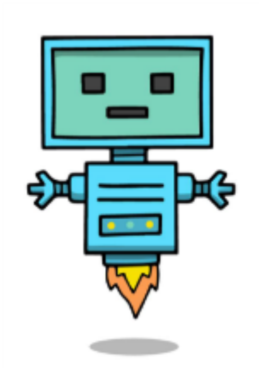


codinc.fun

Coding for Inclusion

#CodincEU

592121-EPP-1-2017-1-BE-EPPKA3-IPI-SOC-IN

Codinc for Inclusion - CODINC
WP3 - Experimentation Report 2019

Coding for Inclusion – CODINC
592121-EPP-1-2017-1-BE-EPPKA3-IPI-SOC-IN
Erasmus + KA3 Support for Policy Reform
www.codinc.fun

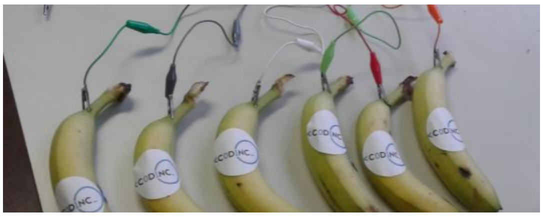
Partners:
ALL DIGITAL aisbl (Belgium), MAKS vzw (Belgium), COLECTIC coop (Spain), 21st Century Competency Centre (Germany), University of Naples Federico II (Italy), Educentrum vzw (Belgium), Cyprus Computer Society (Cyprus)

Table of Contents

Executive Summary

Coding for Inclusion (CODINC) is an Erasmus plus Key Action three project in the field of social inclusion. The project scales up a best practice called Capital Digital created by the Brussels-based project partner in non-formal educational sectors. CODINC takes this best practice of Capital Digital and with that developed a formal methodology to bring it into schools. The idea is developing cooperation between formal and non-formal education to introduce inclusive practices to promote coding and computational thinking in schools. The project was launched in January 2018 and has run for two years, it is led by ALL DIGITAL with six partner organisations from Belgium, Spain, Cyprus, Germany and Italy.

The CODINC methodology is exemplary on how it engages with a peer-learning methodology wherein young students teach their younger peers how to code. The peer-learning methodology is structured to position the young students as being the teachers for their younger peers. This role helps them gain confidence to transfer knowledge and also positions them in a role of responsibility, one where they gain their first working experience. The CODINC experience promotes cohesion and inclusion at the classroom level, and coding is used as a vehicle to deliver this experience so as to motivate students from disadvantaged areas towards become digital creators and not just digital consumers, towards secondary education, STEAM and education careers.



The CODINC experimentation has involved 222 secondary school students from 8 schools in disadvantaged areas trained in coding and learning pedagogies in 15-hour workshops in and outside school hours. The secondary students then went on to teach 481 primary school kids in peer-to-peer workshops with students in 8 schools and 20 teachers involved in 7 cities in 5 countries.

The results of the CODINC experiment have proven significant change in student-teacher relations, social cohesion and inclusion at the classroom level, soft skills development.

I hope you enjoy the reading!

Introduction

The CODINC “Coding for Inclusion” project is aimed at fostering the STEAM (Science – Technology – Engineering – Arts - Mathematics) education of disadvantaged youth through an inclusive educational approach based on a peer-learning pedagogical method for formal and non-formal educational contexts in Europe.

CODINC aims to provide all children with access to ICT-Skills, bringing methodology that can guide them and invite them to guide others to explore the world of ICT and get to know the range and entire spectrum of opportunities brought by implementing coding in daily life including schools, particularly in disadvantaged areas. With all the dynamic and connected diversity there is a basic form, which as a prerequisite for contemporary communication influences the phenomenon of social inclusion: digital code. In the digital world, code is a system that works globally, connects cultures, connects people independent from social background- one could say: code is a common language.

The CODINC project comes at a time when coding, and computer science education is rising on national educational agendas. Across Europe the digital transformation is driving more countries to examine how they can better address the emerging skill gaps in the labour market and prepare young people for the future of work. As a consequence, there are increased efforts to raise the level of digital skills and teach coding in curriculums across Europe. There are a lot of differences in Europe in terms of practices and policies with regards to how coding is taught. One thing that is certain, socio-economic status is a predicting factor for the education level. According to the OECD report Education at a glance (2019) "individuals without tertiary-educated parents tend to be considerably under-represented among entrants to tertiary education. However, inequalities tend to accumulate throughout an individual's educational career. In particular, the period from starting upper secondary to entering tertiary education is critical in determining students' future career and education choices." In Europe "four-in-ten people with low-educated parents have lower secondary education themselves, and only one-in-ten continues on to tertiary education – compared to two-thirds of children with high-educated parents." The same report from 2016 states "that even in Denmark, Finland and Sweden, the majority of students (both male and female) in tertiary education have parents who themselves had attained tertiary-level qualifications."

