
Fractal Pedagogy: Information Models

Gulshan Qayumova^{1*}, Saida Beknazarova², Shaxislam Joldasov³, Botir Bazarbayev⁴

^{1*,2,3,4}Tashkent University of Information Technologies named after Muhammad Al- Khwarizmi, Tashkent, Uzbekistan

Corresponding Email: ^{1*}gulshan.kayumova@mail.ru

Abstract: This article presents the theoretical and methodological prerequisites for the formation and development of fractal pedagogy. In addition, the scientific justification of the principles of fractal pedagogy, its features and principles are considered and given. The result of the research is to determine the structure of personal and professional self-development of the teacher (motivational, design, activity-practical, reflexive, emotional volitional components). The presented research is considered as a variant of understanding the problem of personal and professional self-development of a teacher from a new perspective. Fractal methodology applicable to the problem of self-development of the teacher can be the Foundation for various psychological and pedagogical research in their perspective. Fractal pedagogy allows a different interpretation of the main categories of modern educational methods: teaching, education, self-education, upbringing, self-education, development and self-development, including the concepts of “creative activity” and “self-organization of behavior and activity”. The implementation of the model of assistance in education, taking into account the needs and personal potential of the educational process, allows participants in the educational process.

1. Introduction

Self-development in a rapidly changing socio-cultural environment is one of the main compensations since an actively developing specialist is able to meet the modern problems and new requirements of the professional environment. Philosophical understanding of the problems of our time allows us to formulate this article: all that is known about the future is not known how it will be. In this regard, it is necessary to train a specialist to act in conditions of uncertainty. The effectiveness of solving non-standard tasks under constantly changing conditions is directly related to the process and results of personal and professional self-development.

Digitization of society and the emerging global information network fundamentally change the processes of personal development and self-develop define their characteristics and dominant vectors. Self-development of the teacher takes place in the macro-system of integrated education environment - the macro-system of interaction microeconomics, opportunities and interpretations. The process of personal and professional self-development of the teacher in the conditions of the educational system is fractal in nature.

The purpose of scientific work. Identification of the methodological bases of fractal organization of the process of personal and professional self-development of the teacher in improving the modern educational process, development of fractals classification, self-development process.

In modern environmental conditions, there is an opportunity to consider the teacher's self-development problem in a new way, to determine the prospects of the teacher in modeling and designing the process of personal and professional self-development [15, 8-9].

The brief analysis of the scientific works of other scientists on the topic. The self-development of the teacher should be based, first of all, on the content of motivating changes and the implementation of this process. The notorious psychologist V. Frankl considered the desire of a person to seek and realize the meaning of his life as a characteristic motivational feature for all people. V. Frankl argued that it is impossible to give meaning, it is necessary to find it. Having understood the meaning, a person realizes himself: “the self-realization of a person occurs on his own—not as a goal, but as a result of the realization of the meaning”.

Fractal (Latin fractious - crushed, broken, broken) is a geometrical form, in which a certain part is repeated repeatedly with changes in size. Researchers of this new field believe that the father of the theory of fractals is Frank-American mathematician professor Benue Mandelbrot (born in France). In the last decade of the 1960s, Mandelbrot called his scientific work “fractal geometry” or “nature geometry” (about which he writes in his work “fractal geometry of nature” - “The fractal geometry of nature”). The purpose of fractal geometry is the analysis of broken, twisted and irregular shapes. B.Mandelbrot used the word fractal for these forms, consisting of fragments and parts.

B.Mandelbrot other scientists Clifford A.Pikkover, James Gleick or G.O.Peytgen developed the field of fractal geometry, that is, from predicting the prices of securities in the market to the practical application of them all over the world, to the fulfillment of new discoveries of Theoretical Physics [2-3].

Fractals are often used in science. The main reason for this is that it very accurately describes the existence in relation to traditional physics or mathematics.

