Chapter 20

NEW METHODS OF TEACHING: INTERDISCIPLINARITY APPROACH AND MATHEMATICAL MODELING*

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ABSTRACT
Every epoch has its own specific style of education connected with contemporary instruments and tasks. The problems of our civilization differ from the ones of the previous epoch very much and demand new approaches in educational technologies. The situation in the Educational field now is the following: it is divided into many parts of special disciplines. It is useful for learning, but in real life we deal with complicated systems and complicated problems. To find solutions to such problems we need to unite specialists from different specialties and fields of knowledge. In this chapter we want to discuss the preparation of students for interdisciplinary methodology during educational processes. The best way is to use mathematical modeling and we are using new methods of modeling connected with a synergy approach. We are also discussing the creation of the methodological base for using it in education.

Keywords: mathematical modeling, interdisciplinary approaches, new methods of teaching, synergetic, business game.

1. INTRODUCTION

The main periods of European culture taken into account are antiquity, medieval centuries, modern history, XX century, and contemporary times. Each period has common features from a philosophical point of view. Russian philosophical tradition describes the beginning of every period as a creation of a World picture or a philosophical model of an entire World. The middle time creates understanding of a human being and the last one looking for a social processes and ethic norms for a person in the society and for the society (Motroshilova, 1995-1999). Mathematical modeling lets us see the main properties and structures of social processes. European culture and education have very deep connection with antiquity and are based on its traditions. Antiquity is a background of European cultural history.

The tradition of European Education goes as far back as Euclid. Mathematics was one of the fundamental disciplines, but the knowledge was interdisciplinary. Plato discussed ethics, aesthetics, and harmony of the world and how to describe them all by mathematical methods with his students. As exemplified by the sign placed above the door of Plato's Academy: "Let no one ignorant of geometry enter here (ἀγεωμέρήτος μηδείς είσίτω)". Interdisciplinary approaches are combined in philosophy knowledge and in hierarchy picture of World.

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Despite of the first classification of science made by Aristotle in the 5th century BC, real serious division of science was made in the beginning of 18th century after the science revolution. As the result of this division, great sociologist August Comte concerned application of mathematics in chemistry as harmful. He explained the destroyed effect of mathematics implementation because it contradicts to the spirit of chemistry. According to his opinion, every person and every scientist must only deal with their own job and their own part of science. Ideals of Plato, Aristotle, Leonardo da Vinci, Newton, and Leibniz seemed forgotten in this approach. However, there are examples in the European history when people tried to return to interdisciplinary ideals of Antiquity and we can observe the blossom of science and social life. Renaissance of the 12th century contains the attempt to return to antiquity ideas based on the interdisciplinary approach; and the same effect we can see in the Classic German Philosophy of Emmanuel Kant and Georg Wilhelm Friedrich Hegel. Now we have the same situation when it I necessary to return to ideas of interdisciplinarity. The base of them is applied mathematics approaches with using mathematical modeling. We call them synergetic.

1.1. Focus of the chapter

Changing educational approaches by interdisciplinary in the correspondence with new challenges is the main idea of this chapter. Every time we see the changing of a character of education between periods of history. The process of changing strategic goal of Education leads to changing educational methodology and it causes a crisis in education every time. Now we experience the same situation of changing epochs and technical modes so we can see new methodology and new methods of solving new tasks. Regarding the interdisciplinary point of view, new ways for educational methodology are found. We have revealed that the most of problems and tasks for our civilization from local to global scale have interdisciplinary character now.

