

CLOSING THE EDUCATIONAL GAP AMONG TEENAGERS

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Introduction

This paper focuses on science-specialized high schools – a highly successful educational experiment, initiated and carried out by Russian scientists, ranging from top-level scientists, including the famous mathematicians I.M. Gelfand and A. Kolmogorov, to graduate and undergraduate students. Such specialized high schools have been organized on the base of average schools with enhanced studies of one or several scientific subjects. In the rigorous educational system of the former Soviet Union they co-existed with a large amount of regular schools and foreign language schools.

The extreme success of this experiment, both in bringing up younger generations of top level scientists and professionals, and in increasing the general level of education, led to the development of a widespread system of schools in the scientific centers of Russia, such as Moscow, St.Petersburg, and Novosibirsk that succeeded the Soviet times in Russia and is flourishing up to this day. The first school was initiated in 1958 (Moscow School #2), the next few were started in 1968 (including the famous Moscow School #57). Currently there are over 30 specialized schools in Moscow alone.

While this experiment remains an example of an educational success, rather than a panacea for the educational problems in the world, a similar approach can make a valuable contribution to education in any country by creating a core of intellectuals that can serve as a foundation of the scientific community of educators. This core can be instrumental in setting up standards, principles, and traditions in general education and eventually in becoming leaders in the educational development of students, teachers, and parents, with whom the education really starts.

Principles and tools

Education in specialized high schools was based on four basic principles. First, it integrated learning with cultural and moral development, teaching, besides the scientific disciplines, a system of values that provided the necessary foundation for learning science. Second, it created an atmosphere of 'learning as an adventure', where the teachers assumed the roles of leaders and mentors, rather than simply delivering the information. Third, it made no distinction between students from different socio-economic background. And fourth, it allowed each student to study at their own individual pace, without distinction between the initial performance of different students. Each of these principles is described in more detail below.

Specialized schools used a common set of tools. The first and most important tool was the core of highly enthusiastic university teachers, aided by graduate and undergraduate students. All of them in Russian specialized schools did this work voluntarily, without being paid. Second tool was the educational methods that involved, besides classes, a number of extracurricular activities, designed to create an atmosphere that encouraged students to learn. One of the most important extracurricular activities included educational field trips that, besides teaching, created an atmosphere of companionship, and bonding between students and teachers, and, as a result, turned learning into a collective game. Finally, the specialized schools used as their basic tool regular, average high schools, in no way special by any other criteria.

Here is how the specialized education fit into the regular educational system. All the high schools in Russia had 5 days a week (6 hours a day) of classes taught by a unified nationwide school program, and 1 day a week of vocational education, designed to give students some direction towards a simple profession, for example, a driver, or a seamstress. In specialized schools the basic program was the same, but the vocational education was replaced by the equivalent amount of hours a week (i.e., 6-8) of specialized classes, such as biology, mathematics, or chemistry. In addition there was a slightly heavier load of hours and extracurricular activities, such as field trips and cultural events. This specialized program was entirely up to the organizers in each school and thus it differed a lot between different schools. Therefore the specialized schools fitted naturally into the general education system, but added very important extra elements to it.

Selection process and curriculum

Selection into specialized classes took place in April-May for the upcoming academic year. It was directed at selecting students that were interested in the subject, were able to think independently, and were motivated to learn more. The grades attained in the previous schools were not a part of consideration, and the previous level of education was also generally considered unimportant. Specialized schools aimed at finding students willing to learn and compatible with their educational methods, not merely the top graded students.

For example, selection process into the biology classes at Moscow School #57 – one of the core specialized schools in Moscow – consisted of three rounds. The first round was a written test on subjects of general science within the school curriculum, which selected approximately 100 students out of the general group of applicants. At the second round the students underwent three one-on-one interviews with the members of the organizing groups. These interviews were usually conducted not by main class organizers, but by the university students helping them out, mostly the recent graduates of the same classes. They were aiming to determine the students' thinking abilities and compatibility with the program and therefore didn't restrict their questions to biology or even science (for example they could ask what is an applicant's favorite poem and why). This selected around 30-40 students for the final round. At the third round all the finalists had a 10-minute interview with the main organizer(s) of the class. These interviews, conducted in a format similar to the second round, selected anywhere between 15 and 20 students for the class.