The scientific essence of the article. Fractal in general terms is a structure in which the main properties are self-similarity and repeatability, that is, fractals are collections that have self-similarity. Self-similarity is expressed by the presence in the general form of a replicated element—a fractal (self-similar structure). In other words, the Fractal can be defined as an infinitely similar geometrical form, each of which is repeated with a reduction in the fraction. Thus, the tree horn is similar to the tree itself, so the tree has a fractal structure. Fractals are one of the subjects of the study of synergetic, it examines complex self-organizing systems, and the researcher needs to be structured in order to initially perceive the object under study as a fractal structure coral, starfish, shells, flowers, bronchi, blood vessels, nervous system and many other living nature objects have a clear fractal structure. A vivid example of this is the program of hereditary development, which is absorbed into the genes and is included in the composition of all cells, each of which can multiply the whole organism, similar to the original one. Chemical elements that change their properties depending on the charge of molecules and atoms, their atomic nuclei, crystal lattice and chemical bonds are fractal in their essence. Clouds, seashores, lightning, snowflakes, frosty patterns and other inanimate phenomena are also fractals [3].

Different science based on fractal methodology is based on the similarity of social systems at different levels in research, cyclical nature of trends and the legitimacy of events are examined, socio-political and other fractal models are developed.

2. Materials And Methods

Fractal multiplies itself in these objects at each subsequent level on a smaller scale. Many natural objects are distinguished from ideal fractals by the fact that the structure is not repeated and inaccurate; in this sense, natural structures are quasi-fractals. To the greatest extent, fractal ideas are used precisely and in natural sciences. But the feature of similarity is possessed not only by fractal mathematical collections and natural objects but also by socio-cultural phenomena. It is known that currently, fractals are widely used in computer graphics, physics, and various other natural sciences, as well as in the design of antennas in radio engineering, in the processing of signals in telecommunications, as special effects and visualization elements in film and television, in the light industry, in the drawing of patterns for modern designs on fabrics and carpets, etc. In other words, fractals exist everywhere [1].

The principle of fractality is attributed to many social processes, in this sense it is possible to characterize any side of life on the basis of fractal nature. Examples of the Fractal Organization of socio-cultural systems: words, texts, music, patterns, Russian houses and the architecture, cities and neighborhoods in them. The multifaceted nature of the objects, phenomena and systems in the list emphasizes that fractal art contains everything. To characterize the disproportionate fractal of socio-cultural systems and objects, we use the term “conceptual fractal”. The conjugal fractal is expressed in the form of socio-cultural practice in the conditions of a particular culture. The similarity of the conjugal fractal itself is revealed at the level of concepts, ideas, conceptions, mental constructions, configurations, as well as relations between them. Conceptual fractal self-multiplying at all levels and scales of a certain degree of structure. In such a structure, the concept fractal is the creator algorithm of the organization. On a global scale, one can argue that the whole socio-cultural world is a congestive fractal.

The idea of fractals in technical sciences is not a novelty. Hence, in different science based on fractal methodology, different levels on it is based on the similarity of social systems, the cyclical nature of trends and the legitimacy of events are considered, socio-political and other fractal models are created.

The methods used in the study. The study of the process of personal and professional self-development of the teacher in the modern educational process is based on fractal methodology. In science, this methodology is used in the study of objects characterized by instability and randomness of connections between structures and components. The philosophical and methodological basis of the study is the fractal and chaos ideas in the dynamical systems, while fractal and randomness are regarded as a single integral process (Fig. 1).

When we talk about the Fractal methodology of the process of personal and professional self-development in the improvement of the modern educational process, we understand the set of ideas and worldview positions that underlie the personal and professional scientific and pedagogical development of the teacher based on the consideration of this process from the point of view of the theory of fractals. The leading approach to the study of fractal Organization of the process of personal and professional self-development of the teacher in the modern educational process is an integrated-ecological methodological approach. This approach allows to better understand the essence of fractal Organization of self-development of the teacher in modern environmental conditions [3].

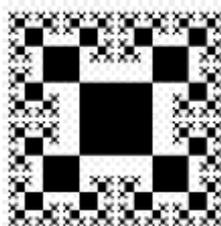


FIGURE 1. Recursive algorithm of fractals.