There is a widespread international and European concern about improving the numbers of people studying Science, Technology, Engineering, Arts and Mathematics (STEAM) fields. Despite a steady growth in STEAM fields, a shortage of qualified job applicants remains in the EU. STEAM education helps explaining and understanding the world around us, it enables us to make more accurate planning and forecasts, and it's about the job market. There is a specific need across Europe to develop the digital and computational competences of all citizens. Unfortunately the education system in many European countries is still not fully adapted to include project-based learning, peer learning and these ever-new technologies.

The second digital divide is about how differently we use digital technologies and the Internet. Students and pupils are competent in using digital technology like computers, smart phones and Internet. Robotics and coding offer new pathways for teaching, based on the interests of kids and students to create project and challenge based learning experiences, and enables them to be producers, not just consumers, of digital content. Their teachers mostly need to further develop their skills to adequately support their students in computational and digital competences.

Methodology

The CODINC methodology was developed to instruct educators and teachers how to engage students through a stimulating pedagogical methodology that has students from secondary schools (aged 15 - 18) teaching basic coding and STEAM education to their younger peers - pupils aged 8-12 years.

The CODINC project took place in disadvantaged areas and the programme aimed to foster inclusion in such contexts. The CODINC project focused on promoting inclusion through a peer-to-peer STEAM and coding educational training programme. The students and pupils targeted in the CODINC project were specifically from neighbourhoods where there were more excluted; this was primarily demonstrated through measured disadvantage in comparison to other areas on a national level. Some countries offer an index identifying schools or areas with higher levels of exclusion and disadvantages. The CODINC project helped raise the confidence of students aged 15-18 from disadvantaged backgrounds by helping them discover their creative, innovative and supportive potential. In practice this was done by training the students in a programme where they learned how to programme, create their own coding and STEAM education projects, and then go to teach younger students. This helped students struggling with identity and looking to find a place in an adult world. Students of disadvantaged backgrounds may have the feeling to be considered as outsiders, with lack of trust and confidence from adults to discover their creative and innovative potential.

Coding and computer science education is often aimed to foster inclusion in a context of poverty and risk of socioeconomic exclusion using coding (computer programming) as a tool, and a specific methodology to motivate young people towards STEM careers and to provoke changes in classroom habits. CODINC tackles social change in schools in a complex socioeconomic environment, and prove the change through 4 standardized assessment scales.

Research Context

The CODINC methodology explicitly chooses a collaborative, peer-to-peer approach, in which older students (secondary education) work together to teach coding to younger pupils (primary education). The CODINC methodology focuses on fostering computational thinking, creative skills, problem solving and design skills.

Creative Skills

Throughout the training, creative skills are actively fostered. The three main aspects of creativity (according to the LEGO systemic creativity framework) are put to work: (1) exploring possibilities, ideas and other people's projects; (2) combining existing skills, ideas, projects and more into new creative endeavours; and (3) transforming existing properties into something fresh.

Problem Solving and Design Skills

Finally, the methodology also addresses problem solving and design skills.
Students learn how to (1) identify a new problem and its components. They also acquire strategies for (2) generating new ideas through brainstorming and (3) how to implement these ideas. Of course, they then (4) evaluate their solution and reflect on the impact of it. Finally, they improve on their solution and re-evaluate the problem in a next (5) iteration of the process.

Computational thinking

The learning goals for computational thinking are divided into two sections: the concepts that are to be mastered by the pupils and the corresponding thinking practices.

There are nine key concepts for computational thinking in this methodology, with which pupils can successfully master coding and create their own games or programs.

Concept	Description
Algorithms	A written set of instructions for a computational device; for example, for a game, an app or even a cooking recipe.
Sequences	Instructions that are given in a discrete order, one following the other. The computer executes them from top to bottom.
Repetition and Loops	Repeating a subset of instructions several times (or infinitely) is called a loop.
Events and Selection	An indication of when an event should take place; for example, the cat starts moving when the 'start' button in a game is pressed.
Conditionals and Logical Operators	Letting the computer make a decision. If something happens, then an event should take place, or not it should not take place.
Mathematical Operators	Algorithms that require mathematics, such as multiplication, addition, … for example for reducing the speed of a ball over time.

