International conference
The Future of Education
2nd Edition

The Ways of Overcoming Cognitive Limits and New Opportunity for Future Education

G. G. Malinetskiy, O. N. Kapelko
IAM RAS; RANEaPA (Russia)
GMalin@keldysh.ru, olga.kapelko@gmail.com

1. Main focus

The drastic increase in human population and in the complexity of the social environment demands new educational approaches. At this stage, people have many new problems in their everyday life as a result of that quantity in complexity.

We now experience unprecedented social 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.

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

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. [2]

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

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

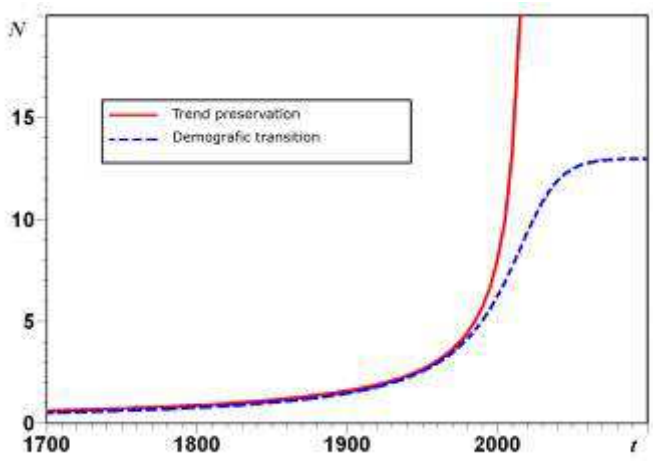

Figure 1. The law of growth in the number of people

It was shown by Sergey P. Kapitza, the law has changed. [1] There is a sharp slowing of population growth, which scientists call a global demographic transition. Kapitza predicts world population will stabilize at about 10 – 12 billion, we can see it on the Fig.1. The scale of the changes in demography and, hence, economics and education, can hardly be overestimated. The difference between the previously plotted and the current trajectory has already reached more than 2 billion people. This has an immediate impact on educational processes.

Figure 2 shows population growth in developed and developing countries in retrospect and prospect.

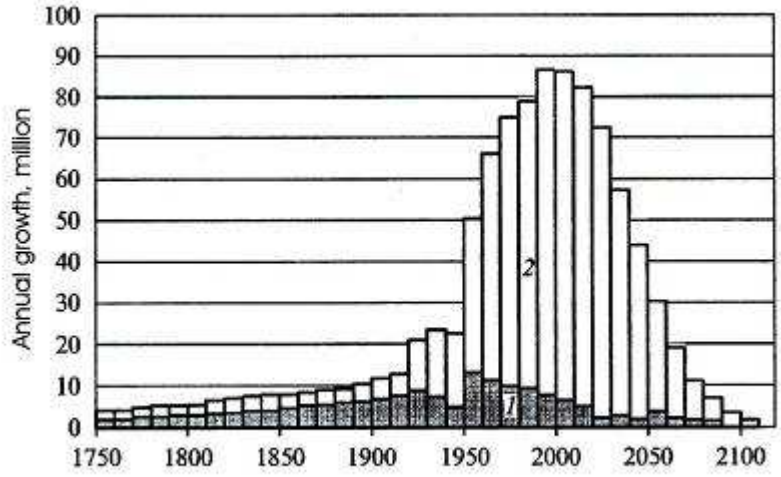

Figure 2 World demographic transition 1750 – 2100 [2]

