

ABOUT THE TRAINING METHODS FOR OLYMPIC STUDENTS IN MATHEMATICS

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Abstract: *This paper aims to find the best training method for students who wish to obtain performance in mathematics. School, special curricula for the gifted and self-instruction are just some of the methods students choose in order to achieve excellence in mathematics. This research aims to outline a general method for efficient student training, also taking into account the anxiety generated by mathematical competitions (Mathematical Anxiety). The study is based on the author's ten years' experience in coordinating advanced mathematics training programs for students in Braşov, Romania.*

Keywords: *training methods, performance in Mathematics, Mathematical Anxiety.*

1. INTRODUCTION

In Romania, all partners involved in the educational process (teachers, students and parents) mutually agree with the necessity of over-average education, in particular, to prepare students for competitions.

The goal of competitions at every level (even in the classroom) is to develop the student's ambition, their desire to win and to be in the top, hoping that they will be able to identify those domains in which they could reach a high level of competence. Starting with primary school, children have the opportunity to participate in many contests, including many mathematical competitions. This technique, to participate in various competitions, searching for that field of knowledge in which a student could be in the top, could also lead to Mathematical Anxiety. This fear is caused by the level of proficiency required by Mathematical competitions, which is very high compared to the level of proficiency taught in schools. Here the math problem books have great importance in schools, helping teachers to provide additional training for gifted students. But sometimes this method is not enough.

Another method to develop students' abilities is called "early tracking". There are countries where the differentiation of talented students in different fields is done early, from the age of ten and there are studies that follow the long-term effect of this differentiation.

According to [1], "The central argument behind tracking is that homogeneous classrooms permits a focused curriculum and appropriately paced instruction that leads to the maximum learning by all students. In such a situation, the teacher does not have to worry about boring the fastest learners or losing the slowest learners. The arguments for ungrouped classrooms largely revolve around concerns that the lower groups will be systematically disadvantaged by slower learning environments that leave them far behind the skills of those in the upper groups."

In Romania's state education, the classrooms are not homogeneous. However, this situation has its own benefits: "heterogeneous classrooms might give rise to efficiency gains through nonlinear peer effects: the higher ability students lose nothing, but the lower ability students gain through the interaction (from motivation, better classroom discussion, and the like)." [1]

They conclude that "Our analysis provides reasonably strong support for the desexualizing effects of early tracking. Variation in performance, measured in a variety of ways, tends to increase across levels of schooling when a country employs early tracking." [1]

Public education standardizes the training of students, generally, not paying attention to advanced training, although the level required at school Olympiads (provided and organized nationally) is significantly above the level of class preparation.

There are in Romania some particular educational institutions, which aim to address this issue. They are recognized and accredited by the Ministry of National Education and they provide differentiated training for students, those with special skills in different fields having a customized study schedule and benefitting from additional training coordinated by teachers in that field. The students in these private schools usually reach most of the top positions in national competitions, which could prove the efficiency of such an education method. However, the fact that these schools are private generates great inequity, considering the students who do not have access to it.

Talking about competitions, heterogeneous classrooms are not the appropriate environment for students to train well. The only solution that appears to be valid in this situation for each student who finds an inclination towards one of the domains is to take private lessons, a type of training financially supported by parents. That is the reason why many teachers choose to invite mathematically gifted students to participate in special training programs. In some large cities, school inspectorates and some non-profit organizations have organized advanced training programs available to students free of charge, in their spare time, to provide them with further knowledge and help them improve the skills needed for high-level performance.

Nowadays, such programs are running in various fields: Mathematics, Physics, Computer Science, Nature Sciences or Humanities, as complementary training to the compulsory school program.

There are studies about the influence of parents in the academic achievements of students, proving that "parental involvement variables that show promises according to their correlations with academic achievement are: (a) reading at home, (b) parents that are holding high expectations/aspirations for their children's academic achievement and schooling, (c) communication between parents and children regarding school, (d) parental encouragement and support for learning" [2]

In the study [2], the authors investigated other 31 studies about the connection between parental involvement and student achievement in both mathematics and comprehension of written text for middle and high school students.