2. CONTEXT

The research of educational processes from historical point of view (Malinetskiy & Kapelko, 2013) and contemporary situation in Russia have been the main points of our work during the last few years. We research school and higher education processes in Russia in special projects supported by some grants (Malinetskiy & Podlazov, 2011). We have studied education as a basic requirement to increase skilled personnel in several research projects: ‘Interdisciplinary investigation of global processes social foundations and new paths for global problems solution’ of Russian Foundation for Basic Research, and ‘Interdisciplinary analysis of innovative strategies and processes of modernization’ for Russian Foundation for Humanities. One of the previous projects, ‘Complex systems analysis and mathematical modeling of world dynamics’, has been implemented in the program of the Presidium of the Russian Academy of Sciences ‘Economics and Sociology of Knowledge’. The project was completed under the direction of the Rector of Moscow State University, V. A. Sadovnichiy. It has been established that many disasters, wrong decisions and problems have occurred because of lack staff able to cope with these situations (Sadovnichiy, Akayev, Korotaev, & Malinetskiy, 2011). As a result we investigated the necessary changes in education and formulated our point of view.

3. BACKGROUND

The new epoch demands new interdisciplinary approaches. Now we face many problems. Studies and modeling of different social processes for educational purposes was conducted over last several years in our Institutes. We pay special attention to the destructive social processes and different ways for modeling such processes. We study methodology of implementation mathematical models for educational purposes. The mathematical and methodological basis of the project is the theory of self-organization, or synergy. Some articles and books in Russian cover the field of the mathematical modeling of social processes and education and using abovementioned for staff trainings in business games (Vasilenko & Vronska, 2010).

Our experience is also related to the system analysis on macro-level base of the state, system trends and problems of Russian education. These studies were carried out by the Ministry Education of Russian Federation. One of these results is the system of mathematical models is describing Higher education in Russia

4. METHODS

There are special tools such as the research of social and educational policy documents, Site of Ministry of Education of Russia, results of mathematical modeling of global processes and mathematical modeling of social processes in specific situations, as well as personality and building learning strategies. We have used mathematical models specially designed for business games in Public Administration area with interdisciplinary approach for our students and educational process.

The discussion is based on data triangulation – mathematical models of human and global trends along with a literature review, first hand experience in the modeling of social processes and using this models for educational activity. We have designed special methodology for implementation modeling in the process of business games decision making.

5. RESOURCES

This investigation was undertaken with our colleagues under the auspices of the Russian Presidential Academy of National Economy and Public Administration, under the President of Russian Federation (Department of the Project Management) and on the basis of Keldysh Institute of Applied Mathematics the Russian Academy of Sciences (Department of nonlinear processes modeling).

6. CHANGING OF WORLD DYNAMIC OF GLOBAL POPULATION

Global transaction is one of the reasons of changing social and educational processes now. Contemporary life is changing rapidly. In fact, we live in a watershed era. This situation is close to Neolithic revolution when people had to change their life, the way of consuming and social structures cardinally. It is a new epoch-making discovery.

Mathematical modeling helps us realize the tendency of social dynamic. We experience unprecedented changes on an enormous scale. The English clergyman and scientist Rev. Thomas Malthus in 1798 wrote that a population under favorable conditions grows in accordance with the law of geometric progression: by the same number of times

over the same intervals. This law stands true for the growth in the numbers of animals of different species in a situation in which there are sufficient resources.

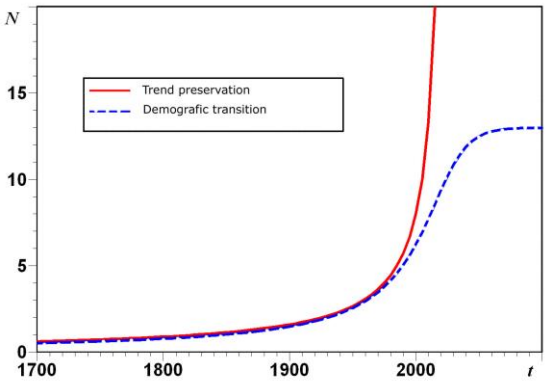
$$\dot{N} = \alpha N \qquad \Rightarrow \qquad N \sim \exp(\alpha t)$$

However, this has not proven applicable to humans. Studies conducted by paleodemographic scientists and systems analysts have shown that throughout human history the population has increased along the time axis in accordance with hyperbolic law. The asymptote for the hyperbola is 2025 (Vasilenko & Vronska, 2010).

$$\dot{N} = \alpha N^2 \qquad \Rightarrow \qquad N \sim \frac{1}{t_f - t} \qquad t_f \approx 2025$$

Had the law remained constant, by that time there would be an infinitely high number of people (Figure 1).