An important addition broadened the implications of this educational experiment. 8-10 students from the neighborhood, for whom that was the closest school, were accepted into specialized classes without such selection, first-come, first-served, based on their willingness to join the class. This was done as an attempt of the program organizers to determine how applicable was their educational system to all students. As a result the specialized classes were very diverse, consisting both of top students from highly educated families all over Moscow, and of students below, often – much below average from common families in the neighborhood.

Contrary to expectations, having these two groups together in the same class didn't produce any problems or conflicts, because the general spirit, created by the teachers, was that of a participation in a special experiment, of blending together instead of emphasizing the differences between the

students' socioeconomic or educational backgrounds. In addition to the spirit of enthusiasm and adventure, the rules were backed up by iron discipline, enforced by the peers through often unspoken disapproval.

Table 1 gives an example of specialized classes taught to the biology students in the Moscow School #57.

Table 1. CLASSES AND EXTRACURRICULAR ACTIVITIES IN THE SPECIALIZED BIOLOGICAL EDUCATIONAL PROGRAM (TWO LAST YEARS OF HIGH SCHOOL, 9TH AND 10TH GRADE, 15 AND 16 YEARS OF AGE, RESPECTIVELY).

Regular classes taught by enhanced program:

Mathematics	6 hrs/week of algebra and geometry
Physics	3 hrs/week
Chemistry	2 hrs/week
Russian and Literature	4 hrs/week
Biology.....	1 hr/week

Specialized biology classes, not taught in regular schools:

9th grade:

Zoology of Marine	1 hr/week lectures, simplified university
Invertebrates	program
	1 hr/week practical course
Biology of Higher plants.....	1 hr/week, special course
Entomology.....	1 hr/week, special course
Cell Biology	1 hr/ week lectures, simplified university program
	1 hr/week practical course
Ecology	1 hr/week lectures

2nd year (10th grade):

Genetics.....	2 hr/week full university course
Human Anatomy	1hr/week full university course
Cell Biology	2 hrs/ week full university course
Vertebrate Zoology	1 hr/week, special course

Extracurricular activities:	1-day field trips.....	1 Sunday/month
	1-week field trips	2-3 times/year, quarter breaks
	2-month field trip	between 9 th and 10 th grade
	Cultural events.....	once a month

In specialized schools some of the regular school subjects were taught by enhanced program. For example, biology students had, in addition to biology, enhanced mathematics, physics, and chemistry. All students had extra activities at other classes, such as literature, where they took time during the class to read and discuss their favorite poetry. On occasion the teachers even managed to include into classes the discussion of the Bible, which was very hard to do in the Soviet times, but in the teachers' opinion necessary to develop the moral values of the students.

The specialized biology classes were taught by volunteer university professors and students. During the first year heavy emphasis was placed on the 'old-style' biology, such as zoology and botany that was regarded as a necessary foundation for the future knowledge of more 'modern' subjects of biology. In the second year the emphasis was shifted to the 'modern' biology, with the curriculum for many subjects actually the same as taught to the first year University students (underlined in Table 1).

Teaching methods: individual pace for each student

A very important reason this education proved so effective was the following. In class teachers gave students the materials and allowed each of them to work at their own pace. At the same time, they were encouraged to ask questions, even if these questions concerned the program of previous classes, which the students were supposed to know.

The rationale, as given to the students, was that questions help not only the student but the teacher, and that the people who don't have questions can never learn anything. The teachers encouraged questions by pointing out that they themselves don't know everything and may very well make a mistake or not know the answer. To make it easier in some classes, along with the 'main' teacher several 'junior' teachers were present, who helped answer questions or refer them to the 'main' teacher if necessary.

As a result, an interesting thing came up. It turned out that most of the chronic non-performers, who used to have bad grades and were labeled as incapable of learning, in reality simply missed some previous parts of curriculum, and as a result lost hope to ever catch up. When they were allowed and encouraged to start from the previous parts of program, - 3 years behind, if necessary, - and ask any questions at all, they started to catch up very quickly, first doing problems at a much lower pace than others, but eventually becoming as good as the rest of the class, or, in some cases, better.

