directed towards obtaining pleasure, enjoyment) [4].

Within the framework of the research object and the effectiveness of culture



formation during higher education applicants training, the scientific reflections of V. Radkevich are relevant, in which the author proves the fulfilment of such paradigms as:

- cultural (values of culturally appropriate education aimed at future teachers' active awareness of ways of behavior, activity, creative interaction, cooperation, cultural development, self-realization in the educational environment);

- socio-cultural (conditions the future teachers' need to master the profession as a cultural-historical model of human activity);

- socio-professional (the professionalism of pedagogical activity is an important condition for the future teachers' social protection, their competitiveness in the labor market);

- subject-actual (formation of professionalism based on the creation of conditions that provide the development of the future teacher's personality as a creative subject of professional and pedagogical activity);

- personally oriented (aimed at the development of the future teachers' personality and the realization of personally oriented goals of education, upbringing, respect both for general cultural values and folk traditions, as well as for people and for oneself;

- cognitive (the projection of educational activities is implemented, as well as its reflection in educational programs, textbooks, educational and methodical manuals);

- functional (ensures the future teachers' preparation for professional activity taking into account socio-economic requirements, personal and subject development);

- competence (presupposes anticipatory updating of the content and forms of education, socialization of the future teacher's personality in a cultural and educational, professional environment, formation of pedagogical thinking, sociability, readiness for personal and professional self-determination in the conditions of multicultural interaction [21].

Based on the above, it was established that pedagogical culture is most often considered in studies devoted to the analysis of the pedagogical activity peculiarities, the study of pedagogical abilities, teacher' pedagogical skills, a way of life, a tool for realizing individual creative potence in human activity (A. Derkach, N. Kuzmina, V. Slastyonin, etc.) [6].

The authors E. Bondarevska (2000), O. Bulkin (2003), I. Vidt (2002), E. Zakharchenko (2002), and others consider pedagogical culture as a complex open system that is self-organizing, informationally provided and guided by science, art, religion, moral and ethical postulates of society, and practical experience of mankind.



At the same time, it reproduces and transmits to new generations the spiritual-aesthetic, moral-ethical values of an individual, society, nation and all of humanity.

In the context of the study, the views of Z. Parshikova (2003) are valid, in which the author considers pedagogical culture as a phenomenon that exists at the level of society and is formed in specific historical and socio-cultural conditions. In terms of content, it is a complex of the most common knowledge about education and upbringing, peculiarities of pedagogical practices; existing norms and traditions of education, including social, family, etc. A certain pedagogical culture also runs in a specific educational institution – a set of ethical, psychological and professional positions, approaches and methods. Finally, each pedagogue, teacher or educator is the bearer of his own pedagogical culture – a set of personal professional guidelines, principles, techniques developed on the basis of experience and skill and reproduced in professional activity. According to the author's definition, pedagogical culture is a complex (sometimes not just a sum, but a system, open or closed) of value attitudes towards education and the learner, which are visibly and practically realized in educational processes. Indicators of pedagogical culture (in its various forms) are the state and quality of education, its level in society, the culture of the organization of education in a proper school, the mastery of an individual teacher, communicative culture. According to the scientist, it is appropriate to characterize the current state of pedagogical culture according to the following changes: in education – it is the individualization of education through self-development, education based on personal knowledge, subjective experience, individual interest, inclusion in a multicultural community, the forming of tolerance; productive socialization through professional orientation and practical (productive) mastery of elementary methods and means of activity in various spheres of social activity; in upbringing – demonstration, critical understanding of generally accepted humanistic values and norms of respect for the individual; attitude to nature, cultural diversity; the development of the learners's independency, self-dependence, ability to act ethically and morality of behavior; pedagogical support is the support of all manifestations of trainee's self-determination, self-awareness, self-development, self-realization; concern for the comfortable conditions of his / her life at school; protection of his / her freedoms and rights; help in solving individual problems. The scientist defines the following main directions, which reflect three global plans for considering the future teacher's culture, such as: a plan for the individual's culture, a plan for the culture of activity, and a plan for the culture of social interaction. In terms of personality, these are the directions: culture of attitude



and culture of self-regulation; in terms of activity – the culture of intellectual activity and the culture of subject activity; in terms of social interaction – the culture of behavior and the culture of communication [6].