Variables and Data Management	Variables are boxes in which numbers (or texts) can be stored. These boxes are then used in code, for example to show the current score of the player.
Functions	Reusing a subset of code, for example for walking forward, with a name label.

Consequently, there are six crucial thinking practices that contribute to becoming a proficient coder and computational thinker. These thinking practices aren't just helpful in the field of technology, but transfer tremendously well to other fields of thinking and life, such as creative problem solving.

Thinking Practice	Description
Incremental and Iterative Work Strategies	Pupils break up their work into small steps, as well as return to previous steps in their thinking to improve their program. Coding is not a linear process, but a spiral that keeps repeating itself.
Testing and Debugging	Pupils can test a game or project against their expectations and learn lessons from it for improvement. They can identify problems (bugs) and use strategies to fix them (debugging).
Reusing and Remixing	Pupils can learn from projects made by others; reuse pieces of code or thought processes; and remix existing solutions or projects into something new.
Abstraction	Pupils can transfer the lessons learnt from a project into abstract patterns.
Modularization	Pupils can break projects down into smaller parts (i.e. movement, speed, score) and reuse those parts in their work.
Information Collection and Management	Pupils can identify sources for information and look for solutions for their problems in various places, such as with peers or online.

These concepts work together to promote science capital. The concept of science capital is derived from the work of French sociologist Pierre Bourdieu, and his concept of cultural capital, which recognized that the different social and cultural experiences that people have affects how they get ahead in life.[1]

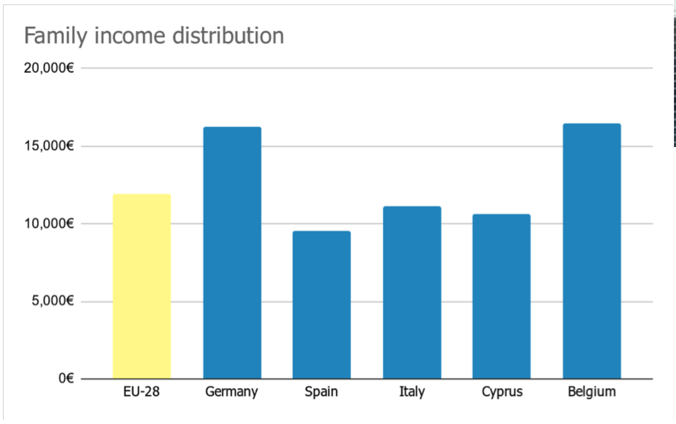
STEAM is an important concern of policymakers across the world, the discussion about STEAM is mainly centred around the actual and foreseen shortage of qualified labour force and how to combat this through fostering STEAM education and science capital in all citizens. STEAM education is about providing young people with opportunities to explore science disciplines, for science learning and foster motivation for future STEAM careers. Science education in Europe was initially important because of the global shortage of science graduates, high numbers of STEM workers are approaching retirement age, around 7 million job openings are forecasted until 2025 - two-thirds for replacing retiring workers. At the same time investment in science

[1] Wikipedia on Cultural Capital and Pierre Bourdieu https://en.wikipedia.org/wiki/Cultural_capital

education for girls and young people with vulnerable socio-economic backgrounds has been increased[2].

According to the European Parliament's Committee on Employment and Social Affairs report on Encouraging STEAM studies (2015)[3], “employment of STEAM skilled labour in the EU is increasing in spite of the economic crisis, and demand is expected to grow. [...] Demand for STEAM skills requires both upper-secondary and university graduates. Medium-level qualifications are required for almost half of STEM occupations and this trend is expected to persist.”

Regional Context



The partners in the CODINC project have much experience in implementing service-learning projects in disadvantaged communities. Prior to piloting the CODINC project, project partners engaged with their local communities to identify disadvantaged schools in the area. The selection process of schools is further developed in the CODINC national reports. To illustrate the disadvantaged contexts in The EU-SILC[4] (European Union Statistics On Income and Living Conditions) is also referred to which includes data on Family income distribution. Since 2010, EU-SILC data is being used to monitor poverty and social inclusion in the EU, with a headline poverty target on reducing the number of people under poverty and social exclusion by 20 million in 2020.