Building the scientific concept of "fractal pedagogy", we were based on the philosophical positions about man as a bio-psycho-socio-cultural existential phenomenon (Aristotle, E. Huserl, G. V. Leibniz, A. E. Kazachinsky, M. Mamardashvili, F. Nietzsche, V. I. Slobodchikov, V. N. Sagatovsky, V. Frankl, M. Heidegger, etc.), the investment theory of creativity (R. Stenberg, T. Lubart, etc.), theories of self-organization (V. I. Arshinov, V. G. Budanov, M. G. Gapontseva, E. N. Knyazeva, S. P. Kurdyumov, V. S. Stepin, N. M. Talanchuk, V. A. Fedorov, I. R. Prigozhin, G. Haken, etc.), theories of fractals (V. E. Voitsekhovich, B. Mandelbrot, V. V. Tarasenko, S. D. Khaytun, etc.), noospheric (G. M. Komarnitsky, N. V. Maslova), health-creating (V. V. Kolbanov, A. G. Majuga, N. N. Malyarchuk, I. A. Sinitsina, G. Spencer, L. G. Tatarnikova, S. Frenet) and holistic types of education (Sh. A.Amonashvili, A.V. Voznyuk, L. S. Vygotsky, A. Maslow, J. Miller, M. Montessori, K. Robinson, I. Pestalozzi, Plato, K. Rogers, J. J. Rousseau, A. I. Subetto, F. Froebel, R. Steiner, etc.).

The essence of the integrated environmental approach lies in the holistic combination of different components that were previously separated. The integration-ecological approach is based on the understanding of the unification of the educational environment as a unit of their diversity, thereby creating a new object with the emerging qualities and potential opportunities of the elements, their relations and relationships. In the research presented in the article, pedagogy is also used in the connection of Science with social (psychology, philosophy, etc.) and technical sciences (computer graphics, engineering graphics, etc.). The methodological basis of such a connection between technical and Social Sciences, in particular pedagogy, is an integrated environmental approach. The establishment of such a relationship is qualitatively different; at a high level it allows the teacher to substantiate the use of fractal methodology in the study of personal and professional self-development. In obtaining the results of the study, scientific methods such as analysis, synthesis, abstraction, generalization, classification and others were used.

The advantages of fractal pedagogy are that it is possible to name a number of important positions, as a result of which it will be possible to consider in a new way the process of bringing socio-cultural experience in the educational system from the teacher to the student. First of all, fractal pedagogy allows a different interpretation of the main categories of modern pedagogy: teaching, education, self-education, upbringing, self-education, development and self-development, including the concepts of "creative activity" and "self-organization of behavior and activity". The implementation of the model of assistance in education, taking into account the needs and personal potential of the educational process, allows participants in the educational process to feel solidarity with themselves and the world, to ensure the design of effective joint dialogues of activities in which they can express their personality (Fig. 2).

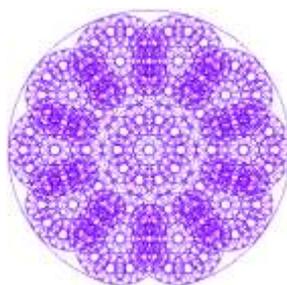


FIGURE 2. Recursive algorithm of a fractal graph.

The use of fractal pedagogical principles in the teaching of computer graphics science is one of the important factors in the teaching of science to students and in the assimilation of students. In this regard, we will develop a method of teaching using the principle of nonlinearity in mastering the topic "geometrical substitutions".

Using the principle of non-sterility of fractal pedagogy, the section of geometrical substitutions in computer graphics science, we will develop new pedagogical technology in the form of a tree-like fractal (Fig. 3).



FIGURE 3. Tree-like fractal.

3. Results And Discussion

Reflection is a component of activity. The activity carried out due to reflection is reflected in the internal plan, which is the material for observation, criticism, or modification of the subject. Reflection allows improving human activity not only internally, but also externally. Also, reflection gives a person the ability to analyze, observe and rethink his or her predestined-social relationships with the outside world as an important component of the developed world.

Classification can distinguish two-stage activities of educators in educational technology:

- manages the educational activities of the educator in the first step;
- the second step will be the subject of the educational process of the educational recipient. In this he enters the reflex activity. He independently (without the help of the teacher) develops goals, functions of activity, methods of action.

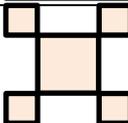
This means that the main goal of the principle of optimization of reflexive interaction is achieved by reflexion of its activity. The realization of the task of self-development contributes to the realization of internal motivation, the awareness of close and distant goals, as well as to the realization that they are subjects in their own life activities, etc.

