

BETWEEN PASSION AND FORMAL EDUCATION

Alicja Kluczek, Adrian Figiel

Studenci: Wydział Matematyki i Informatyki UMK
alicja2602@gmail.com, hokousharingan@mat.umk.pl

Anna Beata Kwiatkowska

opiekun merytoryczny, Wydział Matematyki i Informatyki UMK
aba@mat.umk.pl

Abstract. *This study examines how computer science Olympiad participants from the Baltic region learn and develop their skills, balancing personal passion with formal education. Based on a mixed-methods survey of 40 contestants in international informatics competitions, the research explores educational trajectories, the role of schools and teachers, and the influence of family, institutions, and self-directed learning. The paper contextualizes the findings within the structure of the Baltic Olympiad in Informatics (BOI) and reviews national curricula and digital education policies in Baltic countries and Poland.*

1. Introduction

In May 2025, Nicolaus Copernicus University had the privilege of hosting the Baltic Olympiad in Informatics (BOI), bringing together some of the most talented young programmers from across the region. As a faculty deeply engaged in informatics education, we recognized this event as a unique opportunity to explore how exceptional students develop their skills and navigate the path from general secondary education to international-level competence in computer science.

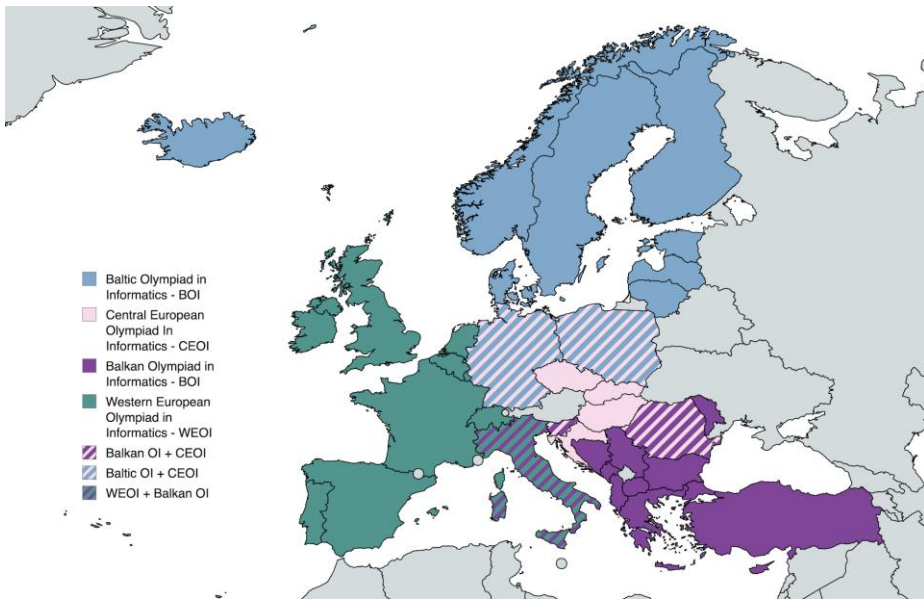


Participants of Toruń BOI

1.2. Regional Olympiads in informatics

The Baltic Olympiad in Informatics (BOI) was established in 1995 in Estonia to bridge the gap between national informatics competitions and the more advanced International Olympiad in Informatics (IOI). Initially involving only three founding countries, the competition quickly gained prestige and expanded. By 2025, twelve countries participated in BOI, including two guest nations—Ukraine and Israel.