So, in this concept, the emphasis is placed on the fact that pedagogical culture is not so much related to the subject content of educational disciplines, but to techniques and methods of interaction positioning with trainees, interpersonal interaction in communication and cooperation.

According to the domestic scientist I. Palshkova, the essence of pedagogical culture begins to take shape and reveal itself in: a person trained and educated in accordance with the various needs and interests of certain social groups, able to actively participate in their life activities; traditions of family, religious, confessional, craft and other education, which were formed within the boundaries of certain social groups and revealed the peculiarities of their worldview, intellection, attitude to the environment and the person himself/herself; values that determined the expediency and directionality of training and educating of a person in different social conditions; certain rules of behavior between the teacher and students, the teacher and parents, the teacher and the social group that involved him in pedagogical activities; special language, terminology that encoded the content of pedagogical activity in the works of folk pedagogy, scientific, religious, philosophical treatises and revealed a certain view of the avocation of an educated and brought up person, the essence of pedagogical activity and requirements for its organization.

In the pedagogical culture, the life experience of a person in certain social roles is fixed, preserved and transmitted to other generations: child, woman, man, member of the family, household, genus, church, local (rural) community, and others. Awareness of the experience of life in society becomes the basis for determining the content of the teacher's activity and the value of its results [19].

But along with this, E. Bondarevska notes that a high pedagogical culture should be considered as the main characteristic of teacher's personality, activity and pedagogical communication. It is implemented as a dynamic system of pedagogical values, creative methods of pedagogical activity, teacher's personal achievements in creating examples of pedagogical practice and their value from the standpoint of a person of culture [6]. The scientist emphasizes that a cultured teacher, from the point of view of the teaching profession norms, is characterized by:

- respect for the dignity of another person, a learner who is studying, and



preservation of one's own dignity in various situations of social interaction (domestic, professional, social), i.e. culture of personality, self-regulation;

- adequacy (appearance, manner of behavior, communication) in situations of everyday, professional, social interaction, i.e. culture of everyday life, work, recreation, healthy lifestyle, communication;

- abundance of ethno-sociocultural traditions, customs, norms, etiquette in mono- and multicultural interaction, i.e. the culture of normative behavior, etiquette, attitude, social interaction in a multicultural space;

- actual readiness to use the individual fund of knowledge (humanities, natural sciences, economic, political, legal, etc.), formed by the content of professional training in the process of solving the tasks of social interaction, that is, the culture of intellectual and substantive pedagogical activity, the culture of the intellect;

- established need for satisfaction and continuation of personal socio-cultural (ethical, intellectual, aesthetic, etc.) development and self-development, i.e. culture of self-regulation, personal self-determination;

- orientation in the main valuable-meaning dominants of the modern world, country, society; directions of history and preservation of the cultural life of the world, country (painting, music, literature, architecture, etc.), i.e. general civilizational culture;

- social responsibility for oneself, for the well-being of others, that is, the culture of social being [6].

Therefore, in the context of the sequence of culture growth as a unique and universal phenomenon, pedagogical culture, by its very nature, concretizes this path, giving all its components a special pedagogical content and meaning.

7.3. Mathematical model of the future teachers' professional development

Despite a sufficient number of scientific studies by N. Bordovska, N. Kuzmina, A. Markova, L. Mitina, I. Zimnaya, etc., it was established that the concept «model» is currently one of the most important general scientific categories. Thus, in the Ukrainian dictionary «model» (from the Latin «modulus») is considered as an object, phenomenon, system (description, diagram, graph, form), which under certain conditions act as a substitute or representative of some other object, phenomenon or system [27]. The generalization of scientific research by Z. Kurlyand [13],



S. Omelchenko [18] allowed us to come to the conclusion that by model is understood the following: a system of signs that reproduces certain essential properties of the system-original, that is a schematic representation of some process or phenomenon, which is used as a simplified replacement for it; a system that, reflecting or reproducing the object of the research, is able to replace it, to provide an idea of significantly important characteristics of a pedagogical phenomenon, system, situation. Examining the content of the terms «model» and «modeling», it was determined that they involve the creation of training quality criteria that a specialist must possess, the establishment of a correlation between them and the pedagogical conditions aimed at their formation [5].