Figure 1. The law of growth in the number of people



Within the generation now living, the law has changed (Kapitza, 2006). We can observe a sharp deceleration in population growth. Scientists call this phenomenon a global demographic transition. It takes only 90 years and during this interval – 1/50000 of human history – a fundamental change in the mode of growth of mankind will happen.

The Keldysh Institute of Applied Mathematics and other organizations predict global population will stabilize at approximately 10-12 billion. The scale of the difference in demography, and hence economics and energy, can hardly be overestimated. The difference between the previously plotted trajectory and the current one has already reached more than 2 billion people.

7. CHANGING EDUCATION WITH INTERDISCIPLINARY APPROACHES

Traditional education system was created for existence in a slow time. Now we live in a “fast” one, with other quality of characteristics of the time perception and the everyday life perception. The very existence of modern society (not to mention its development) is critically dependent on responsible, professional, creative people. So it is important now to add such competence to educational process and methodology to reach it.

With our students we are using new educational technology for group work and teaching organization process. It helps to use interdisciplinary approaches inside the education. Another moment is using the mathematical modeling of destructive social processes to clear the situation in this area. This modeling became the base for business games for making decisions. The main approach is interdisciplinary or synergy as a way of description through mathematical modeling different systems. Our students have to know how to choose the way of modeling system. There are several ways for modeling that we can be implemented in educational process. The most difficult is imitation modeling where we have to consider tens and hundreds of parameters for every process. But mostly we need very few parameters to see the tendency and the result of the process. Another way is the soft modeling and we are using 5-6 order parameters to see main trends and tendencies and discuss them with our students. Most simple is cognitive modeling when we do not have good data base. Using modeling of educational process we can see same moments and find new technology for solving educational problems.

8. MAIN INTERDISCIPLINARY STRATEGIES OF EDUCATION

We will provide three examples showing alternative interdisciplinary ways of education methodology created with modeling (Malinetskiy & Kapelko, 2013). All of them were created as a result of our investigations. The first one has to do with teaching a number of medical techniques specifically, diagnosing a few rare diseases (for which there are insufficient statistics) which are nonetheless dangerous. One example is an experienced physician who achieved considerable success in treating this disease. His experience cannot be verbalized, formalized or passed on using traditional means. Therefore his students have to (in a manner which is customary in the East) “feel the spirit of the teacher” by observing him at work, following his actions and knowledge, until intuitively they learn how to do something similar. For some it takes 5-7 years, for others 10-15, for others a lifetime is not enough.

The problem is that for a number of illnesses, according to the opinion of leaders and standard books, one should take into account 300 to 1000 signs and parameters of the test results. At the same time according to psychology investigation a person can act with certainty when 5-7 of those key parameters are present (order parameters in terms of synergetic). A successful experienced physician in the course of his professional life will isolate those parameters within the space of a huge dimensionality. His younger colleagues would not be able to do that yet.

In order to single out the parameters with respect to the order of magnitude and separate the most important from the secondary, mathematicians can help. At the Keldysh Institute of Applied Mathematics under the aegis of the Russian Academy of Science in the science school of Academician Gelfand, the method of “diagnostic games” as a direction of business games was proposed in order to resolve this problem. The methodic was the next. The mathematician sees the patient’s history, the progress and outcome of which are already known. The mathematician asks the physician to provide the diagnosis. Based on the questions asked by the physician and the point at which the situation becomes clear to him and he is ready to prescribe the treatment, it is possible to realize what criteria are most important, and what is taken into account. This latent personal knowledge (revealed with the help of mathematicians) could be incorporated into a computer based system for decision-making in training courses and books.