Other students had opposite problem – they finished their task much too quickly and were bored. Those students were always given an option to leave or to study more if they wanted. In the atmosphere of ‘learning as a game’ most of them chose to stay and keep studying. As a result those students who had a naturally slower pace of work didn’t feel discouraged, and those who had a faster pace didn’t feel bored.

An important conclusion from this is that *regular school education is directed at a non-existent ‘average’ student*: material is given at an average pace that is too fast for some students and too slow for others. As a result in regular schools some students are habitually bored and might eventually be turned off by the education process in general, and others never have a chance to develop their abilities. The education methods in the specialized classes dealt with this problem in a very efficient way. Even the original non-performers eventually became comparable with the top students in other schools.

Moral values and atmosphere

What was, in the end, so special about the specialized education? Definitely not the extra classes and extra material *per se*: such things are known in many educational systems and by itself they never have produced such striking results. It was not even the extracurricular activities by themselves, and not the unusual teaching methods. It was the combination of all these things and more: the atmosphere, created by enthusiastic teachers who wanted to apply their best effort to bring up a generation of students like them.

In a way these teachers approached the education as they approach the task of bringing up their own children, developing them morally as well as mentally, creating a group of people they themselves would enjoy being with. In such atmosphere the education came naturally, not so much as the result of lessons, but of this continuous interaction, where the most important thing was to come up with the true answer to each question, and searching for these answers in itself was what bonded the students together. This atmosphere bred intellectual hunger that was not confined to the specialized subjects. Students from these classes took turns to stand in line overnight for the tickets to the best art exhibits and plays; on one occasion a large group of students stayed behind after the literature class and spent four hours arguing whether Tolstoy had meant his Count Andrei to be a positive or a negative character.

What these students actually had in school was, on top of education, a life full of fun, companionship, and intellectual challenge, which taught them all the moral values, both in scientific research and in life in general. Many came to the school in search of this companionship, undergoing the tough selection process and often having to travel more than an hour each way to study there.

It is known that roughly around the time of high school teenagers start growing out of their family bonds and looking for a group of people to belong to. In some modern societies they often find only gangs, or rock groups, or extremists groups; or they find nothing at all and then become lonely and depressed. It seems feasible to attempt at providing alternatives for students, such as specialized schools that can give them a chance to belong to a wonderful group of people. It can give the teenagers a lot more, as taught by the example of the Russian specialized schools.

Above all these schools give students a head start, not only for professional science, but for other pursuits as well. Graduates of these schools are now working all over the world, and a few of those are leading scientists in their fields. Some of them have become engineers and doctors, artists and writers, or even military commandos. Several people chose to organize their own specialized classes at other Moscow schools.

Even more than that, such education gives students a broader and keener understanding of life and people, which really makes every aspect of human interaction a much better experience. And finally, for better or worse, it gives them independence of thought in a good sense, a quality – so necessary in a scientist – of questioning everything and arriving at their own conclusions, which in the end is making their convictions and sense of righteousness a much firmer foundation.

Implementations within other educational systems

The tools used by specialized schools exist in virtually any society and can be implemented within almost any educational system. Average schools – the foundation for specialized education described here – exist everywhere. There are certainly many ways to introduce additional classes into a regular school system. Many of those exist already, such as Sunday schools and honor classes. Similarly, there exist field trips for school students, such as scout trips and summer camps. Finally there are University Outreach programs, where scientists give lectures to high school students.

The new element, and the most important limitation of implementing the experience of Russian specialized high schools in any society, are enthusiastic volunteer teachers who would be willing to approach education with the same energy and responsibility as if they are teaching their own children.

Such people exist in any society, but are hard to find on a large scale. Perhaps they should be looked for initially not among the school teachers, but among the scientists, who are willing to bring their knowledge to schools. Tremendously important would be an effort to increase public awareness of science in general and science education in particular, since only then the students, the teachers, and even more importantly – the parents become aware of the necessity to learn science as a part of intellectual and moral development of a healthy individual, as well as a part of survival in the modern world.

While the example of the Russian specialized schools cannot be viewed as a total reform of educational system, but rather a useful addition to it, such an effort seems to be really worthwhile, since the results of such education have extended beyond just mastering the curriculum to the intellectual awakening and change in the value system.