It should be emphasized that today's realities make it possible to assert the rapid development of psychological and pedagogical science, which contributes to the accumulation of a large number of various psychodiagnostic methods by both domestic and foreign scientists. However, firstly, there are no principles that combine various tests into a certain system of adequate procedures for solving specific psychological and pedagogical research tasks; secondly, not all psychological properties can be investigated with the help of diagnostic apparatus both because of the complexity and ambiguity of the research subject itself, and because of the lack of adequate diagnostic tools. Therefore, the research uses well-known testing methods corresponding to the subject of diagnosis, the requirements of reliability and validity.

Note that the specificity of the professional activity of educators, the requirements for them, as well as the results of scientific studies of factors, having a significant impact on the manifestation of professional development, allowed us to come to the conclusion that in order to build a mathematical model, it is necessary to study the internal component of the future teachers' personality and its external manifestation (see the first paragraph). The manual of methods included diagnostic tools corresponding to the research in each of the specified directions. The general list of methods, systematized by research directions, is presented in Table 2.

As we can see from Table 2, the diagnosis of pedagogical thinking was determined using «Pedagogical Situations» method, which made it possible to judge the level of the future teachers' pedagogical thinking based on the way out of a number of pedagogical situations described in it. The ability to correctly solve pedagogical problems was determined by the sum of points scored by future teachers in all pedagogical situations. If the future teachers received an average score above 4.5 points, their pedagogical thinking was considered highly developed. If the average



Table 2 – Directions of experimental research of the future teachers' professional development and manual of methodologies

№	Research direction	Providing methodologies
1	Diagnostics of pedagogical thinking	Methodology «Pedagogical situations» (according to R. Nemov, 2003)
2	Diagnostics of the formation of communicative abilities and skills	Modified version of O. Leontiev's questionnaire (M. Fetyskin, 2005)
3	Diagnosis of Self-concept development	Methods: motivation of success and fear of failure according to A. Rean; self-esteem of the level of ontogenetic reflection according to M. Fetyskin; determination of the level of self-esteem according to V. Ternopilska; (Z. Kurlyand, 2005)
4	Diagnostics of professional and pedagogical value orientations	Methodology for determining groups of values (according to N. Maksymchuk, 2000)
5	Diagnosis of emotional intelligence	Methodology of D. Lusin (2006)
6	Diagnosis of moral and volitional qualities	Methods of A. Vostrikov and N. Kuzmina (1986)
7	Diagnostics of the ability to overcome barriers in professional and pedagogical activities	Interview and questionnaire methods (according to I. Dychkivska, 2004)

score was in the interval from 3.5 to 4.4 points, then pedagogical thinking was considered moderately developed. Finally, if the average score was less than 3.4 points, then the future teachers' pedagogical thinking was considered underdeveloped.

In order to determine the levels of formation of the future teachers' communicative skills, the diagnosis of the effectiveness of pedagogical communications (modified version of O. Leontiev's questionnaire) was used. The purpose of the methodology for diagnosing the effectiveness of pedagogical communications was to identify the «auditory atmosphere», activity, expression of cognitive interest of the future physical education teachers, as well as some manifestations of the pedagogical activity style. Respondents were asked to put the appropriate points in the card of communicative activity of physical education teachers. At the same time, the obtained points were distributed as follows: 7-19 points – low level, 20-34 points – average level, 35-49 points – high level.



When diagnosing the development of the Self-concept, the following methods were chosen: «Motivation for success and fear of failure» (according to A. Rean). The future teachers were asked to answer the questions quickly, without thinking for a long time. If the number of scored points was from 1 to 7, motivation to fail (fear of failure) was diagnosed. If the number of scored points was from 14 to 20, motivation for success (hope for success) was diagnosed. If the number of scored points was from 8 to 13, then it should be assumed that the motivational pole was not clearly expressed. At the same time, if the number of points was 8-9, there was a certain tendency of motivation towards failure, and if the number of points was 12-13, there was a certain tendency of motivation towards success. At the same time, motivation for success refers to positive motivation. With such motivation, a person, starting an affair, has in mind the achievement of something constructive, positive. At the heart of human activity is the hope for success and the need to achieve success. Such people are usually self-confident, responsible, initiative and active. They are distinguished by perseverance in achieving the goal and purposefulness.

