Co-funded by the European Union

Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment

Newsletter 3

February 2024

Dear Readers,

In this 3rd Newsletter, we will inform you about the progress made in the project, we will continue with the series of Consortium Introduced, inform about the project news and latest developments.

CONTENT

1. About CT&MathABLE

CT&MathABLE objective is to support digital transformation of students in multiple dimensions:

1) Improve school students digital skills and self-awareness based on learning-analytics;
2) Enhance computational thinking (CT) and algebraic thinking (AT) through the interactive tasks;
3) Integrate the STEM approach for task-based learning;
4) Create instruments for CT Assessment with learning-analytics, and
5) Provide the interactive tasks and assessment instruments in a format that can be integrated with various learning management systems.

The project aims to provide a learning-analytics based framework to support individualized learning trajectories for students in ages 9-14 across Europe. In this way, all children in ages 9-14 will be able to strengthen their Computational and Algebraic Thinking skills, which are among the key competencies of the 21st century, with Computer Science and problem solving tasks.

The project also has specific objectives in terms of teachers, instructional designers and school curricula. One of them is through the implementation of the CT&MathABLE system, teachers will experience the integration of technology into classroom settings as well as observe the effect of personalized instruction accompanied with the formal curricula. This implementation process is expected to work in a blended learning approach which again will make teachers to think and adopt appropriate pedagogical strategies for the use of interactive tasks through collaborative learning.

2. Eötvös Loránd University, Hungary

Eötvös Loránd University, Budapest
(photo from the ELTE website https://www.elte.hu/content/lagymanyos-leiras-es-galeria.c3c.63?m=135)

Eötvös Loránd University (ELTE) is Hungary's most prestigious university with the richest traditions and the highest international rankings in the country, where tradition and innovation go hand-in-hand. ELTE became a Research University in 2010 and received the distinguished title of University of National Excellence in 2013.

ELTE Faculty of Informatics plays a leading role in the Hungarian computer science education. Study programs and Faculty research are focused on Theoretical Computer Science, Unconventional models of computing, Formal language and automata theory and their applications, Security, Privacy and Trust, Analytic and algorithmic number theory, Mathematical Modelling, Programming Languages, Software Technology, Executable UML, software verification and testing, Computer vision, pattern recognition and geometric modelling, Artificial Intelligence, Human-computer collaboration, Information Systems, Big data, cloud and database technologies.

Teaching informatics at ELTE was initiated in 1969. The courses, offered to students of mathematics, were called computing techniques. In 1972 professor Imre Kátay recognized the growing significance of informatics and initiated a new curriculum called programmermathematician. In order to organize the introduction of the new courses the Department of Numerical and Computer Mathematics was established. The number of students was increasing rapidly, from 60 in 1972 to 400 in the eighties, and it reached 2000 by the end of the nineties. The huge department had to be divided into three specialized ones, which together created the Institute of Informatics later on. In 2003 the Institute of Informatics and the Department of Cartography of the Faculty of Science established the Faculty of Informatics.

More text and information: https://www.elte.hu/en/faculties/informatics

3. Klaipėdos Gedminų Progymnasium, Lithuania

Gedminų progymnasium, Klaipėda, Lithuania

Klaipėda Gedminų Progymnasium implements the 1st and 2nd stage of basic education program. There are 929 students in classes 1–8, 70 teachers, 4 assistance specialists, 1 head teacher and 4 deputies. The school is attractive to students and their parents as a lot of attention is paid to the quality of education, arts and is not limited to standards. There are also classes, which apply the elements of Waldorf pedagogy and the classes for an intensive English language training.

The school seeks students' personal development through high quality education. Participating in this project will help to reach strategic and annual activities plan's goals and aims, better students' reading and writing abilities. The international experience, developed teachers and students' skills, knowledge, increased community collaboration will directly make an impact.

The progymnasium is always open for innovations and takes part in the Education Improvement, Renovation, Partnership (Nordplus, Erasmus +) Projects. School community raised the priority to become a leader in the application of IT in the region. A lot of attention is paid to the curriculum of information technology and its integration with other subjects. Teachers successfully use the latest IT tools and training programs in the learning process. Progymnasium is open for innovations, reaching the highest quality of education.

The school has a lot of innovative and energetic teachers who want to improve the educational process, to make it acceptable for modern children. Teachers constantly learn themselves; they share their best practices by preparing training programs as well as reading the papers in seminars and conferences.