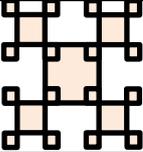
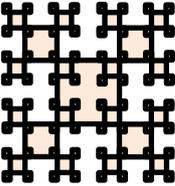
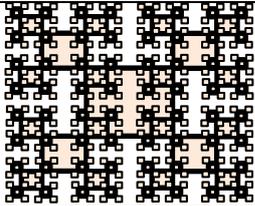
Through the use of the reflexive principle, educators move away from traditional thinking and better master the Educational Sciences. The task of the educator is to activate the reflexive activity of the students, teach them to look at their behavior from the outside, as well as to influence the motivation of the students in relation to knowledge, to teach them to see the prospects of professional and personal development.

The purpose of the article is to develop a new pedagogical technology, introduce it and increase the effectiveness of education in the organization of practical training on the subject of “projection” of the science of “Computer Graphics” through the productive use of the reflexive principles of fractal pedagogy.

When applying the principle of optimizing the reflexive interaction of fractal pedagogy, it is worthwhile to use the recursive algorithm of fractals (Table 1).

TABLE 1. Information model of the principle of optimization of reflexive interaction

	0-step. It is envisaged to give a general theoretical understanding so that students in science can learn independently with the aim of forming knowledge and skills and perform tasks independently.
	Students will be given theoretical information. By conducting a question-answer on the subject, the level of knowledge of the students is determined and the next step is taken.

	<p>1-step. In order to organize education in individual and group forms, students in the group are grouped according to their level of knowledge. Each group consists of students with high, medium and low levels of knowledge. Groups are named.</p>
	<p>2-step. Assignments are assigned to groups in order to direct students towards support that reflects their cognitive activity. The given assignments will be easy, medium and complex with a level of difficulty. Assignments are performed by group members together and they are given time to complete them. After the assignments have been solved by the groups themselves, each of the group members gives an understanding of the assignment from one to the other groups. Tushun the level of knowledge of the students in the process of giving insight and the difficulty level of the assignment is considered. The rest of the groups work the same way.</p>
	<p>3-step. In order to direct the optimal use of the means of reflecting the student's cognitive activity, the tasks performed by each group are summarized, each method is supported in simple and complex examples and the overall result is achieved.</p>

At the formal-semantic level, fractal self-development (self-development, self-management, self-introduction, self-organization, self-regulation and other components of the self-management system) can be identified. The concept of "self - " introduces the following concepts into complex concepts: the direction of the action in relation to itself; the involuntary, independent execution of the action. For example, a modern teacher has the quality of self-management and is the initiator of a continuous independent educational movement [6].

It is possible to use a fractal-resonance approach based on the main stage of the Fractal developing system and the concave position, which is considered as a process of network, fractional, similar transition state.

The fractal resonance approach, in turn, is based on several principles.

- Dynamic chaos principle (geometrical representation of chaotic dynamics);
- The principle of uncertainty of borders (unevenness, uncertain miningturlar);
- The principle of uniqueness of measurement (decimal metric measurement);
- The principle of continuity of formation (the method of development and self-development);
- Hierarchical principle of an organization (similarity);

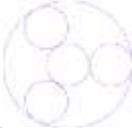
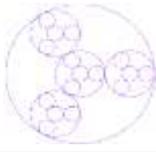
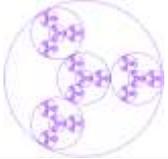
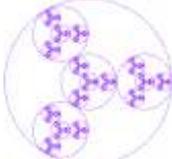
The methodological basis of these principles is the theory of self-organization, the theory of temporary processes, the theory of developing systems, the theory of fractals (V.I.Arshinav, V.G. Budanov, V.E. Voytsexovich, E.N. Knyazeva, S.P. Gordyumav, B. Mandelbrot, I. Prigojin, G. Khaken and others). These theories serve as a scientific basis in the development of human-dimensional strategies of social evolution, social development in conditions of high uncertainty and inconsistency of information.

It is desirable to give a brief description of the main components of the network model of the educational process as a multidimensional scheme of the spatial theory - the spatial construction of objects that exist at the same time.