Regional Olympiads have ever since become increasingly common, providing students with valuable experience in international-level competition in a less pressurized environment than the IOI. The problems tend to be slightly less difficult, offering a supportive stepping stone for young programmers. Currently, there are four major regional informatics Olympiads in Europe:



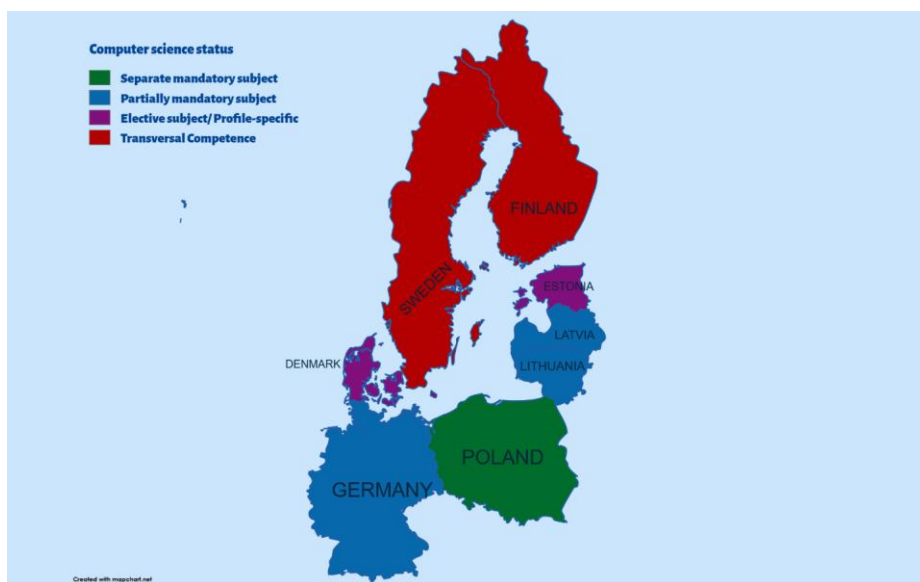
1.3. Research Methodology

During this year's BOI, we performed a voluntary survey among participants.

We received 42 responses, which covers over 50% of all contestants. The research is performed using mixed methods approach - we gathered quantitative data such as age of starting programming, and qualitative data to understand details of the training approach chosen by participants.

2. Summary of the educational structures of the Baltic countries

The analysis of computer science education across Finland, Sweden, Denmark, Lithuania, Latvia, Estonia, Germany, and Poland highlights diverse approaches with both shared and distinctive features. Integrated and Transversal: Finland and Sweden treat computer science not as a discrete subject for all, but as a set of transversal competences integrated into mathematics, crafts, and other disciplines. This model emphasizes algorithmic thinking and programming, often delivered through project-based learning within technical or optional tracks.



Modular and Spiral: Lithuania, Latvia, Germany (depending on the educational path or the federal state) and Poland. These countries employ spiral curricula where concepts like algorithmic thinking and digital literacy return in increasingly complex forms throughout the educational stages. The progression moves from foundational digital literacy to advanced competencies such as programming, robotics, data analysis, databases, networking, and cybersecurity, often complemented by project-based learning.

2.1. Summary of Digital Education Policies and Systems

Flexible and Profile-Based: Denmark and Estonia Denmark and Estonia offer highly flexible systems where CS is often mandatory in technical or vocational tracks (like the Danish HTX) but remains elective in general education programs. These systems cover a broad spectrum of topics, from system architecture and socio-ethical aspects to applied digital skills, with a heavy emphasis on practical projects as a central component.

Finland

Finland integrates digital education into a broader innovation strategy. Support is decentralized, with systemic focus on teacher training in digital pedagogy and ongoing professional development, aligning with international mandates for equitable digital transformation.

Sweden

Governance is highly localized, granting schools autonomy in selecting digital tools. The national strategy emphasizes supporting teachers via training and learning platforms, though the country faces ongoing challenges regarding equal access to resources.

Denmark

Denmark employs clearly defined central and local agencies to support technology integration. The policy focuses on interoperable learning platforms, long-term infrastructure investment (high-speed internet), and the development of learning analytics.

Lithuania

Lithuania invests in educational information systems and management platforms. While actively enhancing teacher and student digital competencies in line with EU priorities, the system struggles with providing consistent technological access in rural areas.

Latvia

Latvian policy prioritizes the development of student and teacher digital competencies. However, systemic support mechanisms, such as dedicated EdTech programs, are less developed, and regional disparities in technological access remain a concern.

