

BENEFITS OF IYPT IN PHYSICS EDUCATION

Mihály Hömöstrei¹, Ábel Beregi²

¹German Nationality High School, Budapest, Hungary, hmisko83@hotmail.com
Physics Education PhD program, Eötvös University, Budapest

²Baár-Madas High School, Budapest, Hungary

ABSTRACT

The International Young Physicist's Tournament (IYPT) is not a new thing in the world of physics education. Hungary has also been a successful participant of this competition since 1989. From the end of 2013 a new leader team helps the preparation of the Hungarian secondary school students. Since then we have been trying to invent and improve the teaching-learning process, which is based on the idea of IYPT and can help any participating Hungarian students to find their own way of getting better in physics. In this short article we would like to show how we are trying to improve the essential skills that are needed because of the special form of this competition – open ended problems, presentation, discussion etc.) - not only physics knowledge but much more!

INTRODUCTION / IYPT IN GENERAL

The International Young Physicist's Tournament (IYPT, Fig.1.) is one of the most important worldwide physics competitions for secondary school students. It is also called the Physics World Cup [1], because it is not a competition for individuals but for teams. And this is not the only difference from the usual physics contests. Around 150 students of approx. 30 countries of the world are competing one another since 1988. This means as well that the official language of the tournament is English. Therefore, besides good physics knowledge students must have relatively high language and communication skills, too.

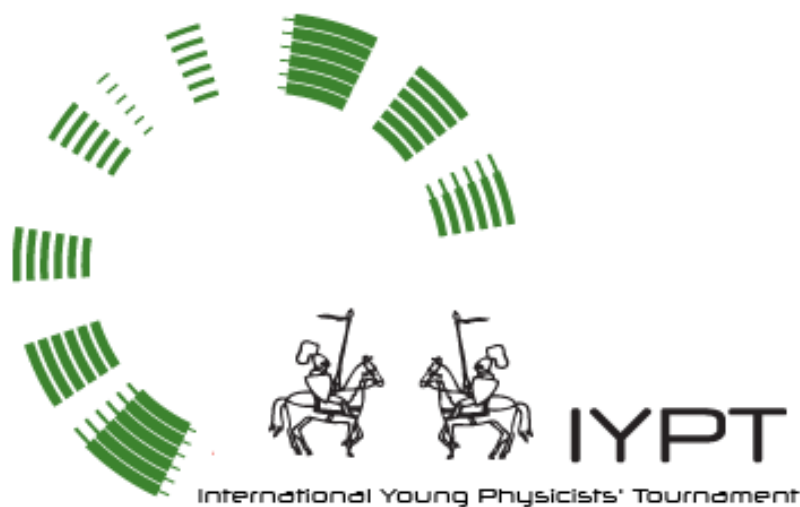


Fig.1. Logo of the IYPT [2]

The other very important specialty of IYPT is that the problems are 17 open-ended phenomena. This means that there are not any known solutions, for every precise result, the students have to work hard on their own. In the competition, students have to present their own results and defend it in a discussion with another opponent team. That needs obviously good presentation, discussion and communication skills. But to be honest, these skills are very important in the 21st century no matter if one is a physicist or not.

PROBLEMS IN IYPT

Every year after the actual competition, the International Organizing Committee (IOC) selects 17 open-ended problems. The problems are formulated in an easy and well-understandable short form. For such problems there are not any well-known solutions or even if there was a known physical background, the solutions of the different students would be very distinct from one another. Besides good knowledge of physics, creativity and preciseness in the measurements are essential to get a sufficient solution.

HOW TO SOLVE PROBLEMS?

Solving IYPT problems is a really hard task because of their complexity and not having an exact solution, but of course, it is not impossible. It takes significantly more time than finding a solution to a secondary school level theoretical exercise. The best way to describe the process is a year-long research (see Fig. 2.). To help students make the first steps, the IOC publishes a document called the Reference Kit, where some articles and webpages can be found which help getting the first ideas and objectives of a problem.

