Co-funded by the European Union

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

Newsletter 2

May 2023

Dear Readers,

Since September 2022, when the first Newsletter has informed the readers about the start of the international project Computational Thinking and Mathematical Problem Solving, an Analytics Based Learning Environment, the CT&MathABLE Project partner countries has made rethink and replan the work in the project taking into consideration the changed situation. So, in this 2nd 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

The CT&MathABLE enhances European educational resilience and capacity leveraging digital transformation tools and pedagogies to realise innovative school curricula to enable recognition and validation of skills and qualifications addressing future demands for citizens with the digital skills and computational literacy needed for digital transformation. The project delivers open, relevant and localized educational resources for developing computational thinking and algebraic thinking of primary and lower secondary school students with novel modes of interaction and high quality content.

CT&MathABLE delivers:

- personalized learning trajectories (Learning Paths) in developing competencies of computational thinking and algebraic thinking combining a learning architecture and cutting edge learning analytics technologies with interactive tasks that have been proven to engage learners in accelerated intellectual development;

- competency frameworks for integrated and automated assessment of learning in Informatics (Computer Science) and Mathematics;

- large scale libraries of interactive tasks designed explicitly to hone computational thinking and algebraic thinking competencies.

1. Introduction to the project Work Packages

The project consists of 5 work packages (WP):

WP1: Project management.

WP2: Developing Learning Paths for CT integrated with AT

WP3: Development of CT and AT Assessment Framework

WP4: Developing Interactive Tasks

WP5: Disseminating CT&MathABLE.

WP 1

Project Management is led by the project coordinator VU with support and effective contributions from all partners. It aims to ensure effective coordination and successful implementation of project activities. According to the good practices of already implemented projects, three main groups – management board, steering committee, and advisory board - ensure successful project management, including progress, quality, and achievement monitoring.

WP 2

The WP2 focuses on delivering learning paths for Computational Thinking (CT) with Algebraic Thinking (AT) for students aged 9-14. In the development of these learning paths, the skills that CT and AT share (e.g., algorithmic thinking, problem solving, abstraction) will be utilized. The main results of WP2:

R.2.1. Learning outcomes for the two age groups separately (9-11 and 12-14) - what students should know, be able to do as a result of participating in this project. Learning outcomes play an important role in assessment and evaluation, making clear what knowledge learners should have upon completion of the learning activity: it gives a basis for WP3.

R.2.2. The activity plan. Learning objectives will be passed to the outcomes and design the activity plans. The activity plan will be based on and paired with Bebras activities (used in partner countries) and contain online, interactive activities (using a tool developed by WP4) and unplugged extending activities, as well.

R.2.3. Tasks on CT with integrated AT. Tasks will be practical, current, and can be used as a basis for digital competence development in any schools. The activities will be integrated into an analytics based learning ecosystem linked with an assessment framework (WP3). At least 100 activities will be developed, translated and integrated. We have two age groups separately with 20 activities in 3 variations in each. We use anchor activities: 5 activities will be the same (with variations) for the age group 9-11 and 12-14.

R.2.4. Materials. The following materials will be translated into partner countries' languages where associated school will participate in pilots: the texts of activities integrated into the ecosystem and used in 1) the pilot questionnaires, 2) forms for feedback, 3) teachers guides - if needed.

R.2.5. Piloting works in cooperation with the pilot in WP3. The feedback and questionnaire give the basis of each partner's pilot reports.

R.2.6. Teacher workshop. The learning paths and the plans of earning activities will be discussed in a Teacher workshop, in Budapest, with the partners and teachers from associated schools in Hungary. This involves the final improvement of the learning activities.

WP 3

To teach the 21st century competences of Computational Thinking (CT) and Algebraic Thinking (AT) by integrating them is unique. As CT and AT share some skills, intertwining them should benefit the development of both CT and AT. Thus the shared skills of CT and AT, most importantly algorithmic thinking and problem-solving skills, will be utilized whilst developing the assessment instruments for CT&MathABLE. There is currently a lack of assessment instruments for CT integrated with AT, but teachers certainly need instruments to assess their students' learning progression and to discover whether additional support is needed.