Estonia

Estonia is a regional leader with advanced systemic support, including the Harno council programs (e.g., ProgeTiiger). Key features include widespread use of digital school management (e-Kool), adherence to the EU DigComp framework, and proactive AI initiatives like "AI Leap".

Germany

Digital support is managed through a complex federal "Länder" structure. While the "DigitalPakt Schule" provides federal funding for infrastructure and hardware, the highly decentralized nature of the system leads to significant regional variations in implementation and access.

Poland

Poland utilizes EU funding for infrastructure and has implemented initiatives like "Laboratories of the Future" to provide schools with advanced equipment (3D printers, VR) and mobile workshops. A major upcoming investment (2025–2026) involves 16,000 AI and STEM labs financed by the National Recovery Plan. Despite these gains, infrastructure inequality persists.

2.2. Number of Hours and Curriculum Content Related to Programming

At the outset, it is necessary to emphasize a significant difficulty: there is no reliable and consistent data that would allow for precise calculation of the average number of hours in lesson plans (lower and upper secondary) dedicated exclusively to learning programming in individual Baltic countries.

There are a small number of reports - with Eurydice being the key report - which do not provide a uniform aggregate of hours for "programming" as a separate component, but refer to the broadly understood "informatics" or "informatics/digital technologies", which complicates interpretation and comparison.

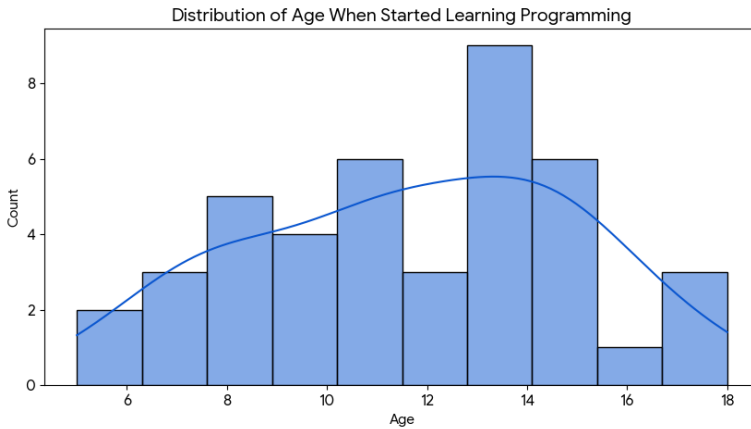
Eurydice reports provide specific examples of the distribution of computer science hours in individual countries at the upper secondary level:

- **Denmark:** In general upper secondary programs (e.g., STX, HHX, HTX), subjects are offered at three levels: C – 75 hours, B – 200 hours, and A – 325 hours.
- The Eurydice report also notes that in **Estonia**, upper secondary offers optional computer science courses: five courses of 26.25 hours each and a development project also of 26.25 hours, for a total of approximately 157.5 hours per course cycle.
- In **Sweden**, Eurydice indicates that upper secondary students can choose optional computer science courses that total "at least 200 hours" throughout the entire course cycle.
- **Poland**, on the other hand, provides for approximately 85.5 hours of compulsory computer science in general secondary schools, while in technical profiles this number may increase up to 900 hours.

