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MATHEMATICAL EDUCATION AT A STANDSTILL

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Abstract: *In this paper we are trying to emphasize that a teacher in mathematics or who uses mathematics as a main working apparatus is not a just an actor, as much as the student is not just a simple spectator. We would like to convey that fact that teachers must help their students understand and get into the concepts of mathematics in order to use them instead of mechanically applying them in resolving problems.*
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WRITING – COMMUNICATION – LEARNING

The ability of communicating effectively or making oneself understood is innate or is acquired very early. We believe that you can't learn that a sentence called conclusion derives from one or more sentences, let's call them premises, and therefore you are born with this ability or not. The same way, we think that you can't learn to effectively express something, some are better than others, so there is no rule in that sense.

It doesn't mean that we can lose hope in improving performance. After all, there are other fields where talent is required and even the most gifted one need practice to reach the maximum of their abilities.

In writing mathematics the same problem arises, as in other types of writing, be that a novel, a scientific paper or a user guide – communicating an idea [1], [2]. And in order to communicate an idea, that has to exist, it has to have a receiver and needs to be organized in a certain manner. These things might seem banal, but a lot of mathematical writing doesn't follow this basic rule – communicating an idea. There are two scenarios – either the text contains too much superfluous information so that the idea is lost in detail, either it tries to convey too much, with the same result.

The ground rule is that we have to write for a specific receiver, we need to know our audience, and from there the variables such as the degree of informality, the details, the need for repetition.

Another principle is that of not forgetting that the main tool we use to express ideas is language, therefore in order to be better understood we need to choose the right words, to avoid technical lingo as much as possible, as well as complicated systems of annotations.

There rules similarly apply to oral communication. The purpose of a talk or a lecture is that of informing, so that the audience can capture the information transmitted. Typically there are not many people disliking a presentation because it is too simple, elementary etc. In reality that's the way a lecture should be – concrete, concise, not overly complicated or technical. The audience is ready to understand better some suggested generalizations rater than decode an abstract idea in the moment. And this doesn't mean that we should focus on certain specific areas and thus lose sight of the bigger picture.

Paul Halmos stated that 'the **best way to learn** is to do; the worst **way** to teach is to talk' [5]. He thought that a good teacher is not necessarily good at public speaking and that generally doesn't give brilliant talks or lectures. A good lecture is usually systematic, precise and boring; therefore it constitutes a poor teaching tool. There are obviously great speakers, charismatic and enthusiastic people who manage to inspire the audience. But for the most part the lecture is the last resort Halmos recommends in teaching. This method is not very beneficial to students either – similar to how you can't explain to someone how to perform a certain move, you can't tell them how to solve a problem, you can't dictate the steps to follow.

Mathematics can't be learnt by reading it, even though reading is superiors to listening, through its component of proactive implication. Mathematics needs to be read and learnt with pen and paper.

TEACHING MATHEMATICS THROUGH PROBLEMS

Last but not least, we need to focus on the problems! A great part of the professional lives led by engineers, technicians and other scientist is spent resolving problems. It should be a teacher's mission (especially mathematics teachers) to approach their students through problems rather than theorems and axioms. A problem or a question will stimulate the student and the effect of this stimulation is extremely valuable. During a course focused on resolving problems the students might be less exposed to theorems, compared to a theoretical course, however the problems present the benefit of developing an approach focused on asking questions, they will provoke the students and guide them towards the right resolution (and instead of memorizing the steps, the students will be able to recreate them, by being used to this type of thinking).

Maybe this will not allow for the entire curriculum to be covered throughout the course. But it is preferable to present, explain and practice (through examples, problems, inquiries, exceptions) part of it, even though some other part is not thoroughly covered, but only mentioned.

Based on a study published by the American Institutes for Research [4], in recent year some of the schools in Singapore have implemented a new strategy of teaching mathematics and have obtained remarkable results. Students are no longer made to quote entire theorems or write long lines of formulas, but are encouraged to be first and foremost creative and discover new approaches.