Annual grow averaged over a decade. 1 – developed counters, 2 – developing countries.
We can see that in the very near future developing countries will have an overwhelming demographic bulge. This leads to the conclusion that there is a very high probability of a new global migration of peoples. It is an absolutely new situation with respect to educational needs. We have to survive most important educational information for the next generation in new conditions, when the population of developed countries cuts and population of developing countries grows.
Therefore, we can argue that humanity has been approaching its own cognitive limits through technological and social development, widespread use of information and telecommunications systems and computers. As such, modern culture understands cognitive limits as limiting conditions. For this reason we can say that human beings are now the weakest links in the management of technology for the future.
Today we learn about the past, so instead we must teach for the coming future. Is it possible to overcome the cognitive barrier using the educational system, and how is it to be done?
We will provide three examples showing alternative paths to resolve the problem.
The first one has to do with teaching a number of medical techniques specifically (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 young 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.
One example we provide is about an experienced physician who achieved considerable success in treating disease. The problem is that for a number of illnesses, according to the opinion of leaders and standard text books in the area, one should take into account 300 to 1000 signs and parameters of the test results. At the same time a person can act with certainty when 5-7 of those key parameters are present (order parameters in terms of synergetic). 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. The method of “diagnostic games” was proposed in order to resolve this problem. The methodic was the next. The mathematician has in front of him the patient 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 in fact 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. [3] We named that strategy “**firestarter**”. The methods of diagnostic games and computer technologies are very helpful for this purpose. 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 arises 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. [4] In this case simulations or team-based computer business games are helpful. Here a simulation makes it possible to demonstrate to any team what happens as a consequence of the decisions it makes.

Another area where this approach can be used is the training of government officials. 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 situation 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 errors in the actual running of the country. We named this strategy "**coming down** to earth".

The third strategy was tried in a number of specialized Moscow schools with advanced curricula in mathematics: Schools Nos. 2, 57, 18, Kolmogorov Boarding School.

Unfortunately, domestic school curricula are overloaded with details, particulars and secondary fragments. 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 the students "rediscover" what was invented 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. Students looking down from reached "metalevel" and many specifics and details become obvious. These are the 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.

2. Conclusion

In this paper we argue that the goals of education should be changed according to the strategic goals set for the society. Meanings, values, and the shared vision of the future have acquired fundamental importance. Conventionally, new education could be called multi-disciplinary or synergistic. If the nineteenth century could be called the century of geopolitics, the twentieth century could be called the century of geo-economics, and we hope to call the twenty-first century the century of geo-culture.

The human being of the future must became a creator and designer of social reality and not an appendage to a computer or some other machine. "The Human Use of Human Beings", father of cybernetics Norbert Wiener said [5]. Now we have to convert this challenge into our life.

The very existence of modern society (not to mention its continued development) is critically dependent on the presence of responsible, professional, creative people. Humanity now is undergoing a significant turning point (point at which historical processes change), and so new education and science must differ markedly from before. People who study now should feel themselves confident in their education, and should be able to create in all three spheres: rational, emotional and intuitive. Today we can draw the desired contours of future education and further self-improvement in the eternal students, artists, glass bead-game players, according to the words of the German Nobel laureate Hermann Hesse.

Finally we shall argue that in order to discuss the education we should understand which standards we have to talk about, especially what for the educational standards demanded for tomorrow. 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. 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. Education is a product which creates the future, which will be demanded tomorrow. It is necessary to realize the needs of society, not only for today, but for tomorrow. [6]

References

[1] Sergey P. Kapitza Global Population blow-up and after. The demographic revolution and information society. Sergey Kapitza, 2006, 236 p. Kapitza institute for Physical Problems, RAS. Moscow

[2] Merric T.W. et. al. Word population in transition. Population bulletin. 41(2). Population Reference Bureau, Wasingtom D/C/1991

[3] Котов Ю. Б. Новые математические подходы к задачам медицинской диагностики. М.: Изд. 2 Едиториал УРСС 20011, 328 с. (Синергетика от прошлого к будущему.

[4] Взаимодействие органов власти с институтами гражданского общества. Под общ. Ред. Л.А. Василенко М.: Изд-во «Проспект», 2010. – 280 с.

[5] Norbert Wiener The Human Use of Human Beings. The Riverside Press (Houghton Mifflin Co). 1950

[6] G.G. Malinetskiy, O.N. Kapelko Changing of educational approaches with changing of social and economic structures //The Challenge for Graduates in a Changed World, Dublin All Ireland Society for Higher Education Dublin City University, 25th and 26th August 2011 p.76