Models of ECM (Extracurricular Mathematics) Education

I would like to begin by describing several models of extracurricular math education as they developed in the former Soviet Union and Russia, then move on to their possible uses and implementations in the United States, and problems that could arise around those.

1. Models

First of the models I will tentatively call "**Metropolis – Math Circle**" and this is the model widely used in my native city of St.Petersburg. Basically, we have here a big city with numerous universities and strong traditions of out-of-school scientific education. At some moment in the 1960s local enthusiasts, professors from local colleges, teachers and graduate students reached a point where they felt they needed to educate school kids outside schools since elementary mathematics had so much non-traditional material to offer to the kids. That was something that could attract the students and motivate them as opposed to the same old boring stuff they were very repetitively taught in public schools. So during that time they began creation of a network of math circles which eventually by the end of the 1970s gelled into a rather large system of 40-50 math circles (not counting regular math seminars conducted by teachers-enthusiasts in schools) concentrated around two centers – one of them was inside this official structure called Palace of Pioneers and Students and the other one was affiliated with the St.Petersburg State University and called Youth School of Mathematics.

Currently this system is still operating although on a smaller scale but I need to emphasize here the results of the process. For the last 30 years within the limits of St.Petersburg (and that's population of 5 million) that system made sure that no child was left behind, so to speak... meaning that if a school kid feels she has at least some abilities or attraction to mathematics or science then she knows, her teacher knows and her parents, they all know what to do – they know there are mathematical circles, and that there is this organized and advertised system of olympiads with very precise and well-known structure.

Second model is a "**Metropolis – School Seminars**" model – again the name is probably not the most precise one but it should do for now. That is a model which was put to use in Moscow (although currently it is not the only one available there) and it mainly consists of a loose network of school seminars and classes conducted in several schools by teachers who are usually either graduate students or recent graduates of Moscow universities and colleges. Some of them are doing that part-time while pursuing academic careers, some of them decided to dedicate their lives to teaching full-time. The advantage of this approach is that the teachers do both regular and extra-curricular mathematics within the confines of the same school and almost at the same time so they can easily merge them together, use one to enhance another etc. The downside is exactly the same thing, the other side of the coin – they have to adhere to some standard curriculum while teaching regular mathematics, they have to account for the fact that this is a public school and majority of the kids in their class are not ready for advanced math and so on.

Success of both models described above is deeply rooted in the fact that whatever system is in place, it is very firmly linked to the local universities and colleges. The teachers come from that pool and they inevitably and quite properly orient their kids to enter that same system, to aim for the higher education and not be content with going to mediocre colleges. I want to mention here that olympiad system in these cities and in many others is officially sponsored by local state universities; some of them even grant automatic admissions to the winners of city- or higher level olympiads.

Third and fourth models are for midsize and smaller cities and can be called respectively "**City – University**" and "**City – Teacher**". Their differences from models 1 and 2 are presented in their names and everyone can easily deduce what exactly I mean here. The main problem usually is insufficiency of the local pool of educators, that is, of people willing to spend their time teaching kids extra-curricular math. Among Russian towns where some approximations of these models are put to use are Kirov, Beloretsk, Krasnodar, Arkhangelsk and many others – I only mention here the ones I am more or less familiar with.

What I want to emphasize here is that Russian experience shows that to be successful these two models (#3 & #4) must be supported by either larger local network of similarly modeled clusters or by some centralized education center which is where I come to my last model here and that is – Correspondence School of Mathematics.

This fifth model can be used, of course, not just in bigger towns but also in small ones or in villages while connecting a number of nodes into a network. Naturally, there are two main requirements for such a node – 1) a local leader, enthusiast, a teacher, perhaps, or any other "math education"-minded person; and 2) communications infrastructure that allows that leader to be a conduit from the correspondence school to the kids. So we can also call this system something like "**Network – Teacher**" to be consistent in naming. It is no coincidence that in Soviet Union it was created about the same time when other models of extra-curricular education were initiated – first half of the 1960s. It gave enormous support to all the other educational efforts and it was a huge success although a much less publicly acknowledged one.

I know that attempts at creating an American correspondence school of mathematics have been made already and some of them failed. In my opinion, this model could be the most important one at the current stage of development of extra-curricular math education in the United States. I am by no means talking about one huge central entity covering the entire country – that didn't happen even in extremely centralized Soviet Union of the 1960s. Instead several such networks were created covering most of the country's regions which is what should be done here as well.

2. Implementation points

As I mentioned before when I talked about St.Petersburg & Moscow models one of the main things about them is the fact that everyone knows about them. Especially in big cultural centers they were and still are very well publicized and people who have at least

some ideas about giving their kids decent mathematical education know about them, and they also know that this system is not just for geniuses.

So even if we imagine that we already have all possible models working here it won't do us a lot of good if kids and parents are not using them since they don't know about them or don't care for what is taught there.

This is something that needs to be done in the United States in addition to developing those models: making the information about the local models and their nodes readily available, very accessible and easily found.

Now for a couple of more controversial points. First, let's try and make extra-curricular math more attractive by emphasizing its "sports-like" appeal, by drawing their attention to the contests and olympiads – this is something I always campaigned against in St.Petersburg but current situation in the US is vastly different. Not only because kids in Russian cities already have those working models already in place but also due to the fact that American schoolchildren still have so much more possible options to consider. Kids are more than willing to abandon their skills in pure sciences in order to go into medicine or law or philosophy or some complicated money-juggling. This is definitely a huge issue for American scientific community and it has no easy solution…

Secondly, my suggestion is to sell ECM as it was not sold here before. When Quantum magazine tried to promote extracurricular math a few years ago, that attempt eventually failed, mostly, as I understand, due to lack of funding and also lack of interest from schoolteachers. Perhaps when somebody tries to do this next time the magazine itself should be smaller and more of magazine's articles should be simpler, more popularized, basically bringing math as close to the earth as possible but at the same time trying to promote one BIG idea that would make this worthwhile – the idea of real mathematical proof, real rigorous logic versus mindless number tricks (which unfortunately is how math is taught in the majority of schoolrooms all around the world). If we manage to successfully plant this into the kids' heads then I think the future generations might just forgive us for temporary bastardizing this stage of mathematical education. Of course we all would rather teach our kids Galois theory and then dazzle them with a complete proof of what can and cannot be constructed using straight edge and compasses but we would surely lose 95% of them during this ego trip especially when doing this without properly laid foundation.

To recapitulate, endlessly giving students brainteasers which develop their skill in "math drawing" but at the same time do nothing for their abstract thinking – that is something I am strongly against. Brainteasers are good at the first stage when we try to attract schoolchildren to mathematics by showing them that mathematics can be fun but if a teacher then does the same thing over and over again it not only kills the motivation but also misrepresents what mathematics really is to the students most of whom are hopefully interested in more profound and wider understanding of it. So what we need is this – simpler, more popularized ECM education with strong main message of logic and proof.