WP3 is developing two valid and reliable assessment instruments of CT and AT for use with students from age 9 until age 11 (COMATH1) and from age 12 until 14 (COMATH2). The need for two separate assessment instruments arises from the different development phases of the students. The students of the first age group are in the early phase of learning CT and AT whereas the second age group has progressed to more advanced content. Hence, the assessment instruments also need to reflect the differences in the difficulty levels. To capture the development in these skills later on, at least 5 anchored items will be used in COMATH1 and COMATH2. The following will be the main results of this work package.

The main results of WP3:

R3.1 Based on the definition of learning outcomes of CT (WP2) and the systematic review, we will develop assessment instruments for CT and AT skills, COMATH1 and COMATH2, for two different age groups. COMATH1 and COMATH2 will be of high validity and reliability as they are theoretically grounded and guided by well-established design frameworks, thus fully unravelling the complexities of students' digital skill development and capturing the level of students' CT and AT thinking skills.

R3.2 Short and clear guidelines for teachers on how to use the assessment instruments will be created in collaboration with all partners. Teachers need them to ensure the correct use of the assessment instrument for 9-11 and 12-14-year-olds.

R3.3 Short and clear guidelines for teachers on how to interpret the results of students' performance.

R3.4 The guidelines for teachers will be developed in English and then translated into two languages (partner schools).

WP 4

The goal of the WP4 is to develop a set of interactive task and design/program a tool for creation interactive tasks for the CT integrated with AT skills development. The created interactive tasks and tool will be integrated into the ecosystem with learning analytics.

Many tools are developed to promote teaching and learning through interactive learning material. Most of them are designed to teach programming or present the content in an attractive way. However, students also teachers are lost in the supply of instruments or lack programming skills to use the tool. We propose a tool for creating interactive tasks, which is distinguished by interactive and animated digital content that engage students to develop both CT and AT competences based on templates. The tool and tasks will be developed by professionals with many years of experience in education and based on the ideas from the world most popular Bebras challenge. By using the developed tool integrated into the ecosystem with learning analytics students will be involved to solve CT and AT tasks. Students will be encouraged to share their

own ideas and solutions, look for associations in similar real-life situations, and apply the problem-solving approach in practice.

The WP4 will focus on developing a set of interactive tasks and a tool for the creation of interactive tasks, and then integration of the interactive tasks for a selected learning environment with learning analytics. Expected results of the WP4 are the following:

R4.1: A set of classified interactive tasks according to the concepts of computer science / CT integrated with AT;

R4.2: A framework of interactive tasks - it can serve for creating new interactive tasks on CT;

R4.3: A tool for creating interactive tasks will be designed and programmed, additionally templates for type of interactivity, criteria for interactive tasks, etc. will be developed. All classified tasks would be presented using the tool and the ability to create new tasks will be provided (templates for type of interactivity, criteria for creating interactive tasks)

R4.4: A set of interactive tasks for implementation using the developed tool will be created. This set will be piloted in partner schools as well as in the project associated schools and feedback how to improve will be collected;

R4.5: The integration of the tool into an analytics based learning ecosystem. Also functionality for the students to solve those interactive tasks will be implemented in the learning ecosystem together with the tool.

R4.6: Translation of the created interactive tasks and organizing Workshop #2 held in Klaipeda Gedminai Progymnasium for piloting the interactive tasks and tool.

R4.7: Research on the usability of the learning tasks. Through observing user experience based on evidence, interaction design will be improved throughout the tasks.

WP 5

WP5 links key project results to stakeholder groups where they contribute to change in three dimensions, Policy, Academy and Education. To achieve this WP4 activity will be coordinated by a strategy group that meets regularly throughout the duration of the project. All dissemination is managed through targeted multiplier events - ME's. ME's for policy makers are implemented through production of a series of whitepapers linked to bi-annual information meetings in which the strategic communications group summarizes the relevance of the project outcomes for school districts and schools. This activity informs school education ministers and other relevant educational service providers as a paper report and a short film. This links the work done in the main work packages of the project to events designed to inform education ministers, boards of education, education providers and school principals.

WP5 communicates the outcomes of WP2-WP4 to key stakeholder groups and provides support for long term adoption and sustainable educational practices built on the CT&MathABLE education architecture. The primary aim of the dissemination package is to articulate and transfer programme outcomes to achieve broad visibility in academic leadership, inform educational policy and achieve widespread adoption in national school systems. Engagement in the multiplier events will provide training to 100 teachers in local schools. White papers and short films summarizing key milestones in the project will be delivered to education departments in all partner countries, as well as school regions and schools through the collaborative partners. The CT&MathABLE Educational Summit will gather the project team and policy makers to achieve high level input and facilitate systemic adoption of the CT&MathABLE education architecture in national and state education systems.