The indicator «formation of reflective skills», during the diagnosis of the development of the future teachers' Self-concept, was assessed using the diagnostic questionnaire of self-assessment of the level of ontogenetic reflection. Applicants of higher education were considered to have a high level of reflection if they scored 150-113 points. Sufficient level of reflection was inherent in higher education students who were diagnosed within the range of 112-75 points. If higher education students scored 74-37 points, then they had an average level of reflection. 36-0 points characterized higher education applicants with a low level of reflection.

The last indicator of the future teachers' Self-concept development, the ability for self-assessment, was evaluated using the methodology proposed by V. Ternopilka. Those with a score of 0 to 25 were classified as having a high level of self-esteem. The sum of points from 26 to 45 testified to a sufficient level of the learners' self-esteem. The sum of points from 46 to 65 indicated an average level of self-esteem among them. The sum of points from 66 to 128 indicated a low level of self-esteem among applicants of higher education [26].

The diagnosis of professional and pedagogical value orientations was determined using the methodology of N. Maksymchuk. This technique was aimed at diagnosing such groups of values as: professional; status; personal; universal; material; self-improving; altruistic.

D. Lusin's methodology was used during the diagnosis of emotional intelligence.



The questionnaire was based on the interpretation of emotional intelligence as the ability to understand one's own and other people's emotions and manage them. The ability to understand emotions means that a person: can recognize emotion, that is, establish the very fact of the presence of an emotional experience in oneself or in another person; can identify an emotion, i.e. establish which emotion he / she or another person feels, and find a verbal expression for it; understands the reasons that caused this emotion and the consequences to which it will lead. The ability to manage emotions means that a person: can control the intensity of emotions, primarily suppress excessively strong emotions; can control the external expression of emotions; can, if necessary, arbitrarily evoke one or another emotion. Both the ability to understand and the ability to manage emotions can be directed both at one's own emotions and at the emotions of other people.

Determination of the future teachers's moral and volitional qualities was carried out according to the methodology of A. Vostrikov. The purpose of this technique is to identify the presence of students' strong-willed qualities, such as: determination – indecision; courage – fearfulness; initiative – lack of initiative; restraint – impertinence; self-control – lack of self-control; persistence – non-persistence; tenacity – lack of tenacity; independence – non-independence.

The diagnosis of the ability to overcome barriers in professional and pedagogical activity was carried out using interview and questionnaire methods, based on the research of I. Dychkivska [10].

It should be emphasized on the difficulty of using these methods, which consisted in the fact that most of these qualities or states (for example, flexibility of thinking, self-esteem, activity, cognitive interest, etc.) are hidden both for future teachers and observers.

The next stage of developing a mathematical model of the future teachers' professional development was the selection of a representative sample, which had to meet such requirements as: respondents should be representatives of the pedagogical profession; it is necessary to take into account the multifaceted requirements for both the process and the result of the professional activity of a modern teacher, since the availability of research on the features of the above-mentioned process can be judged only by the results, the respondents should study in the system of higher educational institutions.

Therefore, the general totality, as a set of all objects included in the study, were chosen out of the third- and fourth-year higher education applicants of the Institute of



Physical Culture, Sports and Rehabilitation of the State Institution «South Ukrainian National Pedagogical University named after K. D. Ushinsky» (specialty 014 «Secondary education (Physical culture)»; specialty 017 «Secondary education (Physical culture and sports)»; 56 people of the above mentioned specialties took part in the study.