How's it like to participate in a mathematics class in Singapore? Students are allowed to debate, to build new mathematical constructs by using their imagination. The classes are interactive, the students are encouraged to ask questions and find the answers on their own. On the other hand, they are allowed to get familiarised with certain objects, quantities and sizes of the real world, passing onto graphical representations and finally abstract formulas, but these processes generally require a far longer period than we have available in the teaching process. This method, considered quite new, is extremely similar to the Moore method. He believed that students have to discover the subject themselves, and the teacher would only act as a guide throughout this process. This method entails however much attention paid to the student – the level of the group will be different and then the teacher, in his new role, will need to adapt its behaviour, will give more precise indications etc. Not everyone can apply this method as it

requires a deeper understanding of each student and therefore much more time dedicated to every one of them.

The European Union has obviously carried out studies about the improvement of the teaching/learning process and has published reports [3] with the findings. Teachers are recommended to use the inductive pedagogical method instead of the deductive one, unfortunately still the most utilised in most European schools. If during the deductive approach, the teacher will present the concepts and give examples, in the inductive approach the student is the one to observe and experiment, guided by the teacher. In Mathematics, this method is known as *Problem-Based Learning*.

The same scientific papers also suggest other criteria technology teachers should meet: they need to be good educators, they need to be confident, motivated and be part of the community and teaching network. Being part of such a community offers them the chance to exchange ideas, materials, experience, to enrich their practices and cooperate with various researchers; these networks motivate and stimulate their activity.

INSTEAD OF CONCLUSION

Being part of the educational system it's not hard to notice that in recent years young people are less and less interested in studying mathematics. Although many teachers have issued warnings, there are no known actions or projects meant to reverse this tendency or at least ameliorate it. Innovation as well as the quality of the educational act is declining as well.

The reason why young students are not as attracted to science, particularly mathematics, stems in the way it is being taught in schools and high schools. In 2001 a study carried out at an European level, 59,5% of the subjects thought that the technology classes are *insufficiently interesting*. The euro barometer of 2005 showed that only 15% of the European citizens are pleased with the level of science classes [3].

Based on the European reports, although students have a natural curiosity towards these topics, the traditional formal education nips their interest in the bud and therefore has a negative impact in understanding technological science. These traditional methods are focused more on memorizing theorems and formulas rather than understanding them, teaching is done in a way too abstract and therefore students perceive these subjects as irrelevant and difficult.

At this point we have to ask: how can we spot a good teacher? What defines them? Probably the most convincing and clear answer refers to performance, the results obtained by their students and the path they choose to take after graduating.

Students should not be just passive receivers of mathematical information, and mathematics should not be presented as something too abstract and in no relation to our daily routines. Students should be encourages to create their own learning systems, they will reinvent mathematics by solving problems, they will develop their analytical sense, they will be better organised and capable of articulating better syntheses.

In each class different students will position at different level of knowledge; the teacher's mission is to raise the bar gradually, to challenge them and to lead them towards knowledge, probing, invention.

There is no recipe for creativity; there are no steps to follow for progress. Mathematics is not a deductive science and when we prove a theorem we don't just line up a set of hypotheses and then start rationalizing. Try, experiment and error will come into play. The mathematician's work resembles that of chemist, it is different only in its degree of precision and type of information. The mathematician starts with some assumptions, arranges and rearranges ideas, becomes convinced of their authenticity long before beginning to actually write a valid demonstration. But this type of conviction comes only after many attempts, fails, discouragements and wrong starts.

However, it is clear that within the current context, where the challenge of integrating ICT in the classroom is essential, the role of the teacher will be to come up with innovations and implement the new technologies. Therefore, teacher training still remains the key to success in obtaining an appealing mathematical education. Putting more emphasis on shifting the approach of mathematical education process regarding the use of new technologies will lead in time to increased productivity and performance.

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