Utilization of this approach has made it possible to bring down mortality rates from a number of dangerous diseases by more than three times. We named that strategy “fire

starter". If there are specialists who possess the fire of knowledge, in specific situations this fire can be easily and effectively started by others. This method is famous in India as *shaktipad* from very ancient times. The methods of diagnostic games and computer technologies are very helpful for this purpose for contemporary times (Kotov, 2011).

However, in a number of cases there is no such specialist, and the knowledge for an individual or a team has to be developed in the process of learning. This situation happens particularly frequently in the process of concurrent optimization, using a number of criteria, or while searching for a compromise. In this case simulations or team-based computer games are helpful. They are indispensable in the process of designing complex systems and/or reaching critical management decisions (Akayev, Korotaev, & Malinetskiy, 2010).

This was first understood in the design of military equipment. A modern fighter plane entails a rational choice of over 1500 separate decisions. This is beyond the capabilities of one person, but is possible for a trained team. A simulation makes it possible to demonstrate to the team what happens as a consequence of the decisions it makes. What will the performance of the "virtual fighter plane" they design be in a battle with other machines (Moiseev, 1979). Later this experience was expanded to training for decision-making.

During the training of government officials it is possible to use different models and organize the work in a situational or cognitive center. This normally enables all the participants in the simulation, including the teacher or facilitator, to gain a better understanding of the problem and try on different roles in order to better understand one's true objectives, capabilities or limitations. It is much easier to make mistakes and correct them while ruling virtual cities and countries than make mistakes in the actual running of the country. We named this strategy "coming down to earth" from virtual reality.

The third strategy was tried out in a number of specialized Moscow schools with advanced curricula in mathematics: Schools No. 2, 57, 18, Kolmogorov Boarding School. Unfortunately, domestic school curricula are overloaded with details, particulars and secondary fragments. It comes down to "a little bit about everything, specifically about nothing". Those Russian schools took a different path: the best way to learn something is to discover it yourself. So both at home and in class students "rediscover" what was invented or discovered by Pythagoras, Euclid, Leonhard Euler and Newton, following along the path of the great scientists. And here the teacher has to take on the role of Socrates, asking precise questions, expressing doubt about the answers, directing the discussion and admiring the achievements of his students. As a result of this methodology, the students reach a "metalevel", they reach the summit: looking down from it, many specifics and details become obvious. These are schools that produce the highest number of winners of national and international contests in physics and mathematics. We named this method "Rodin's Strategy". The great sculptor believed that a true artist "simply" removes from a block of marble all that is extra, in order to create a masterpiece. A teacher needs to understand how to bring his charges to their greatest potential without getting distracted by the details: teach them how to create. There is a serious body of pedagogic tradition in Russia on which one could base solutions of similar tasks (Shklyarskiy, Chentsov, & Yaglom, 1965).

9. FUTURE RESEARCH DIRECTIONS

Need of changing educational way connects with demands of the Future life. Now the period of technological mode changing has started. The previous 5^{th} technological with Kondratiev cycles has finished. The 6^{th} technological mode is starting and it needs in other

types of specialists. The country that will be the winner in the process of preparing new specialists and developing the new mode will be the leader of Modernization and Globalization in the next period of the world history. The new technologies combine with interdisciplinary approach as an index of complication of social Systems and its goals. That's why changes in the education are so important nowadays and have to be new to correspond to the 6th technological mode. We have to realize what type of education is needed for the next technological mode. The base for the New Education could be interdisciplinary contest and self-organization approach according to the logic of evolution systems. Despite the increase of quantity of information we can use the way of self-organization – the "tsar way" for education and use the lows of existence complex social systems for receiving best educational results.

The proponents of the new approach present the comprehensive goal of discussing at a systemic level a broad spectrum of issues related to long-term use. A new vision of goals is needed in order to find an acceptable solution, taking into account new situation in the World. Focus on the interdisciplinary processes in modern education lets us see new goals and tasks of educational process. Conventionally, new education can be called an interdisciplinary or synergistic.

First, we shall argue that the base to the new approaches became mathematical social modeling. It creates new methods of teaching according to new demands.