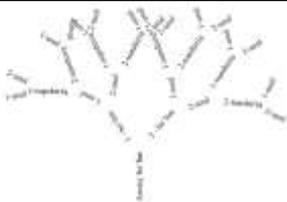
The complete resonance interaction of fractal pedagogy is an information model using the recursive algorithm of fractal graphics, table 2.

TABLE 2. Information model of the principle of resonance interaction

<p>k-the number of students in the Group $k=2,3,4,\dots$, a-the number of theses, n-the number of steps, m-the number of assignments, t-total time of execution of assignments, t_1,t_2,\dots,t_m – the time given to master each assignment</p>	
<p>$n=0, k=3, t=40\%$</p> 	<p>0-step. Theoretical information is given to students by the teacher</p>

<p>n=1, k=3, t=5%</p> 	<p>1-step. Strengthen the subject, determine the thesis on the surface of the subject, determine the software.</p>
<p>n=2, k=3, t=10%</p> 	<p>2-step. Associate lecture sessions with practical and laboratory classes, apply the learned theses, work independently in the performance of assignments and associate them with the field of specialization.</p>
<p>n=3, k=3, t=10%</p> 	<p>3-step. Work in partnership. Group work, summarizing the results of structural assignments in the performance of a single task based on individual work.</p>
<p>n=4, k=3, t=10%</p> 	<p>4-step. Test the completed assignments, work on submission errors, get resonance from the whitelist.</p>
<p>n=m, k=3, t=5%</p> 	<p>n-step. To fully master the thesis on the subject, to obtain accurate results for the given tasks, to formulate professional knowledge, to evaluate the knowledge acquired by the teacher.</p>

Through the use of the reflexive principle, educators move away from traditional thinking and better master the Educational Sciences. The task of the educator is to activate the reflexive activity of the students, teach them to look at their behavior from the outside, as well as to influence the motivation of the students in relation to knowledge, to teach them to see the prospects of professional and personal development.

	<p>5-step. The parts that are appropriate and incompatible with the purpose of the teacher will be considered. After the subject is explained with the help of examples, science is linked to its relations and professional activities. Each link will be shown in Method 2 again and students will be given time to complete their assignments.</p>
---	---

Through the application of the principle of the imperfection of fractal pedagogy, the topic of geometrical substitutions is taught to students in a sufficiently understandable way. This requires the teacher to go through self-professional and personal development. It is important for students to be able to quickly master in the group to be able to show solutions to any complex case studies and to come up with modern examples. The teacher will face many difficulties in teaching students with a high level of knowledge if they are not self-professional and personal developmenttirib. Self-assimilation even in the teaching of sluggish students, the teacher must self-develop. It is necessary for students to have the ability to deliver in an understandable language.

4. Conclusion

In the place of the conclusion, we can say that the reflexive principle is based on the technologies of mutual respect and education and pedagogical cooperation, independently solving practical problems by mastering the

required volume and preparation for the chosen professional direction of the content of the educational program, developing self-education skills, organizing the activity itself, creating a creative approach and trust. The most important thing is that in the educational activity of the student, self-awareness, self-management, self-control skills serve as the basis for the content.

5. References

1. V.S. Lednev Material and technical base of the system of continuing education and factors of its development. Methodology of theoretical and experimental forecasting of the development of secondary school educational institutions. - M.: RAO. 1990. - 317 p.
2. P.S. Lerner To the teacher about engineering and technical design. School and production. 1999. - No. 2. - pp. 21-23.
3. A.A. Makarenya Cultural environment: status, structure, functioning. - Tyumen: TOGIRRO. 1997. - 65 p.
4. Pedagogical Encyclopedia. Vol. 4. - M.: Soviet Encyclopedia, 1968. - 911 p.
5. N.A. Scarecrow From devices to complexes, from complexes to systems. Public education. 1997. - No. 10. - pp. 81-84.
6. E.N. Yastrebseva The concept of the development of the educational and material base of the school media library. - M., 1990. - 19 p.
7. S. Beknazarova, N. Latipova, J. Maxmudova, V.S. Alekseeva, Filtering of digital images by the convolution method. International Journal of Mechanical Engineering, 2022, 7(1), p. 1182–1191