Head of the Project in the school – Asta Jankauskienė (Project management, administration, dissemination activities). The main teacher of the Project in the school – Indra Sudeikienė (Project implementation activities, dissemination activities). Financial coordinator – Svetlana Perekatova.

More information: https://gedminai.lt/

3. Project Meeting in Budapest and Hungarian Teacher Workshop

Tolgahan Ayantaş, Tuğba Öztürk, Ismail Güven, Fatma Özdemir Öncül, Beytullah Azteki, Nilüfer Tan Yenigun, Halil Yilmaz, Nuray Akpinar, Dorottya Vincze, Eugenio Bravo, Javier Bilbao, Valentina Dagienė, András Margitay-Becht, Zsuzsa Pluhar, Daranee Lehtonen, Anikó Rumbus, Indra Sudeikienė, Heidi Kaarto, Arnold Pears, Asta Jankauskienė, Pal Samasagi, Anikó Rumbus, Vaida Masiulionytė-Dagienė.

CT&MathABLE project partners had meeting in Budapest in May 30-31 – June 1, 2023. Partners discussed teaching Computational Thinking and Algebraic Thinking in their countries, Informatics curricula and assessment tools.

On the first day of the meeting, the partners presented the results of their part of the project. The following day, the next day was used to decide on further work in the project. Discussions were held on a common understanding of the definition of informational thinking, since, based on various scientific studies, there is still no unanimous conclusion on how to define informational thinking. Information videos were made to introduce the project. Further work and responsibilities were agreed.

Pál Sarmasági presented details of Algebraic Thinking in curricula of each country. Algeraic Thinking means thinking analytically, studdying and representing relationship, quantitative reasoning, relational thinking, variables, symbolic relation, mathematical language.

What is the distinction among concepts of CT? Example with the task of finding church. There are several solutions. Discussion how task reflects abstraction concept. Discussing, how decomposition, algorithm thinking everyone understands. Generalization -> Transferability.

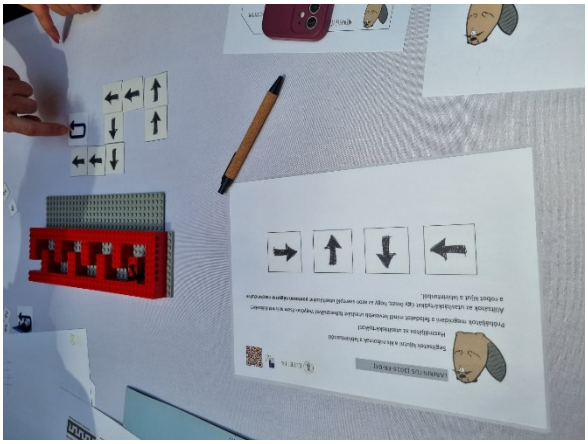
Suggestion to discuss on CT definition based on this document:
https://docs.google.com/document/d/1l5DJukdUuHvC5yARLseOI-1zny2jEO_P/edit

About the project meeting: https://www.fsf.vu.lt/naujienos/fakulteto-ivykiai/5581-ct-mathable-projekto-partneriu-antrasis-susitikimas-budapeste

Teacher Workshop on CT Unplugged Activities

On the third day, a workshop for Hungarian teachers was held. During the workshop, teachers tried out the interactive Bebras tasks already developed and integrated in the ViLLE system, as well as CS Unplugged activities based on the Bebras tasks: they could crochet hamburgers, code words, create fractals with chopsticks, find common features in jars of sweets and many other activities.