Secondly, we shall show that the quality of education has to be changed too and we can control the process through the quality of education measurement. We should understand which standards have to be used as educational standards demanded for tomorrow. It is a very difficult process to find new standards and change the standards of education and here the quality can be helpful.

To describe new standards we need to realize that education is a product that creates future and will be needed tomorrow – not yesterday. It is necessary to understand the needs of the society, not only for today (which is already can be considered as the past for education), but for tomorrow. The quality of education needs to manage according to the strategic goals set for that society in which the quality is monitored. Moreover, we must not forget that the overall result of the educational process can only be seen in the future. As such, the quality of the product is the means by which we reveal the correspondence between the end product and a standard product (relative quality) or the ideal product – the absolute quality. This is particularly true for today, when the world is developing rapidly. If the 19th century may be called the century of geopolitics, the 20th century was the century of geo-economics; the 21st century can be the century of geoculture. Culture is becoming a strategic potential. Meanings, values, and a shared vision of the future have acquired fundamental importance, and are influenced by decisions made in politics, economics and education.

After all we shall argue that the cycle of the quality control in education is similar to the quality control of any management process (monitoring, forecasts, prevention, analysis, and planning) and we can study it from new positions. Here we see interdisciplinary features too. At the core of quality control of a management process is monitoring of the process on which we make forecasts, prevention, analysis, and final planning. Management tools here would also be quite traditional and relate to organization, finances, resources, human resources and information. As such, we can highlight the essential elements in the educational quality control such as:

i) System (it can be argued that education is constructed in a system way);

ii) Culture, which is the basis and a medium of social existence;

iii) Mechanisms of 'cultural transmission' of social customs, values, attitudes.

Interdisciplinary approach lets us use all the parts of the process in one field of educational knowledge and implement methodology for combining all parts in one wholeness or unity.

10. CONCLUSION

The chapter will conclude that the new aim for education is to prepare staff for solving new problems facing mankind in the 21st century. These problems have interdisciplinary character so and education has to receive interdisciplinary character too. The World has changed a lot with comparison to previous epochs. But education is a very inert process. Today we learn according to the past experience, so instead we must teach for the future needs.

Thus education get new dimension and quality of education became a new characteristic for all the process with monitoring from very beginning till the end.

For good results it is important to organize all-round complex approach to monitor the educational processes. This monitoring system of quality becomes now stimulus for educational institutions for maintenance of necessary educational level and improvement of quality of their educational programs. And finally, we will briefly discuss new approaches in education connected with interdisciplinary context. A lot of problems and risks of contemporary civilization get into interdisciplinary area and need proper specialists for solving them. We can recognize that our education today is in front of its cognitive limits and demands new approaches in future.

The paper concludes that in the USSR and now in Russia we have thought a lot about the future of education and have made many attempts trying to change it. This is interesting that everyone who knows about these educational problems is the key for the future.

Basing on mathematical modeling of the decision-making process in various fields it becomes clear which parameters play the most important role. Selecting order parameters allows us to design new technologies in education.

Experience that has been used for our results at the micro level is also connected with our teaching at the Academy of the National Economy under the Government of the Russian Federation (RANEPA) under the President of Russian Federation, MIRT, and the Moscow Higher Technical School (MHTS) named after Bauman, and with our participation in some international schools as well as workshops at Arizona State University, Riga State University and some other organizations.

As a result, our experience has shown that many tasks, problems and difficulties have hidden general systemic issues associated with the need to radically reconsider the content and style of education with the extensive use of interdisciplinary approaches (Malinetskiy & Podlazov, 2011).

If we all succeed in work out a new interdisciplinary or synergies education, the chances for successful evolution of humanity in the 21st century will increase.

School teachers' and college professors' complains on generality of study programs, fragmentariness and incompleteness of modern education rise sharply nowadays. Science and industry leaders complain about the acute shortage of competent, creative-minded researchers. These are the signs that people today come very close to the cognitive barrier. If we want to overcome this barrier we need to learn new ways of teaching to move from classical "Euclidean model" to a new interdisciplinary approach.