"Parental involvement in the form of valuing academic achievement and then reinforcing it has shown a significant positive association with students' mathematics achievement throughout high school, since parental control, which refers to excessive control and pressure on children, is negatively related to academic achievement. For example, students' evaluations of parental academic pressure negatively predicted their self-efficacy, mastery goal orientation, and achievement in math." [2]

We usually agree that "performance is an exceptional achievement that exceeds the level customarily achieved" [3]. Generally, parents consider that their children must perform as well as possible, in many areas.

Thus, a secondary school student (aged 11-14) or a high school student (aged 14-18) gets to work for his training for almost 10 hours a day, much more than the average daily working hours of an adult.

In this paper, we investigate the advantages of such an effort and the way in which students perceive this extra training, this “school after school” system.

According to [4], “Mathematics Anxiety” (MA) refers to feelings of tension, fear, and physiological reaction (i.e., negative affect) and self-deprecatory thoughts and worries about one's performance (i.e., negative cognition) that interfere with solving mathematical problems in ordinary life and academic situations. According to the reciprocal theory, past failure and negative experiences in mathematics performance may lead to MA, which subsequently leads to poorer mathematics performance and vice versa. [...] The authors suggested that poor mathematics performance first boosts MA, which subsequently and negatively affects mathematics performance in a vicious cycle.”

Moreover, students who participate in competitions are exposed to a high level of stress that can lead to the development of MA even though they have exceptional results at school.

We agree with the idea that "Mathematics is a living subject which seeks to understand patterns that permeate both the world around us and the minds within us", [5], and we consider that we need to change the perception of the students about it. "Although the language of mathematics is based on rules that must be learned, it is important to motivate students to move beyond rules and to be able to express things in the language of mathematics. This transformation suggests changes in both curriculum content and instructional style. It involves renewed effort focused on seeking solutions, not just memorizing procedures; exploring patterns, not just memorizing formulas; formulating conjectures, not just doing exercises." [5] The special programs for gifted students aim to offer them "the opportunities to study mathematics as an exploratory, dynamic, evolving discipline rather than as a rigid, absolute, closed body of laws to be memorized. [...] to recognize that mathematics is really about patterns and not merely about numbers." [5]

We can conclude that “Engaging students in verbal communication or discourse about mathematics and encouraging students’ use of appropriate mathematical language are therefore two specific instructional practices related to the engagement of students as mathematicians during instruction and development of a community of learners.” [6]

2. PURPOSE OF STUDY

Starting from the previous ideas, the main purpose of our study is to analyze possible methods for students to achieve advanced performance in mathematics with reduced Mathematical Anxiety.

3. METHOD

The participants in the study were 61 fifth-to-twelfth graders from different schools and high-schools in Brasov, Romania. They were all participants in the advanced training program in mathematics, 65 % girls, 35% boys aged between 11-18. A number of 46 secondary school students (S-s-s) and a number of 15 high school students (H-s-s) participated in the survey.

A number of 36 parents of the students mentioned above (parents of the secondary-school students P-s-s-s and parents of the high-school students P-h-s-s, respectively) and 11 math teachers (T) were involved in this program (5 of them were women, the other 5 were men), based on the idea that “the exploration of the teaching-learning phenomenon from the viewpoint of all participants is necessary in order to establish an environment of open communication and understanding between teacher and students.” [7]

The following methods were used in order for the aims of the paper to be achieved: the analysis of school papers, with the instrument the curricula of Mathematics (advanced mathematics training programs for students in Braşov), the identification of the main training methods used by the students and the study of the other related studies.

We also conducted a survey, having for an instrument a questionnaire addressed to secondary- and high school students, parents and teachers, all involved in this program. The questionnaire with 6 multiple-choice closed-ended questions (Q1-Q6) was based on students' experience in preparing for participation in Olympiads and other Math contests. The items were organized around the theme: the training methods of the Olympic student in Mathematics and the level of the Mathematical Anxiety. Questionnaires were administered to the participants in order to be filled in, in the last face to face meeting of the program, under the supervision of the author of the paper.