Diagnosing respondents according to the specified methods and analyzing its results made it possible to obtain empirical data for constructing a mathematical model of the future teachers' professional development according to such stages as: standardization of the measurement apparatus; determination of the quantitative limits of the zones of manifestation of professional development according to each method: active, potential, passive; calculation of empirical values of the future teachers' professional development; building the level of multiple linear regression as a mathematical model of the future teachers' professional development; calculation of theoretical values of professional development and evaluation of the obtained level of linear regression; evaluation of the parameters of the mathematical model of professional development; identification of the quantitative limits of the zones of manifestation of the future teachers' professional development; ranking of factor characteristics and qualitative analysis of the model of the future teachers' professional development.

At the first stage, quantitative and qualitative analysis of the researched phenomenon was implemented – the professional development of the future teachers of physical culture due to the satisfaction of certain requirements, one of which is the standardization of the measurement tool. The basis of this requirement is the concept of the norm, since an individual assessment of the manifestation of professional development can be obtained only by correlation with the results of other respondents. Due to the standardization of the methods, it was possible to compare the results obtained from respondents using different methods and to express real test evaluations in relative indicators.

It should be emphasized that two forms of standardization are distinguished in psychological diagnostics, such as: processing and regulation of the procedure, unification of instructions and examination forms, methods of recording results, conditions of examination, characteristics of the contingent being under research; transformation of the normal rating scale into a new scale based not on the quantitative empirical values of the studied indicators, but on their relative place in the distributing the results of the respondents sample [7].



Based on the subject of the research, both forms of standardization were used, as a result of which their weighted average values were calculated for each respondent by all methods, which made it possible to reduce all test results to a single measurement system.

The next stage was the identification of passive, potential and active areas of manifestation of the future physical education teachers' professional development. To solve this problem, the method of determining root mean square deviations was used. At the same time, the results obtained by each of the methods were considered as values of discrete random variables X_1, X_2, \dots, X_9 . For each of these values, the mathematical expectation of their rates, as well as their mean square deviation, were calculated using the following formulas:

$$\bar{x} = M = \frac{\sum_{i=1}^n x_i}{n}; \quad \sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

where M is mathematical expectation; σ – mean square deviation; x_i – value of the observed characteristic; n – the number of observations [24].

Therefore, the passive zone of the manifestation of professional development (according to each method separately) includes the results of the examination of those respondents, whose weighted average values exceeded the value of mathematical expectation (M) by less than $0,5\sigma$; in potential – weighted average values ranged from $M - 0,5\sigma$ to $M + 0,5\sigma$. The results of the research on the professional development of the future physical education teachers, the weighted average values of which exceeded $M + 0,5\sigma$, formed an active zone. Note that, taking into account these values, for each of the 9 methods used, the number of respondents (in %), that were conventionally divided into passive, potential and active zones of manifestation of the future physical education teachers' professional development, was calculated. Those results are summarized in Table 3.

As we can see from Table 3, 18% of the total number of respondents fell into the active zone of pedagogical thinking, 32% into the potential zone, and 50% into the passive zone. According to the results of the diagnosis of the level of communicative skills and abilities, it was established that almost the same percentage of respondents was found in the passive (43%) and potential (45%) zones, and only 12% of respondents from the total number were in the active zone. After diagnosing the development of the future teachers' Self-concept, it was established that 58% of the total number of respondents showed motivation for success and fear of failure in the



Table 3 – The number of respondents by relevant areas of professional development (in %)

No	Methods	Passive zone	Potential zone	Active zone
1	Pedagogical situations	50	32	18
2	Questionnaire for determining the level of communicative skills and abilities	43	45	12
3	Motivation for success and fear of failure	9	33	58
4	Self-assessment of the level of ontogenetic reflection	34	40	26
5	The level of self-assessment	10	50	40
6	Groups of values	28	42	30
7	Determination of the level of emotional intelligence	35	62	3
8	Determination of moral and volitional qualities	38	47	15
9	The ability to overcome barriers in professional and pedagogical activities	30	56	14