Future human being must be a creator and not an appendage to a computer or other machine. "Leave to human being humanistic and to machine cybernetics" father of cybernetics Mr. Norbert Wiener said. And now we have to convert this challenge into reality.

People who study now should feel confident in their education and should be able to create in all three spheres: rational, emotional and intuitive. Today we can draw desired contours of future education and further self-improving for the eternal students, artists, players of beads, according to the words of Nobel laureate Germany Hess.

In this chapter we argue that the goals of education should be changed and managed according to the strategic goals set for the society. Meanings, values, shared vision of the future have acquired fundamental importance. They are influenced by decisions made in politics, economics and especially in education. Conventionally, new education can be called multi-disciplinary or synergistic.

Inspiring examples of Russian pedagogies and researchers success can be very useful for our colleagues. And the most important issue is public awareness of contemporary cognitive challenges and responses to them that we can and must give. This will determine our common future. This will determine to what kind of history we open the door in the 21st century. We want our distant descendants estimate the age we live in (not as the beginning of the end but) as the beginning of new history of human civilization.

REFERENCES

Akayev, A. A., Korotaev, A. V., & Malinetskiy, G. G. (2010). *Prognoz i modelirovaniye krizisov i mirovoy dinamiki* [Forecast and simulation of crisis and global dynamics], Moscow, Russia: LKI.

Kapitza, S. P. (2006). *Global population blow–up and after: The demographic revolution and information society* (Report to the Club of Rome; Report to the Global Marshall Plan Initiative). Hamburg, Germany: Global Marshall Plan Initiative. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.132.3287&rep=rep1&type=pdf

Kotov, Y. B. (2011). *Novyye matematicheskiye podkhody k zadacham meditsinskoy diagnostiki* [New mathematical approach to the problem of medical diagnosis]. Moscow, Russia: Editorial URSS.

Malinetskiy, G. G., & Kapelko O. N. (2013). History of European education from Euclid to contemporary times: Moving towards cognitive limits as the foundation for education in the future. In P. M. Pumilia-Gnarini, E. Pacetti, J. Bishop, & L. Guerra (Eds.), *Handbook of research on didactic strategies and technologies for education: Incorporating advancements* (2 Vols., pp. 193-207). Hershey, PA: IGI Global.

Malinetskiy, G. G., & Podlazov, A. V. (2011). YEGE kak katalizator krizisa rossiyskogo obrazovaniya [Unified State Examination as catalyst of Russian educational crisis]. In V. A. Sadovnichy, A. A. Akayev, A. V. Korotaev, & G. G. Malinetskiy (Eds.), *Stsenariy i perspektiva razvitiya Rossii* [Scenarios and prospects of development of Russia] (pp. 234-287). Moscow, Russia: Lenand.

Moiseev, N.N. (1979). *Matematika stavit eksperiment* [Mathematics guides an experiment]. Moscow, Russia: Nauka.

Motroshilova, N. V. (Ed.) (1995-1999). *Istoriya filosofii: Zapad-Rossiya-Vostok* [History of philosophy: West-Russia-East] (Vol. 1-4). Moscow, Russia: "Greko-latinskiy kabinet" YU. A. Shichalin.

Sadovnichiy, V. A., Akayev, A. A., Korotaev, A. V., & Malinetskiy, G. G. (Eds.). (2011). *Stsenariy i perspektiva razvitiya Rossii* [Scenarios and prospects of development of Russia]. Moscow, Russia: Lenand.

Shklyarskiy, D. O., Chentsov, N. N., & Yaglom, I. M. (1965), *Izbrannyye zadachi i teoremy elementarnoy matematiki* [Selected problems and theorems of elementary mathematics] (3 Vols., 4rd ed.), Moscow, Russia: Nauka.

Vasilenko, L. A., & Vronska, M. I. (2010). *Vzaimodeystviye organov vlasti s institutami grazhdanskogo obshchestva* [The interaction of Public Administration with civil society institutions]. Moscow, Russia: Izd-vo Prospekt.

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