4. FINDINGS

For the purposes of this paper, the primary analysis of the results consisted of an examination of the 6 items regarding the different methods for training typically used the Olympic student in Mathematics.

The ability to perform greatly in mathematics could be a native gift, but this is not sufficient to obtain good results at local or national competitions. The scholar curriculum contains all the concepts are required in mathematical competitions. However, this curriculum is rather focused on teaching problem solving algorithms and computing techniques. We prepare our students two hours a week, teaching them how to use the concepts they have learned at school, in a creative way. Furthermore, we encourage students to work a lot on their own.

Concerning this idea, interviewees have been asked:

Q1: "Which is, in your opinion, the most important activity to obtain great performance in mathematics?"

- a) The daily intensive training.
- b) The participation in a special program."

Most of the interviewees considered the both activities to be very important, with some minor differences, as we can see in the Fig.1.

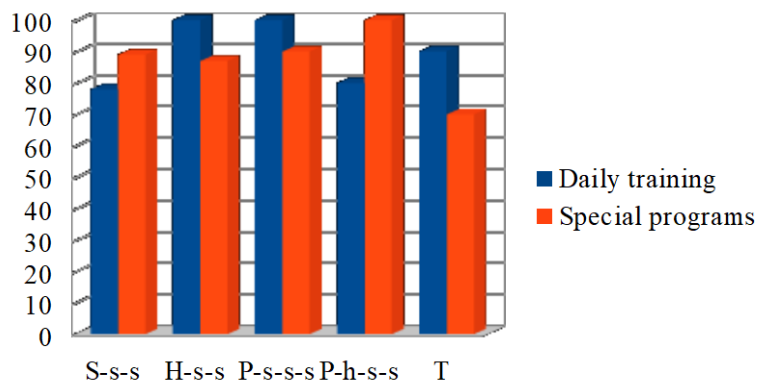


FIG.1. The most important activity

The high-school students, the parents of the secondary-school students and almost all teachers marked the daily training to be the best training method.

On the contrary, the secondary-school students and the parents of the high-school students appreciate the special program as a more useful method.

The explanation could be: in the case of secondary school students, some of parents probably are still able to recognize and to remember mathematics at that level and in many situations, they can help their children. So, they consider that all their children need to do is to work more than they already did, while the children feel that they need more specialized support, a teacher who could organized them work schedule.

In the case of high-school students, almost none of the parents are able to help their children at the level required by Olympiad-level tasks, so they consider that it is more beneficial to follow a special program, while the students know very well what they have to do, that the special programs are useless without a lot of individual work.

The following three questions come to detail these options.

Thus, the answers given in Fig.2 and the interpretation of the Q2 item, referring to the utility of school for students to obtain good performance in Mathematics, whose general statement is:

Q2: “How useful is the school training for the performance?”

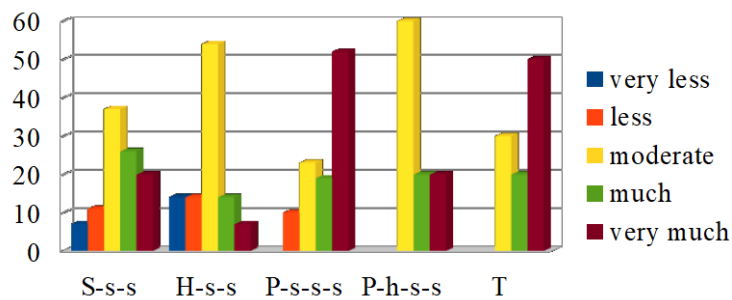


FIG.2. The usefulness of school training

show that school training is considered to have a moderate influence by students (37% S-s-s, 54% H-s-s) and by the parents of high-school students (60%), while the teachers (50%) and the parents of the secondary-school students (52%) consider that the school is very important. The basic preparation of the students is made during the school program, but many times the curricula of the Olympiads are more advanced than the usual curricula, and this difference must to be covered by the special programs.