The main results of this work package:

R5.1: Bi-annual briefing reports (whitepapers), and 3 minute films summarizing key outcomes delivered over three years;

R5.2: White papers and films, articles in teacher magazines and presentations at professional development events for teachers;

R5.3: Planning and conduct of multiplier events in each country: each partner university will organize ME for policy makers in their country, and each school partner will organize ME for teachers of associated partner schools in their country.

R5.4: Planning and conduct of Final Event - CT&MathABLE Education Summit (Sweden)

2. University of the Basque Country

School of Engineering, Bilbao (photo from the School website https://www.ehu.eus/en/web/bilboko-ingeniaritza-eskola)

The University of the Basque Country (UPV/EHU) is a teaching and research institution officially founded in 1980, although some of the centres that make up the university predate that date. For example, the School of Engineering of Bilbao, to which the members of the UPV/EHU that participate in the Consortium belong, has its origins in 1897. Its name is School and not Faculty, due to the fact that, at that time, professionalizing studies, closely linked to industry, were taught. The university employs over 7.500 people in 31 faculties and schools distributed in three different campuses, with more than 57.000 undergraduate and postgraduate students. The UPV/EHU offers the highest number of doctorate programmes of all Spanish universities, one third of which have received a mention of excellence from the Spanish Ministry of Education. The UPV/EHU has been recognised as an International Research Campus of Excellence by the Spanish Ministry of Science and Innovation (MICINN), and, in 2021, was awarded the HRS4R award by the European Commission for human resources excellence in research.

Since the first European Research Framework Programmes, the UPV/EHU has been very active and has participated in a wide variety of collaborative projects. In the 7th Framework Programme (2007-2013) the University of the Basque Country participated in 94 projects, of which it coordinated 22, amounting to more than 30 million Euros. In Horizon 2020 (2014-2020), the UPV/EHU has so far been successful with 144 projects that have already attracted a total sum of more than 40 million Euros in research and innovation financing, including 9 ERC grants, of which 2 are Advanced Grants and one a Synergy Grant, and 9 projects from the FET programme. In addition, the UPV/EHU recently obtained its first MSCA Cofound grant in the last call of the H2020 programme.

The UPV/EHU is already participating actively in the new Horizon Europe programme (2021-2027) and has so far won six projects, two of which are ERC grants, with the UPV/EHU also coordinating two Pathfinder projects. In 2014, the University of the Basque Country (UPV/EHU) started to support Erasmus + Programmes. By the time it has been the beneficiary of six Jean Monnet, more than twenty KA2 Strategic Partnerships, five KA2 Capacity Building, and three KA2 Sports, also KA2 Knowledge Alliance, KA3 Support for policy reform, and KA2 Universidad.

The Applied Mathematics Department performs high quality teaching and research activities within the UPV/EHU. It is composed of more than 80 professors that aim at educating undergraduate and graduate students in the Applied Mathematics knowledge area, with special emphasis on Engineering and technological applications. Professors of the department are responsible of the subjects related to Mathematics, which are taught in several degrees like Industrial Technology Engineering, Mechanical Engineering, Industrial Electronic, Automation Engineering, Architecture, etc.

The department participates also in a Doctorate Program to train PhD students in the aforementioned knowledge areas. The department has three teaching and one research laboratories devoted to teaching activities and research activities related to Renewable Energies, Reverse Engineering, and new Technologies applied in Education.

Two key staffs are heavily involved in this project: Javier Bilbao, Ph. D., Professor at School of Engineering of Bilbao, and Eugenio Bravo Ph. D. in Industrial Engineering.