B, C, D
C, F
A, E, F
A, B, E
B, E, F
A, C, F



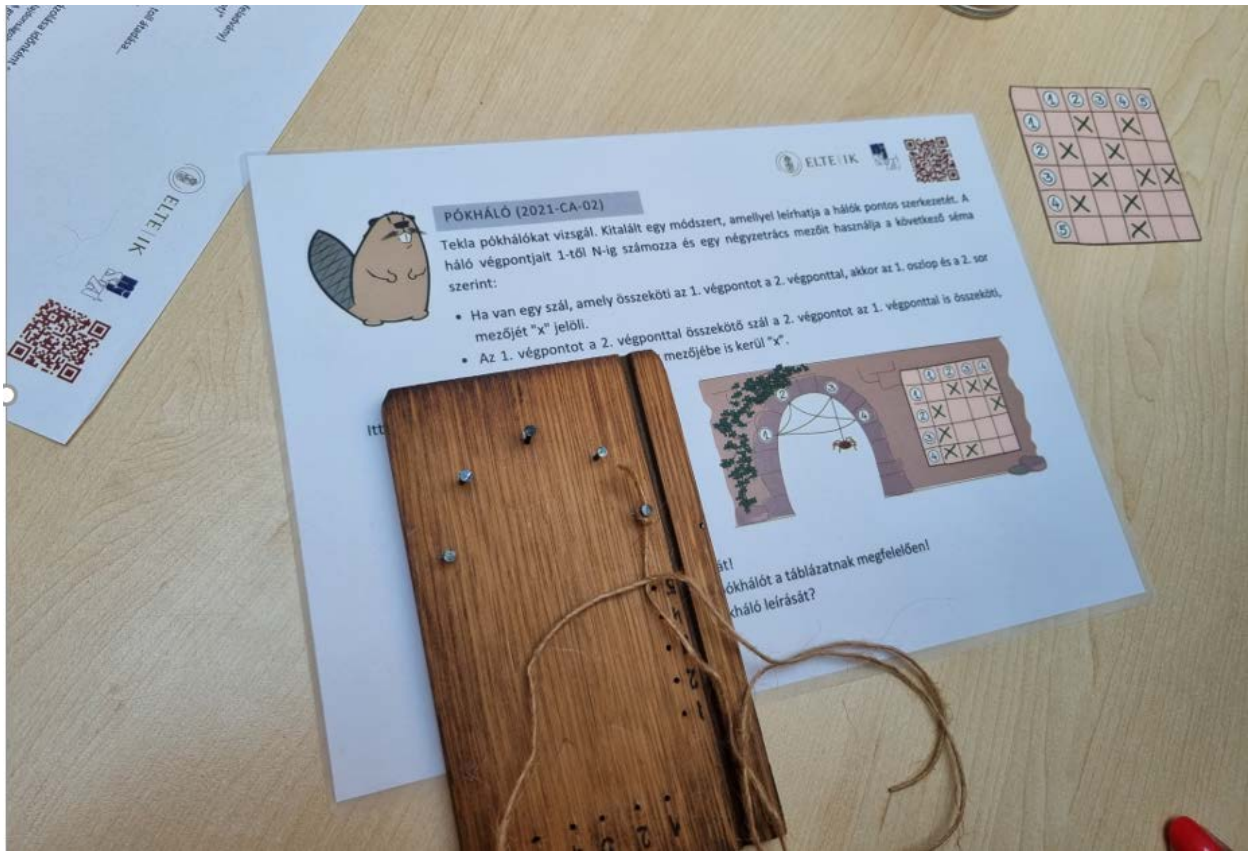
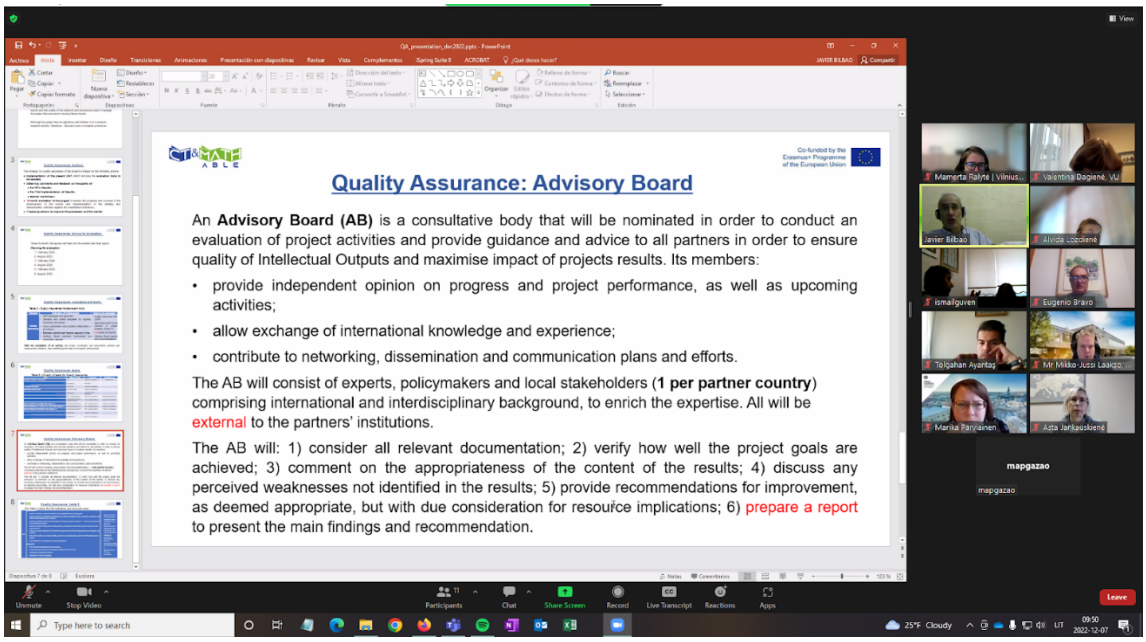