active zone, 33% in the potential zone, and 9% in the passive zone; self-assessment of the level of ontogenetic reflection in the active zone was determined in 26%, in the potential zone – 34%, in the passive zone – 40% of the total number of respondents; the level of self-esteem revealed 40% in the active zone, 50% in the potential zone, and 10% in the passive zone (of the total number of respondents). According to the results of the diagnosing the value groups, it was established that 30% were found in the active zone, 42% in the potential zone, and 28% in the passive zone (of the total number of respondents). Determining the level of emotional intelligence made it possible to diagnose only 3% of respondents in the active zone, 62% of respondents in the potential zone, and 35% of the total number of respondents in the passive zone. Determination of moral and volitional qualities made it possible to diagnose 38% of respondents in the active zone, 47% of respondents in the potential zone, and 15% of the total number of respondents in the passive zone. The generalized results obtained by using interview and questionnaire methods show that the ability to overcome barriers in professional and pedagogical activity was diagnosed in the active zone by 14% of respondents, in the potential zone by 56% of respondents, and in the passive zone by 30% of the total



number of respondents.

Therefore, the distribution of weighted average values according to the active, potential and passive zones of the manifestation of the future physical education teachers' professional development revealed quantitative limits for the results of testing according to the above-mentioned methods, which is presented in Table 4.

Table 4 – Quantitative intervals of the detection zones of professional development according to the appropriate methods

№	Methods	Passive zone	Potential zone	Active zone
		Intervals		
1	Pedagogical situations	0 – 0,277	0,277 – 0,497	0,497 – 1
2	Questionnaire for determining the level of communicative skills and abilities	0 – 0,573	0,573 – 0,657	0,657 – 1
3	Motivation for success and fear of failure	0 – 0,402	0,402 – 0,474	0,474 – 1
4	Self-assessment of the level of ontogenetic reflection	0 – 0,38	0,38 – 0,498	0,498 – 1
5	The level of self-assessment	0 – 0,409	0,409 – 0,523	0,523 – 1
6	Groups of values	0 – 0,772	0,772 – 0,786	0,786 – 1
7	Determination of the level of emotional intelligence	0 – 0,702	0,702 – 0,736	0,736 – 1
8	Determination of moral and volitional qualities	0 – 0,36	0,36 – 0,546	0,546 – 1
9	The ability to overcome barriers in professional and pedagogical activities	0 – 0,124	0,124 – 0,180	0,18 – 1

According to the results of the regression analysis, the following regression equation was obtained: $Y = 0,07 \cdot X_1 + 0,145 \cdot X_2 + 0,077 \cdot X_3 + 0,17 \cdot X_4 + 0,144 \cdot X_5 + 0,137 \cdot X_6 + 0,092 \cdot X_7 + 0,055 \cdot X_8 + 0,11 \cdot X_9$, where the dependent variable Y is an effective sign of professional development of the future physical education teachers, that depends on many variables – factor characteristics X_1, X_2, \dots, X_9 , and influenced the use of multiple linear regression in the study. In the constructed model, the statistical reliability of the results is provided, since the condition is fulfilled: $n \geq 3(m + 1)$, where n – the number of observations (56), m – the number of factorial features (9). In our case – $56 \geq 30$. According to this, we have a standard error of $S=0$, which indicates the accuracy of the valuations.



The general quality of the linear regression equation is revealed by the value of the coefficient of determination, which determines the destination of the general dispersion of the resulting characteristic Y according to the regression equation –

$0 \leq R^2 \leq 1$. That is, the closer R^2 is to 1, the better the linear regression equation explains the behavior of the outcome characteristic Y . Considering Y as a linear function in regard to the variables X_n , its smallest and largest value in the interval $[0; 1]$ was found, namely: $Y_{\min}=0,07$ та $Y_{\max}=1$.

The next stage made it possible to take into account the intervals of change of each of the arguments according to the active, potential and passive zones of the manifestation of the future physical education teachers' professional development. Substitution of the limit values of the change intervals of each argument for the corresponding detection zone in the linear regression equation and the determination of the smallest and largest values among them made it possible to obtain the following: in the active zone $Y_{\min}=0,6644$; $Y_{\max}=1$; in potential: $Y_{\min}=0,5007$ and $Y_{\max}=0,6644$; in the passive zone: $Y_{\min}=0,2150$ та $Y_{\max}=0,5007$. So, the active zone of professional development manifestation falls on the interval from 0.6644 to 1, which is 19.64% of the total number of respondents. The values of Y , ranging from 0.5007 to 0.6644 indicate a potential zone of manifestation of professional development and indicate an insufficient level of formed qualities, motivation, thinking and skills inherent in pedagogical activity. Such respondents were found to be 52.79% of the total number. The values of Y in the range from 0.2150 to 0.5007 indicate the absence of the above-mentioned qualities and conditions that provide the future teachers' professional development, or their non-actualization. The results made it possible to state that 27.57% of the total number of respondents entered the passive zone of manifestation of professional development.