The third item investigated the estimated impact of personal training for the knowledge required in Mathematical Olympiads. The Fig.3 contains the answers at the question Q3: “How useful is the individual training?”.

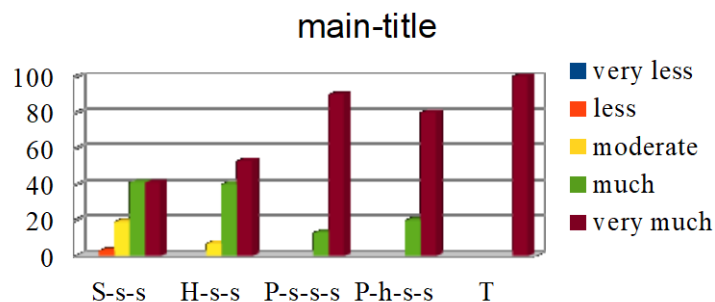


FIG.3. The usefulness of individual training

All the teachers agree that this method is the most important because the taught ideas could be fixed only by individual working. No matter how much information and work techniques a teacher transmits, students learn only through exercise and individual training. Most of the parents of students (80-90%) have the same opinion, while not all the students consider this method to be as much important, since only 41% of the secondary-school students and 53% of the high-school students marked it to be very useful.

The percent of 3% of secondary school students said that the individual training has no much importance in their mathematical achievements. They could be either those students very gifted which instantly understand and which can easily apply the notions and concepts, either students which do not agree hard working and which will not do performance in mathematics.

Finally, the third method, the special programs was the topic of the fourth item which study the impact level of this training method. The answers at the question

Q4: “How useful is the special training?” could be followed in Fig. 4:

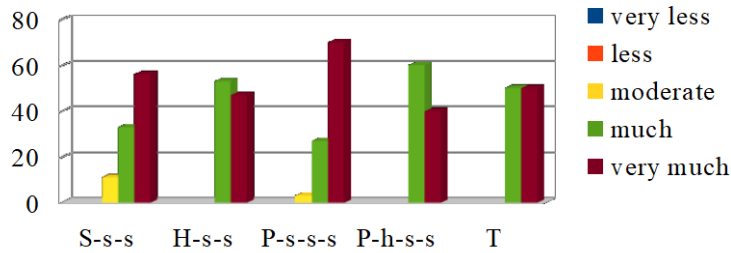


FIG.4. The usefulness of special training

The utility of a special programs is very appreciated by the secondary-school students and by their parents, 70% and 56% of them, respectively, marking this method of training at the maximum level. The high-school students and their parents think that this training method is not so important, this being a confirmation for their previous option about the utility of the individual working.

Some of the secondary school students and their parents (11% and 3%, respectively) said that this method has a moderate impact, while none of the following categories: high-school students, their parents and teachers chose that level (moderate) for the special programs of training in mathematics. A half of the teachers evaluate the special programs at a maximum level of importance for the students’ training.

Another remark is about the parents of the secondary school students. They appreciate all the three methods to be important at a high degree, which means that they are very interested in the advanced training of their children, but this could also be a source of stress for the children.

The Mathematical Anxiety is evaluated by the last two items of the questionnaire.

There are some obviously effects of the Mathematical training: developing of the ability of logical thinking; forming a correct attitude towards hard work and, of course, obtaining of a high level of knowledge. Asking the participants, the following question

Q5: “Which are the advantages of the performing in Mathematics?”

- a) Ability of logical thinking
- b) Good attitude to the hard work
- c) High level of the knowledge “,

we obtained the answers from the Fig. 5.

