The Huge Positive Impact of Extracurricular Activities at TELEKI High School

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Abstract

According to my experience education plays a crucial role in the development of society. It is important to realize that our future is entrusted to the young people leaving today's education system, and it is up to us, teachers, how to motivate, teach, inspire, educate and guide them on the path. I believe that extracurricular activities can play a crucial role. Of course, the personality of the teacher also determines the development of students, but this requires incredible consistency and also the willingness of students to accept. Teachers play a key role in education. They not only transfer knowledge, but also inspire, mentor, and guide students, supporting their high school research activities. By attending talent development programs, which is unique in Hungary, students get more involved in scientific competitions, research, and TDK [1] work. This contributes in the long term to choosing scientific careers and educating the next generation in STEM fields. My experience supports the fact that even a small success can turn an entire community in a different direction, and make them love physics, love STEM. By conducting action research, I aim to prove the usefulness and benefits of high school research work in developing students' various competencies by supporting specific results. One of the positive impacts of talent management is reflected in students' attitudes towards physics: the program makes the learning process experiential and personal, thus increasing motivation and active participation.
Our students develop 21st century competencies such as problem solving, critical thinking, they use digital tools, data analysis and scientific communication. The positive impact of the extracurricular activities at TELEKI high school can be clearly established, based on the feedbacks of the yearly hard work done.

Keywords: *scientific student work, research activity, STEM, talent management, development of scientific competence*

1. Introduction

The Scientific Student Circle (TDK) is an excellent opportunity for students in higher education and secondary schools to develop their talents and explore a topic of their choice in depth.
The history of TDK dates back to the 1950s, when the first conference was organized. Since then, it has become one of the most important forms of talent development in Hungarian higher education.
Students work in small research groups under the guidance of a lecturer or mentor. They carry out scientific research, investigate unique problems, and create innovative projects. During this process, students formulate hypotheses, conduct various measurements, learn how to analyze data, draw conclusions, and evaluate the validity of their results.
The outcome of this collaborative work is a research paper that goes beyond the standard curriculum. It is scientifically demanding and presents the chosen topic from a new perspective. Preparing such a thesis requires extensive learning, research, and several months of dedicated work.
Every year, higher education institutions organize local TDK conferences where students present their research results. Participants defend their theses through oral presentations in front of a professional jury, which evaluates and scores their work.
The most successful projects may be nominated for the National Scientific Students' Conference (OTDK), which is held every two years. This event is the largest scientific student conference in Hungary and is unique in Europe. It features the research of the most outstanding university students in thematic sections. Last year more than 4,000 projects were presented at this conference.
In recent years, this research opportunity has also been extended to high school students, allowing them to participate in scientific research at an early stage.

2. Student Selection Process for the "2T – Talent Management in Teleki" Program

The selection of students for the **"2T – Talent Management in Teleki"** program (Experimental Learning and Digital Innovation in Physics Education, Motivation, Understanding, and Talent

Development) is primarily based on the observation of students' individual abilities, motivation, classroom performance, and interests.
Teleki Gymnasium, our institution with long standing traditions and excellent results in the field of talent support. By our complex programme of talent care, we aim to identify students' fields of special gifts, developing talent maps and helping the gifted ones develop as well as providing them with follow-up opportunities. As an accredited talent support point, we are part of the talent support point network, and maintain a closer cooperation with our partners, especially with Budapest University of Technology and Economics (BME).
In our talent program 2T cycle, individual interviews proved to be the most effective method for selecting participants. It was important for me to speak personally with each student, draw their attention to opportunities beyond the classroom, and explain the possibilities available to them. Before applying, students were informed about the achievements and expectations of previous participants.
As a result of individual face-to-face or online conversations via Microsoft Teams, students voluntarily applied for both the program and personal development. They were informed in advance that this talent development program focuses on building multiple competencies. The program effectively fulfils the three core principles of successful talent management: enrichment, acceleration, and individual differentiation [2].
Thanks to this preliminary information, applicants were fully aware that their written and oral communication skills would improve. In addition, through hands-on activities and individual experiments, their practical skills, creativity, intelligence, and problem-solving abilities would also develop. Students were encouraged not to feel intimidated by these expectations.
It was also clear to students that progress in physics, chemistry, and biology is not possible without strong mathematical skills. Therefore, basic scientific competence is essential, while higher-level achievement requires further development. Applicants are expected to possess at least basic mathematical competence. However, if necessary, this will also be developed within the program.
Students are expected to be able to:

- clearly understand the role of mathematics in physics through simple examples;
- perform calculations based on formulas accurately;
- derive general and parametric solutions using known physical formulas;
- evaluate measurements and correctly interpret experimental results.

During the selection process, students' digital competence is also assessed. If their skills are insufficient to meet program goals, targeted development is provided. It is important that students are able to:

- use graphical user interfaces confidently and take advantage of digital tools for learning physics (animations, videos, simulations, educational software, etc.);
- interpret and apply computer simulation programs;
- critically evaluate online information and identify scientifically reliable sources;
- use their own digital devices to carry out simple experiments.

3. Program Rationale and Objectives

The **2T – Talent Management Program** at our school is based on the recognition that contemporary STEM education must go beyond the traditional model of knowledge transmission. The decline in student motivation, decreasing interest in the natural sciences, and stagnating STEM career choices indicate that pedagogical practice must be renewed through innovative, experience-based, experimental, and digitally supported methods [2].
As part of the program, I formulated the following guiding questions:

- What methods can be used to enrich natural science education?
- Is participation in the talent management program motivating for students?
- Does research-based teaching and learning improve students' competencies and scientific vocabulary?
- Does the use of personal digital devices (BYOD) make physics education more effective?
- Is informal learning motivating for students?