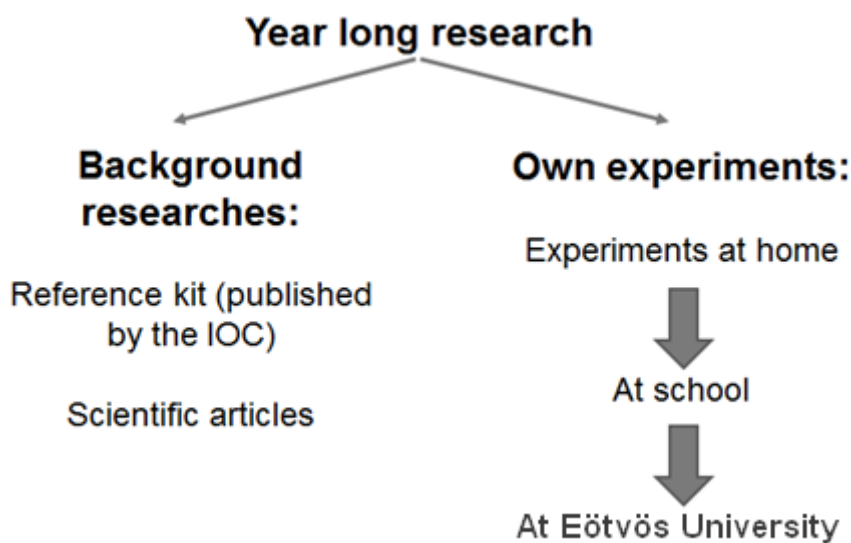


Fig.2. Structure of the preparation process

The Reference Kit is often not enough to set up the theoretical model, thus further investigation is needed from other scientific articles. Sometimes even physicists do not know what the exact explanation of the given phenomenon is, so students need to find out a simple theoretical model.

Since IYPT is about research, besides theory, conducting experiments has a major role in solving a problem. Choosing the right experiments and the right method is one of the hardest part in the process. Measurements are done at home firstly but usually the results are not precise and accurate enough, therefore a more sophisticated experimental method and apparatus is needed which can be found in secondary schools. After getting into the Hungarian team, students work in the laboratories of the Eötvös University where the required

accuracy and precision can be obtained because of the better equipment, set-up and the help of the academic staff.

THE PHYSICS FIGHT

The main scene of the IYPT is called the Physics Fight (PF). During the tournament, each team has 5 PFs in which they compete against 2 or 3 teams from other countries depending on the number of participants. There are 3 main roles (see Table 1.), each team takes a role (in the case of 4-team fights, one team is just an observer), then they switch roles.

Table 1. Subjects of the three roles in a physics fight

Reporter	Opponent	Reviewer
<ul style="list-style-type: none"> - Presents own solution. - Defends it in a discussion. 	<ul style="list-style-type: none"> - Gives an overview of the report. - Challenges the reporter in the discussion. 	<ul style="list-style-type: none"> - Tests the knowledge of the reporter and the opponent. - Gives a review of the report and the discussion.

The structure may be complicated at the first sight but it is very logical (see Fig.3.) The first role is the reporter, who presents own solutions and defends it in a scientific discussion with the opponent. The opponent's job is to give an overview of the report and to challenge the reporter's understanding of the presented concepts; theories and principles in a discussion (see Fig.4.). The third role is the reviewer, who tests the knowledge of both the reporter and the opponent, and gives an objective summary of the report and the discussion. The performances of the reporter, opponent and the reviewer are graded by an international jury, whose members can test the knowledge of any of the 3 teams by questions. (see Fig.5.)

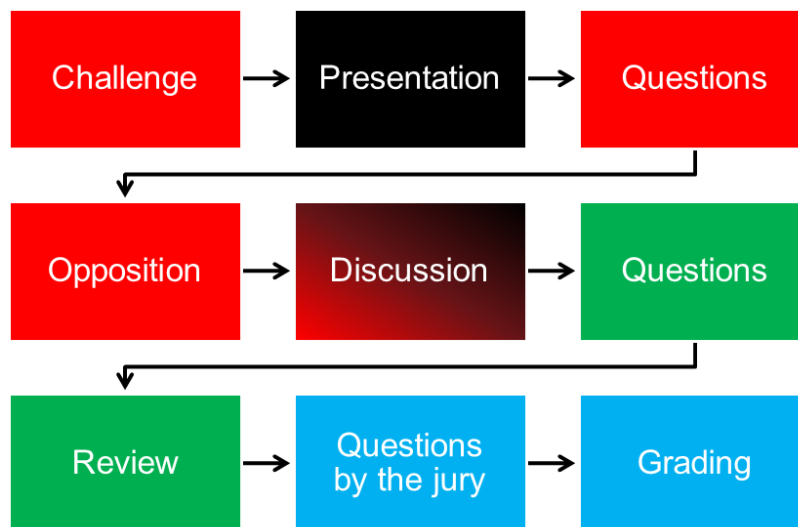


Fig.3. Structure of a physics fight

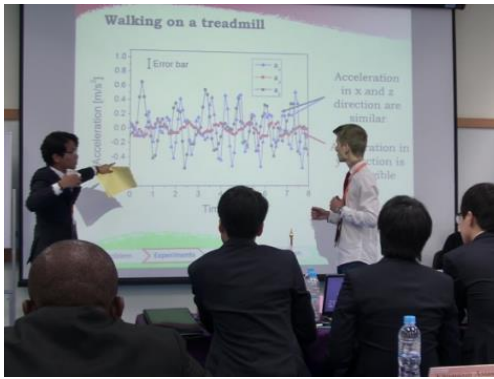


Fig.4. Discussion



Fig.5. Scores of the jury

BENEFITS FOR STUDENTS

Preparing for IYPT takes a lot of free time from students but it has numerous advantages. It is a significant opportunity for one to learn about some really interesting topics in physics which are not covered by secondary school curriculum. Also, they learn how to plan and conduct experiments, which is an essential skill for a physicist. Furthermore, they learn how to evaluate experimental data using basic and more advanced computer methods. After the national selection tournament, students work in pairs, this way teamwork can be learnt.