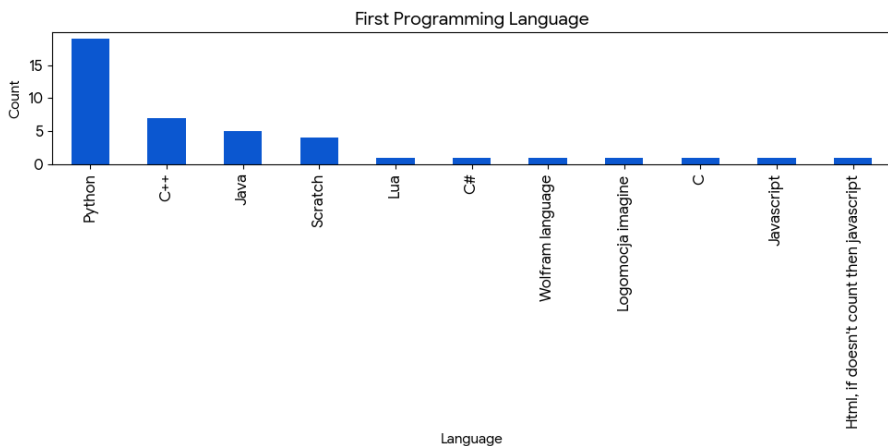
3. Survey Results

This chapter presents the analysis of survey data collected from the competition participants regarding their background, training habits, and needs in competitive programming. The participation rate is around 53% - 42 responders out of 78 competition participants.

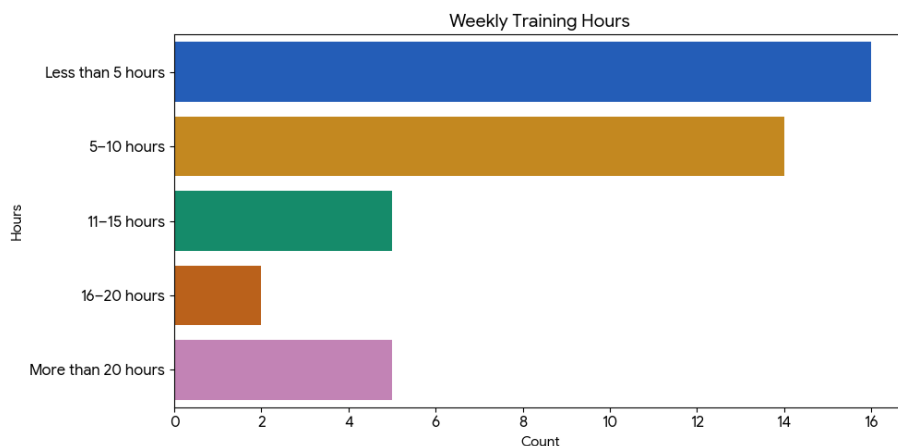
3.1. The "Profile" of a Contestant



The survey data suggests that competitive programmers typically start their journey at a young age. The average age for starting to learn programming or informatics is approximately 11.7 years, with a median of 12 years. The starting age ranges from as young as 5 to 18 years old, indicating a wide window of entry, though most students begin in their early teens.

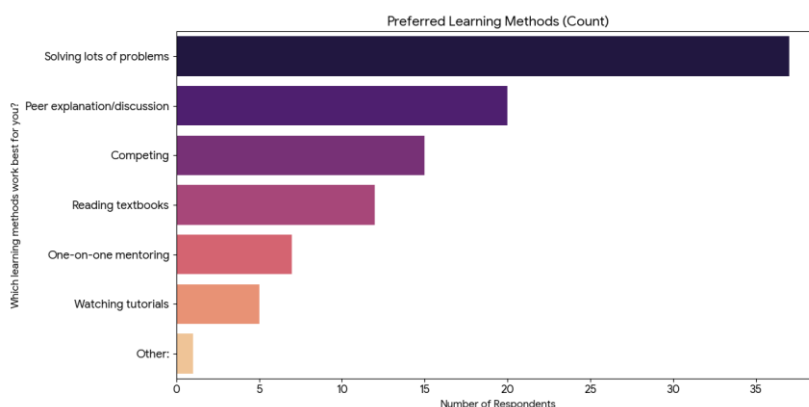


Python is the most common entry point, selected by 19 respondents (45%) as their first language. This is likely due to its syntax simplicity and widespread use in introductory courses. C++ follows with 7 respondents, and Java with 5. Block-based languages like Scratch were mentioned by 4 respondents, serving as a stepping stone before moving to text-based coding.



Most students train at a moderate intensity. The most common training duration is **"Less than 5 hours"** per week (16 respondents), followed closely by **"5–10 hours"** (14 respondents). A dedicated minority (7 respondents) trains more intensively, devoting over 16 hours a week specifically to informatics competition preparation.