It should be emphasized that in order for the values of Y to fall into the interval from 0.6644 to 1, during the diagnosis of a certain respondent's professional development, it is not necessary that the corresponding values of all the factor characteristics X_1, X_2, \dots, X_9 fall into the active zone. This is explained by the fact that low values of some characteristics can be compensated by higher values of others, which in total provides the necessary value of the resulting characteristic Y in the range from 0.6644 to 1 and indicates the future physical education teachers' professional development.

So, the mathematical model of professional development makes it possible to further rank factor characteristics according to the levels of professional development



of the future physical education teachers and predict their degree of manifestation during professional training based on the values of the module parameters $\beta_1, \beta_2, \dots, \beta_9$. However, the analysis of the mathematical model of professional development makes it possible to assert that this process is a special state of the future teacher personality, which is based on its natural properties and represents consistent by time, methods and results of actions in pedagogical activity. On the other hand, this model provides an opportunity to determine the criteria and indicators that affect the manifestation of the future physical education teachers' professional development, based on the analysis of external and internal factors.

Summarizing, we come to the conclusion that such results testify to the need and expediency of carrying out appropriate work on further purposeful development and personality formation of the future physical education teacher during professional development, based on the achievements of modern pedagogical science.

Conclusions

The conducted theoretical work made it possible to determine that professional development is characterized by content, activity and procedural directions of self-realization, which contributes to the development of motivation for learning, future teacher's internal and external self-organization, the ability to build a trajectory of self-learning, thanks to which he / she becomes the subject and product of constructing his / her own future activity.

Summarizing the results of the scientific fund analysis, it was established that the present time encourages teachers to constantly improve themselves, to realize the prospects of their own professional development, to make the most of personal intellectual abilities, to evaluate their own professional activity and its effectiveness, which, in turn, is closely related to their professional worldview, the level of formation of which has an external manifestation in motivation, communication, activity, behavior and emotions.

Theoretical analysis of psychological and pedagogical literature made it possible to establish that the result of the future teachers' professional development can be pedagogical culture, which acts as a sense-forming factor and is divided into such types as elite and mass, spiritual and material, national and personal, linguistic and thinking, informational, behavioral and communicative, reading, emotional and intellectual,



physical, etc. Considering the essence of the mentioned phenomenon, the functions of culture and the forms of its manifestation were analyzed. During the systematization of the scientific search according to the research subject, the essence and content of the concepts «model» and «modeling» were analyzed.

After analyzing the scientific sources from various fields of science, it was established: firstly, there are no principles that combine various tests into a certain system of adequate procedures for solving specific psychological and pedagogical research tasks; secondly, not all psychological properties can be investigated with the help of diagnostic apparatus both because of the complexity and ambiguity of the research subject itself, and because of the lack of adequate diagnostic tools.

The mathematical model of professional development contributed to the investigation of the internal component of the future teachers' personality and its external manifestation. Diagnosing the respondents according to the specified methods and analyzing its results made it possible to obtain empirical data for building a mathematical model of the future teachers' professional development according to such stages as: standardization of the measurement apparatus; determination of the quantitative limits of the zones of manifestation of professional development according to each method: active, potential, passive; calculation of empirical values of the future teachers' professional development; building the level of multiple linear regression as a mathematical model of the future teachers' professional development; calculation of theoretical values of professional development and assessment of the obtained level of linear regression; assessment of the parameters of the mathematical model of professional development; identification of the quantitative limits of the zones of manifestation of the future teachers' professional development; ranking of the factor characteristics and qualitative analysis of the model of the future teachers' professional development.

The perspective directions of scientific research require the development of educational and methodological recommendations and technologies for the formation of the internal component of the future teachers' professional development in the conditions of university education.