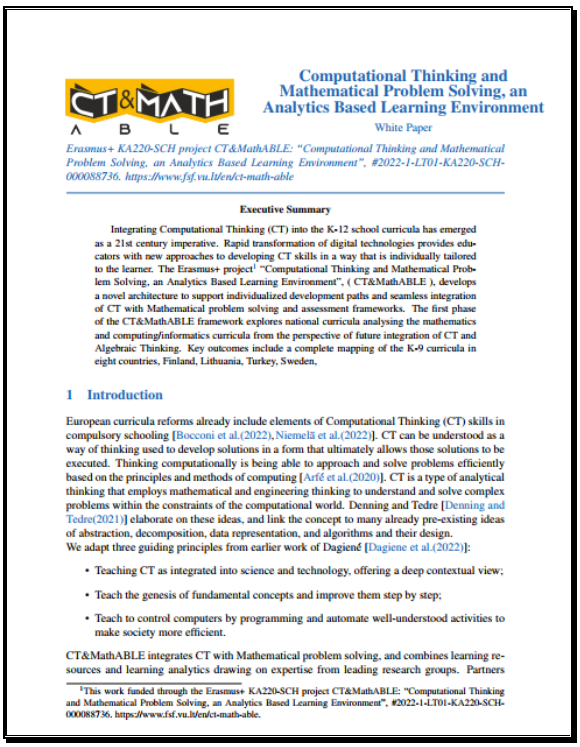
Photo by V. Dagienė

Online meetings – in the first week of each month

In the first week of each month, the CT&MathABLE partners meet to discuss the progress of the project, the main activities and results have achieved. Agreements what should be done further are discussed and confirmed.



Two White papers were released.



Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment

White Paper

Erasmus+ KA220-SCH project CT&MathABLE: "Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment", #2022-1-LT01-KA220-SCH-000088736. https://www.fsf.vu.lt/en/ct-math-able

Executive Summary

Integrating Computational Thinking (CT) into the K-12 school curricula has emerged as a 21st century imperative. Rapid transformation of digital technologies provides educators with new approaches to developing CT skills in a way that is individually tailored to the learner. The Erasmus+ project[1] "Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment", (CT&MathABLE), develops a novel architecture to support individualized development paths and seamless integration of CT with Mathematical problem solving and assessment frameworks. The first phase of the CT&MathABLE framework explores national curricula analysing the mathematics and computing/informatics curricula from the perspective of future integration of CT and Algebraic Thinking. Key outcomes include a complete mapping of the K-9 curricula in eight countries, Finland, Lithuania, Turkey, Sweden,