The overall goal of the **2T – Talent Development Program at Teleki** is to transform physics education into a modern, experience-based, experimental, and digitally supported learning environment that stimulates students' interest and develops scientific thinking in a sustainable manner.

4. Assessment and Project Implementation

The primary aim of the projects was to increase students' commitment and motivation toward STEM education—especially physics—while developing their intellectual abilities, abstraction skills, complex thinking, integrated reasoning, psychomotor skills, creativity, flexibility, and problem-solving capacity.
At the beginning of the program, students built a strong theoretical foundation through the study of professional literature and learned how to design, conduct, and evaluate measurements. This contributed to the development of their language skills, because most of the relevant papers are available in foreign language (mostly English).
Developing students' ICT competencies was also essential. In today's digital environment, it is no longer sufficient to prepare measurement protocols and reference scientific sources; students must also be able to manage digital tools and academic resources effectively [3].
As a first step, I assessed students' prior knowledge. Then, simple but meaningful experimental tasks suitable for school settings were introduced. These tasks went beyond standard graduation requirements and helped students develop analytical thinking, teamwork skills, and subject knowledge.
Within the framework of targeted talent development, students received differentiated tasks according to their abilities and were involved in their chosen research projects and TDK activities. Most TDK projects were carried out in the laboratories of the Budapest University of Technology and Economics (BME), in close cooperation with university consultants.
We would like to express our gratitude for the close cooperation between BME and Teleki High School, which has helped us to pave the way for our students' success.
Through one year of dedicated work, students learned to write abstracts, prepare full-length (approximately 30-page) research papers, deliver presentations, and defend their work professionally.

5. Our Results

Students participating in the program demonstrated strong engagement in research activities and showed a willingness to explore STEM subjects in depth through experimental work.
As a result of their scientific development, students became able to:

- distinguish between essential and non-essential factors in investigations;
- interpret phenomena and differentiate between scientific and pseudoscientific views;
- draw valid conclusions from experiments;
- present experimental data graphically;
- understand major physical discoveries and systematize their knowledge.

Beyond academic success, the program also created lifelong experiences, friendships, and clear professional orientations. A key strength of the project was providing students with access to a real laboratory environment, enabling them to experience the full research process.
In November 2025, we organized our first in-house Scientific Student Circle Conference at Teleki. On November 3, students presented their research on seven topics to peers and teachers after nearly a year of extracurricular work [4].
Following the presentations, invited experts and consultants provided constructive feedback. Students used this guidance to refine their work in preparation for the November 19 competition.
Students summarized their results in written papers and presented them at the TDK Conference, successfully defending their work before professional juries and academic audiences.
In the current academic year, our school was represented by a 24-member team at the BME Secondary School TDK Day, including 9 presenters and 15 supporters. Our students actively participated in research projects across several faculties of BME, working on a wide range of interdisciplinary topics.
Their research focused on areas such as artificial intelligence, large language models, image processing, and vehicle control; railway level crossing safety and traffic risk analysis; the investigation of polyhydroxybutyrate production in *Cupriavidus* species under varying temperature conditions; plastic recycling, 3D printing, and riverine plastic waste management; and the use of coffee as an environmentally friendly reducing agent in the synthesis of gold nanoparticles within the framework of green chemistry.
These diverse research projects led to outstanding academic achievements and numerous awards, reflecting the students' dedication, scientific curiosity, and high professional standards.
Awards and Achievements

- Boda Tünde Lívia, Szepesi Szófia – 1st Prize (60 points)
- Kövesi Szabolcs Gergő – 1st Prize (60 points)

- Sándor Levente – 1st Prize (60 points)
- Nagy Dóra Mária, Szőke Benedek – 2nd Prize (60 points)
- Dang Dang Duong – 2nd Prize (60 points)
- Czufer András – 3rd Prize (60 points)
- Iványi Adrienn Emese – Commendation (30 points)

These institutional points may later be used for admission to BME faculties.
We sincerely thank the BME consultants, supporters, colleagues, and parents for their invaluable contributions.

Fig. 1. Our potential students

6. Summary

My experience clearly shows that students who voluntarily joined the program became significantly more motivated. Experiential learning, freedom of choice, research participation, and competition success transformed their curiosity into lasting, intrinsic motivation.

7. Conclusions

Extracurricular activities play a vital role in sustaining students' interest in STEM subjects, particularly in the context of reduced physics class hours. Hands-on experiments, study visits, and science performances offer real-world applications that deepen understanding and motivation.
Collaboration with universities and professional partners further enhances learning by exposing students to advanced research and practical applications.
This project demonstrates that even small successes can positively influence learning communities and encourage students toward technical and scientific careers. By continuing and expanding such initiatives, educators can create more engaging and inspiring STEM environments.
Student feedback confirmed significant improvements in their attitudes toward science, learning motivation, and self-confidence.
The primary objective of the program was to increase interest in natural and technical sciences while developing key competencies through diverse teaching methods. Students involved in experimental activities retain scientific concepts more effectively and enjoy collaborative learning experiences.
Based on evaluations and personal interviews, my hypotheses were confirmed: physics topics became more engaging, understandable, and connected to everyday life. Participants developed stronger motivation through meaningful extracurricular experiences.

8. Acknowledgement

Support of the Hungarian Nuclear Society is acknowledged, who not only supported me financially but also encouraged me and raised my motivation to pursue my goals with greater determination.

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