Fig.6. Hungarian team in an ancient Thai temple

They also spend significant time on meetings with the team leaders so they can get an insight into the work of a physicist. At the university high-class equipment is available which was never used by an average secondary school student. For those who get into the team, the IYPT is also a great opportunity to get to know different countries and cultures. (see Fig.6.) Above all, a really good community is built between the students and the team leaders.

DIDACTICAL ASPECTS

It is very important for us that every Hungarian high school student gets the chance to participate in the Hungarian selection process. To reach this aim, we publish a call to participate in the KöMaL (Mathematical and Physical Journal for Secondary Schools) every year in September. Furthermore, we send posters and calls for many Hungarian high schools directly and we are using the internet as well as possible. The selection process has three rounds. Each round is a bit different so we can improve a wide spectrum of skills [3].

The 1st round: writing a scientific essay. Till the end of November students have to investigate a self-selected problem and write a scientific essay in the limit of 8 pages in Hungarian language. The improved skills and capabilities in the 1st round are:

- reading scientific papers (English comprehension, finding the main points),
- doing own research (logical structure, precision),
- improving creativity (using physics in practice),
- cooperating with the teacher as a workmate (a new role for teachers and students, too),
- writing a scientific report (how to explain findings to others).

The 2nd round: Hungarian Young Physicist's Tournament. This round is for the best 15 students based on the written essay mentioned above. In the middle of December students present their results in 10 minutes using English as the language of presentation. The jury is made up of professors of the Eötvös University. Beside the presentations the participants have to oppose an old IYPT presentation to show how good they are in finding the errors and shortcomings in someone's presentation. The best eight students can work further at the Eötvös University. The improved skills and capabilities in the 2nd round are:

- using criticism in a positive way (evaluation of the 1st round can help to improve the first results),
- creating appropriate presentation (logical structure, easy to follow and to understand),
- English language and presentation skills,
- getting deeper and more detailed physics knowledge in the selected problem.

3rd round: Selection of 5 team members for the team Hungary in IYPT. The selected 8 students work in pairs after the 2nd round. This is the first step of the team building. Since IYPT is a team competition, working together and team building are essential, just as they are in the real life. The team members can learn presentation and communication and IT skills from experts in the Hungarian IYPT committee.

To be a member of the 8 students' team is a great feeling for our students because they can work together with professors of the ELTE University. A laboratory is available for the IYPT students where they can conduct experiments in pairs under the supervision of the university professors. In the middle of March the best 5 students are selected after another presentation of their problems. The three students who do not make it into the team can participate in an international preparation contest, the Austrian Young Physicists' Tournament. Improved skills and capabilities in the 3rd round are:

- working in pairs and smaller teams,
- using lab equipment (mostly at Eötvös University but sometimes at the Technical University of Budapest and at Szent István University)
- presentation and communication skills.

NO FUTURE WITHOUT TRADITIONS

Whatever we have done in the last few years for the preparation of the Hungarian IYPT team, it was obviously not without antecedents. As it was mentioned at beginning of the article, Hungary has participated in the IYPT since 1989 with numerous [2] [4] medallions. The team leaders Zsuzsanna Rajkovits, Lajos Skrapits, Judit Illy, and Péter Kenesei between 1989 and 2012 were not only preparing the students for the competition, but also built the most important communication channels to students and teachers. Without their work and

help it would have been impossible to reach a wider range of Hungarian students. Beside all of this they could even organize the IYPT in Budapest in 2000. Their work made an excellent basement for the cooperation with many physicists of the Eötvös University [4], which is essential for the future teams, too.

As a proof of the success of the former leaders we could mention many names of the former Hungarian teams who have become great engineers and physicists in many countries of the world. Some of these former participants help the further work of the Hungarian team. What could prove the success of the pioneer team leaders and the IYPT itself more than the ex-team members who join the Hungarian team of future physicists?!

CONCLUSIONS

The benefits of the IYPT, such as the preparation itself, are based on the modernity of this physics competition. The Hungarian education system actually raises mostly students who have a relatively huge amount of lexical knowledge but they are not practiced in working in teams. We have to face that the keys of success in the future are creativity, good practical sense and capability for teamwork. With this competition we can reach students who may not be the best in theoretical physics but are capable of learning by doing. Meanwhile our students improve their communication, presentation and language and team-working skills which help them to be successful in their entire life!

REFERENCES

1. https://en.wikipedia.org/wiki/International_Young_Physicists%27_Tournament
2. <http://www.iypt.org>
3. G. Tibell: Student's skills developed by participation in international physics competitions, GIREP/MPTL Conference: Physics Curriculum Design, Development and Validation, Nicosia, Cyprus, 2008.
4. Zsuzsanna Rajkovits: International competitions – talent spotting. Budapest, Hungary, 2010. (in Hungarian)
5. https://fizika.elte.hu/uploads/ajanlatok/4c8f7d43f2599/ortvay_rajkovits_tehetseggondozas.pdf