3.2. Deep Dive: Effective Learning Methods

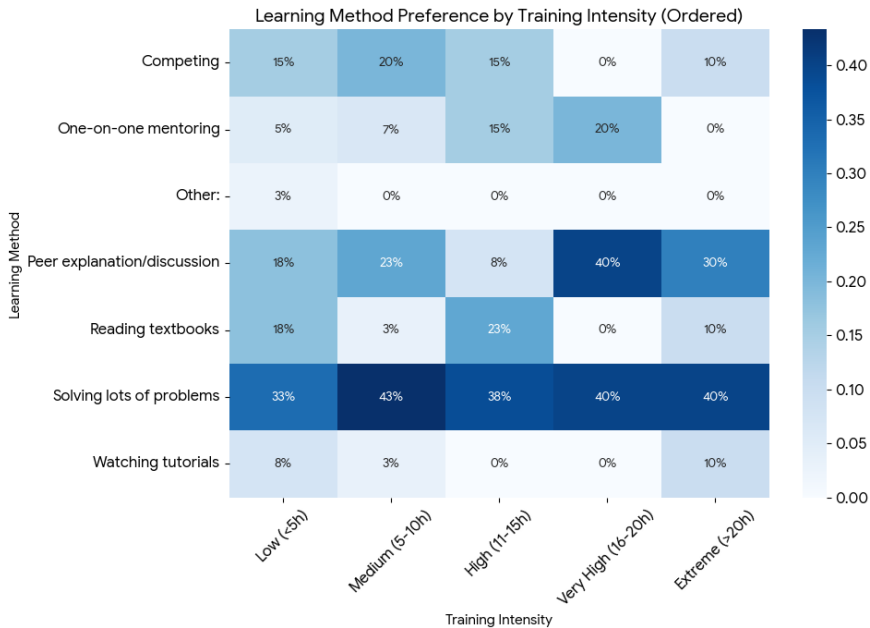


Respondents were asked to select which learning methods work best for them. The results show a clear hierarchy of preference favoring active over passive learning.

"Solving lots of problems" is the undisputed king of preparation, selected by **90% of respondents** (37 mentions). This was followed by **"Peer explanation/discussion"** (20

mentions) and "Competing" (15 mentions). Passive methods like "Watching tutorials" (5) and "One-on-one mentoring" (7) were significantly less popular.

A cross-reference with training intensity reveals a **shift in strategy** as students advance.



Beginners/Moderate Trainees (<10h/week): Utilize a mix of resources, including textbooks and tutorials.

Elite Trainees (>16h/week): Abandon textbooks almost entirely. Their learning is driven exclusively by raw problem-solving and peer discussion.

3.3. School Environment

The vast majority of respondents attend \textbf{Public schools (40 out of 42)}. Interestingly, **81% (34 respondents)** stated that their school **does not specialize** in competitive programming training. Furthermore, when asked if their school's curriculum helps with Baltic Olympiad in Informatics (BOI) preparation, the **feedback was overwhelmingly negative**. Common responses included "No," "Math class is way too low level," and "No programming course exists in my school." This indicates that competitive programming is largely an extracurricular pursuit, independent of formal education.

3.4. Discovery and Support

Students primarily learn about the Olympiad in Informatics through friends or **class-mates** (11) and **family** (9), rather than teachers (6). This peer and family network appears crucial for initial exposure.

Family and friend support is robust; 73% (30 respondents) reported that their friends and family support their journey "strongly," with another 11 reporting "somewhat" supportive environments.

While schools may lack resources, mentors play a varied role. Responses ranged from "I am basically entirely self-taught" to mentors being a "big part" who provide "90% of the theory." Key themes regarding the value of mentors included:

- Providing motivation and emotional support.
- Selecting good practice problems.
- Debugging code and explaining difficult concepts.