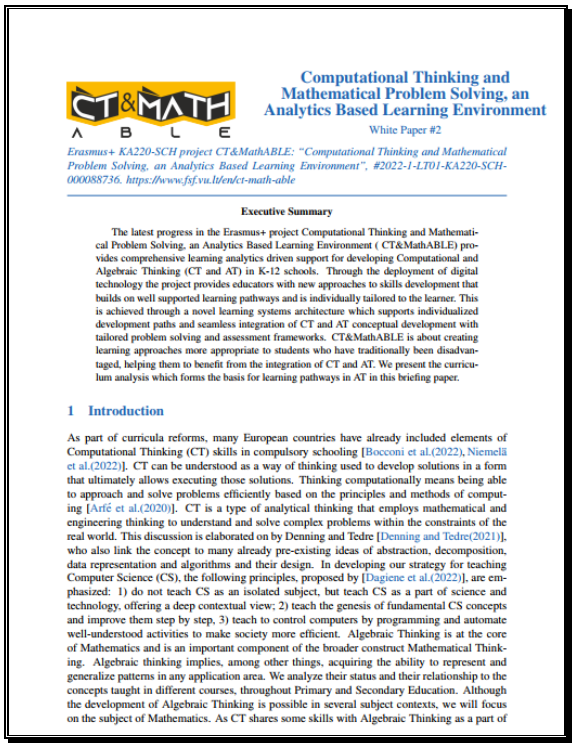
1 Introduction

European curricula reforms already include elements of Computational Thinking (CT) skills in compulsory schooling [Bocconi et al.(2022), Niemelä et al.(2022)]. CT can be understood as a way of thinking used to develop solutions in a form that ultimately allows those solutions to be executed. Thinking computationally is being able to approach and solve problems efficiently based on the principles and methods of computing [Arfé et al.(2020)]. CT is a type of analytical thinking that employs mathematical and engineering thinking to understand and solve complex problems within the constraints of the computational world. Denning and Tedre [Denning and Tedre(2021)] elaborate on these ideas, and link the concept to many already pre-existing ideas of abstraction, decomposition, data representation, and algorithms and their design.
We adapt three guiding principles from earlier work of Dagienė [Dagiene et al.(2022)]:

- Teaching CT as integrated into science and technology, offering a deep contextual view;
- Teach the genesis of fundamental concepts and improve them step by step;
- Teach to control computers by programming and automate well-understood activities to make society more efficient.

CT&MathABLE integrates CT with Mathematical problem solving, and combines learning resources and learning analytics drawing on expertise from leading research groups. Partners

[1]This work funded through the Erasmus+ KA220-SCH project CT&MathABLE: "Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment", #2022-1-LT01-KA220-SCH-000088736. https://www.fsf.vu.lt/en/ct-math-able.



Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment

White Paper #2

Erasmus+ KA220-SCH project CT&MathABLE: "Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment", #2022-1-LT01-KA220-SCH-000088736. https://www.fsf.vu.lt/en/ct-math-able

Executive Summary

The latest progress in the Erasmus+ project Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment (CT&MathABLE) provides comprehensive learning analytics driven support for developing Computational and Algebraic Thinking (CT and AT) in K-12 schools. Through the deployment of digital technology the project provides educators with new approaches to skills development that builds on well supported learning pathways and is individually tailored to the learner. This is achieved through a novel learning systems architecture which supports individualized development paths and seamless integration of CT and AT conceptual development with tailored problem solving and assessment frameworks. CT&MathABLE is about creating learning approaches more appropriate to students who have traditionally been disadvantaged, helping them to benefit from the integration of CT and AT. We present the curriculum analysis which forms the basis for learning pathways in AT in this briefing paper.

1 Introduction

As part of curricula reforms, many European countries have already included elements of Computational Thinking (CT) skills in compulsory schooling [Bocconi et al.(2022), Niemelä et al.(2022)]. CT can be understood as a way of thinking used to develop solutions in a form that ultimately allows executing those solutions. Thinking computationally means being able to approach and solve problems efficiently based on the principles and methods of computing [Arfé et al.(2020)]. CT is a type of analytical thinking that employs mathematical and engineering thinking to understand and solve complex problems within the constraints of the real world. This discussion is elaborated on by Denning and Tedre [Denning and Tedre(2021)], who also link the concept to many already pre-existing ideas of abstraction, decomposition, data representation and algorithms and their design. In developing our strategy for teaching Computer Science (CS), the following principles, proposed by [Dagiene et al.(2022)], are emphasized: 1) do not teach CS as an isolated subject, but teach CS as a part of science and technology, offering a deep contextual view; 2) teach the genesis of fundamental CS concepts and improve them step by step, 3) teach to control computers by programming and automate well-understood activities to make society more efficient. Algebraic Thinking is at the core of Mathematics and is an important component of the broader construct Mathematical Thinking. Algebraic thinking implies, among other things, acquiring the ability to represent and generalize patterns in any application area. We analyze their status and their relationship to the concepts taught in different courses, throughout Primary and Secondary Education. Although the development of Algebraic Thinking is possible in several subject contexts, we will focus on the subject of Mathematics. As CT shares some skills with Algebraic Thinking as a part of