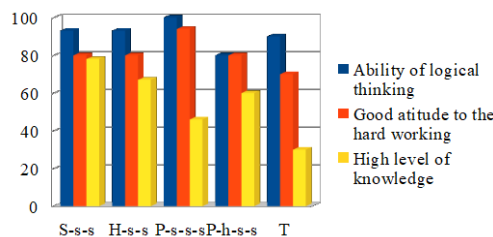


FIG.5. The benefits of advanced mathematical performance

All the participants agree with the formative effects, the development of the ability of logical thinking being the main advantage for 93% of the students, 90% of the parents and for all teachers. The formation of a positive attitude towards hard work was also voted as an advantage by 80% of the students, 80-90% of the parents and 70% of the teachers. The accumulated knowledge during the training for performance in Mathematics are concrete advantages which are not so important as the formative advantages, in the participants' opinion.

However, preparing for performance and participating in competitions in any field involves long hard work and exposure to stress. In Mathematics, the great difference of level between the school training and the contests increases also the Mathematics Anxiety, the necessary time for the training and the fatigue of the students. This is why many students give up advanced training in math and choose another field to perform.

The last item from the investigation questionnaire is about the disadvantage of the advanced training in math. Most of the parents (80% parents of the high school students and 71% parents of the secondary-school students) and 54% of the high-school students reported the accumulated fatigue as the main disadvantage, while the stress from the contests seems to be the main disadvantage for the secondary school students (60%) and for the teachers (50%).

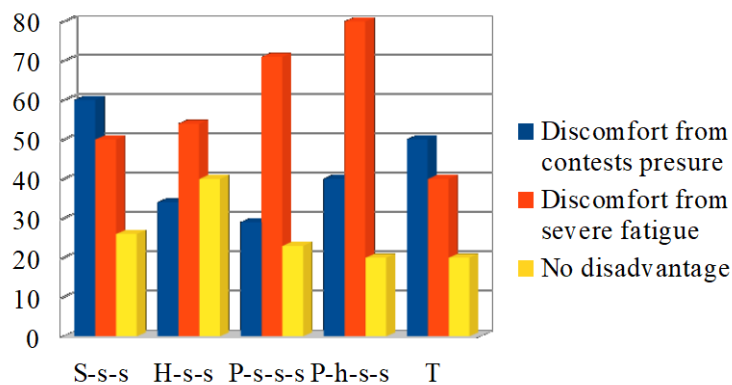


FIG. 6. Disadvantages of advanced mathematical performance

Even so, many of the participants agree that there is no disadvantage, mostly being high school students, those students which are passionate by mathematics and for who training in mathematics becomes a pleasure. It is also interesting the opinion of the high school students about the stress from the contests, only 34% of them choose that to be a disadvantage.

CONCLUSIONS

The results presented focus on two main provided answers to the purpose of the study.

The daily individual training and the participation at a special program of training are the main the methods that help achieve good performance in national and international Mathematics competitions. Concerning the best training method, the students and their parents have different opinions in some cases.

Thus, in the case of secondary school students, they consider that following a special program of training helps them to archive a better performance than the school program and the personal training. Their parents said that the individual training must to be the main method, thinking however that the fact that the participation at every kind of organized training is also very important.

In the case of the high school students, they chose the individual training to be the best method for obtaining performance in Mathematics, since the school program helps less to the advanced training and even the special programs do not assure the good achievements in contests. The most of their parents agree with the opinion towards the school and the individual training, but they consider the participation at the special programs to be the best activity for achievements of better results in the contests.

As a second conclusion, the quantitative analysis also revealed the fact that the Mathematical Anxiety is induced by two factors: the stress from the contests for the secondary school students and accumulated fatigue for the older students. This research revealed the necessity of an equilibrate effort since the students and their parents reported as a main disadvantage of the advanced training in mathematics the accumulated fatigue.

One final observation puts emphasis on the fact that all the participants appreciate that the advanced training of the students has a formative effect, the ability to logical thinking, which is considered to be the main advantage of this kind of activity.

Some limitations of this study are: the relatively small number of participants in the program and the fact that all the opinions referred to the same special training program.

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