When asked what could be improved in their country's support, students expressed a desire for:

- More training opportunities (camps, workshops).
- Psychological support to prevent burnout
- More opportunities to participate in international events (e.g., "make the ministry of education allow us to go to IOI").

3.5. Stress and burnout

70% of participants expressed that participating in competitions and practicing is a stressful event for them. Coping mechanisms are often simple and physical. "Taking breaks" (including "calm walks to the bathroom") is a recurrent theme.

Many students reported they have not experienced burnout ("I don't do enough to experience burnout ;)"). Those who have experienced it cited "taking a break" as the only effective remedy.

4. Suggestions for Supporting Gifted Students

The survey revealed a significant gap between the needs of gifted students and current school support. Here are the 3 main recommendations:

1.1.1. **Advanced CS in School Curricula:** Schools should offer specialized tracks in algorithms and data structures, allowing high-apptitude students to advance at their own pace.

1.1.2. **Institutionalizing Training Camps:** National bodies should increase the frequency of camps (focusing on training, not just selection) and secure professional funding to prevent organizer burnout.

1.1.3. **Financial and Psychological Support:** Introduce scholarships or government grants to cover travel and training costs. Integrate psychological support into national team training to help students handle competition pressure and prevent burnout.

Literatura

1. Problems from Baltic Olympiad are available on BOI 2025 website.
2. The official 2024 English translation of the Finnish national core curriculum for general upper secondary schools can be found at Opetushallitus (OPH).
3. Information regarding local IT course offerings in Finland (such as ATK1 and ATK2) is available via Peda.net.
4. A case study on the transformation of informatics education in Finland and across Europe is provided by the Digital First Network.
5. English versions of Swedish subject plans for upper secondary school (GY11) are hosted by the National Agency for Education at Skolverket.
6. An overview of the GY25 educational reform in Sweden and its impact on the school system is available at GymnasieGuiden.
7. The official portal for the new GY25 curriculum framework in Sweden is located at Skolverket.
8. Technical specifications for Swedish computing subjects, such as digital systems technology, can be accessed via Syllabuswebb.
9. A description of the four main upper secondary education programs in Denmark (STX, HF, HHX, HTX) is provided by the Danish Ministry of Children and Education.
10. Detailed objectives for the Higher Technical Examination (HTX) program in Denmark are found at UVM.dk.
11. A guest post by Michael Caspersen regarding the development of the Danish computing curriculum is available at Computing Education.
12. The Lithuanian general education programs and digital literacy standards are accessible through the eMokykla portal.
13. Methodological materials for IT education in Lithuania are hosted at eMokykla Metodinė medžiaga.
14. Official regulations on Latvian secondary education standards and model programs are published at Likumi.lv.

15. The OECD Education Policy Outlook for Latvia provides a comprehensive country profile at [OECD.org](https://www.oecd.org/).
16. A video presentation detailing the Skola 2030 educational reform in Latvia can be viewed on YouTube.
17. The Estonian elective curriculum for Computer Science in upper secondary schools is available at [Oppekava.ee](https://oppekava.ee).
18. The consolidated text of the Estonian National Curriculum for Upper Secondary Schools is hosted at Riigi Teataja.
19. A database of German school curricula (Lehrpläne) across various federal states is provided by [Bildungsserver](https://www.bildungsserver.de).
20. The Informatik-Monitor 2025/2026 report on the status of computer science education in Germany is published by [Stifterverband](https://www.stifterverband.org).
21. The Polish core curriculum for secondary schools is available on the Integrated Education Platform at zpe.gov.pl.
22. A comprehensive Eurydice report on Informatics Education at School in Europe can be downloaded from [Eurydice Indire](https://eurydice.education.europa.eu).
23. Comparative data on global education systems and policies is accessible via [OECD GPS Education](https://gps.oecd.org).
24. The Digital Education Action Plan (2021-2027) for the European Union is outlined at [NASK](https://nask.gov.pl).
25. Information on funding for Polish school infrastructure through the National Recovery Plan (KPO) is available at gov.pl.