Javier Bilbao is Industrial Engineer and he is teaching in the Applied Mathematics Department at the School of Engineering of the University of the Basque Country. Since academic year 2003/04 till 2015, teacher of a subject (C language) in the G9 Group of Spanish Universities (a group of 9 Spanish universities to teach subjects in a virtual way, using ICT). Use of teaching mathematical software at least from 1997 (for example, Mathematica and Matlab). Use of learning platforms (LMS, etc.) from at least 2002 (Moodle). Javier Bilbao has been teacher of teachers in Moodle course. Various research projects in Education: “Application of the web services to university learning”, “Design of Curricula in the European Harmonization Process in Higher Education based on the use of e-learning tools”, “Adaptation of the Linear Algebra area by means of the use of the new technologies”, “E-material for educational supporting”, “Matrix Project: Telematic learning modalities and interuniversity extrapolated results to blended learning”, “Attractive renewing of Mathematics for the jump from High School to University”, etc. Various articles in journals (more than 50), conferences (more than 120) and chapters of books or books (more than 15). Javier Bilbao was member of the Evaluation Committee of the Industrial Engineering Graduate for the National Plan for the Evaluation of Quality of the Universities of Spain and Consultant of the Evaluation Committee of the Mining Engineering Degree, speciality Energy Resources, Combustibles and Explosives, for the National Plan for the Evaluation of Quality of the Universities of Spain (1998-2000). He is also the president of the Health and Safety at Work Committee of the Bizkaia Campus, and deputy director of the Applied Mathematics Department.

Other members of the research group of Javier Bilbao contributing to the project are: Olatz García Ph. D. in Mathematics, also director of the Applied Mathematics Department; and Carolina Rebollar Ph. D. in Mathematics, also Academic Secretary of the School of Engineering of Bilbao. All members of the team from UPV/EHU are involved in training teachers from Primary and Secondary Education in the area of STEAM and digital competence.

3. Project Meetings

The kick-off project meeting was organized by the University of the Basque Country on 26-28 October 2022. It was the first out of 5 international meetings planned in the project. Other meetings will be organized in four partner countries.

Kick-off meeting in Bilbao (from the left): Eugenio Bravo, Carolina Rebollar, Vaida Masiulionytė-Dagienė, Javier Bilbao, Asta Jankauskienė, Indra Sudeikienė, Pal Samasagi, Arnold Pears, Zsuzsa Pluhar, Valentina Dagienė, Mikko-Jussi Laakso, Ismail Güven, Olaz Garcia, Mamerta Ralytė, Fatma Özdemir Öncül, Tolgahan Ayantaş.

Overview of the project goals and special objectives, discussion and clarification of the target groups: teacher trainers, policy makers and politicians, presented by the project coordinator professor Valentina Dagienė, Vilnius University. Introductions by project partner institutions: University of the Basque Country, Vilnius University, Eötvös Loránd University, Turku University, KTH Royal Institute of Technology, Ankara University, Mamak Özkent Akbilek School, Türkiye, and Klaipėdos Gedminų Progymnasium, Lithuania.

Discussion about involving different disciplines teachers. During the project activities, the main fucus should be on mathematics and informatics (computing, information technology) teachers but others like science or technology teachers could get involved at some point of projects, for example in piloting activities.

Partners have provided brainstorming on developing Learning Paths, many ideas were collected, overviewed and going to be implemented in work package 2 especially.

Intensive work was dedicated to revise the project reviewers recommendations, and the assessment. All partners made comments on the project assessment sheet.

The main goals of the kick-off meeting were to introduce and strengthen the multi-national and multi-disciplinary consortium team; to overview the project activities, to present, discuss and agree on operational plan, time schedule, work package coordination and activities planning; to discuss in detail each partner responsibilities.

There were the main project management issues discussed: the appointment of persons to the Steering Committee and the Management group, the budget and financial management rules, the internal communication, quality assurance and main qualitative and quantitative indicators, a quality control plan and its implementation, the dissemination strategy of project results.

As VU has an overall coordination responsibility, it was agreed that all partners will contribute equally to the different activities and co-manage intellectual outputs. To facilitate this, dissemination and quality coordination is forwarded to partners/supported by partners. This arrangement keeps the workload manageable, while insuring that at the same time all partners are involved in overall project coordination. Decisions are made by majority vote and communicated to all partners using the created group Email address. The partners use Skype meetings, video conferences, project management software (Trello) and e-mails to formalise communication paths within the consortium as well.

It was agreed on dissemination strategy and project website to be developed within the website of the VU Philosophy faculty. It can be found at the following address: https://www.fsf.vu.lt/ct-math-able

There is a google drive arranged for internal communication of partners. It has the uploaded presentations, photos, documents, templates, drafts, etc. There were templates, necessary for the project implementation activities, and for their development.

Online meetings

The CT&MathABLE project partners have meet online every month for an hour general meetings and information exchange. Smaller working groups on specific questions meet according their demand.