Youth unemployment rates are generally much higher, even double or more, than unemployment rates for all age groups. The youth unemployment rate in the EU-28 reached its minimum value (15.1%) in the first quarter 2008, while the following economic crisis hit severely the young generation, youth unemployment rate started an upward trend peaking in the 2013 first quarter with 23.9% before receding again. High unemployment rates reflect difficulties faced by young people in finding jobs. High youth unemployment rates do reflect the difficulties faced by young people in finding jobs, but this does not necessarily mean that the group of unemployed persons aged between 15 and 24 is large, as it includes also young people who are studying full-time and therefore not working nor looking for a job. Transitioning from school to work includes specific

2 https://edu-arctic.eu/news/23-why-is-stem-so-important-for-europe

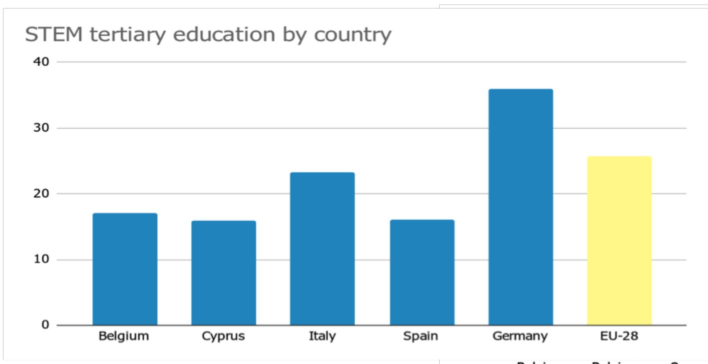
3 Encouragement of STEM Studies https://www.researchgate.net/publication/280298391_Encouragement_of_STEM_Science_Technology_Engineering_Mathematics_Studies_Labour_Market_Situation_and_comparison_of_practices_targeted_to_young_people_in_different_Member_States

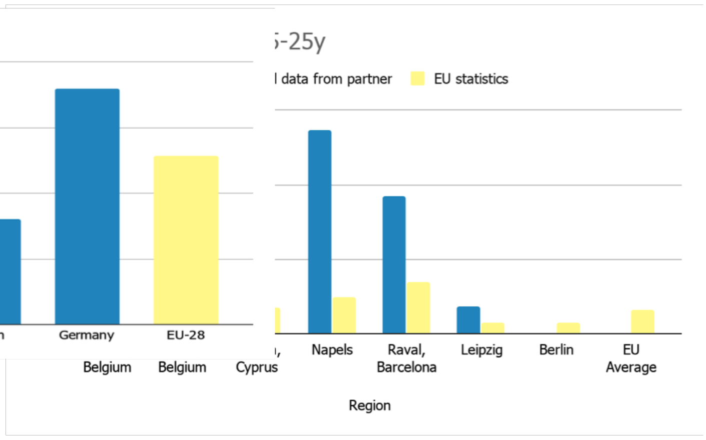
4 https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

challenges resulting in relatively low employment rates, high unemployment and high rates of young people who are neither in employment, education or training (NEETs).[5]

Educational Contexts

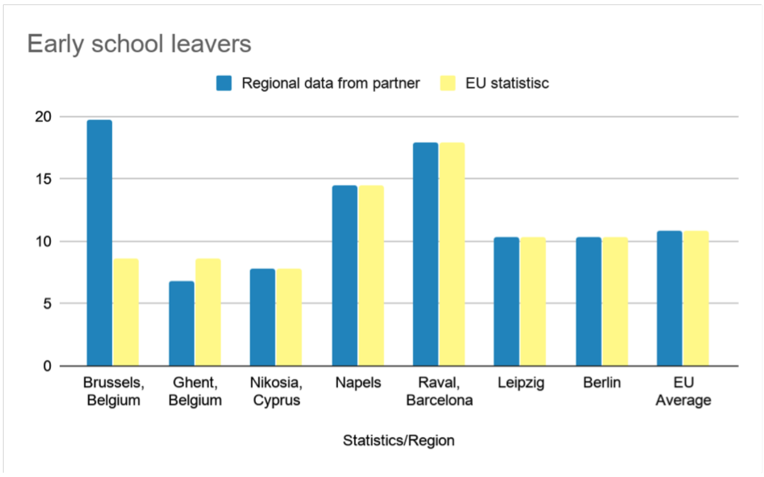
In the countries where the CODINC project was piloted, there is no regularity in the number of STEAM students as a portion of all tertiary education students.





According to the Tertiary Education Statistics for 2018 Spain, Cyprus and Belgium have a much lower ratio of STEAM students than the EU-28 average, while Italy is near the EU-28 average and Germany about 10 percent points above, as shown in the graphic.

As the European Semester Thematic Factsheet on Early School Leavers[6] establishes, "reducing early school leaving is currently a main target for EU member states and policy makers and a major challenge for national and regional education and training systems. All EU countries have committed to reducing early school leaving rate to less than 10% by 2020 (EU, 2010)."



In Belgium the primary school curriculum does not include computational competencies. Although the teachers from the two participating schools in Brussels were quite interested in STEAM-education, their training and resources to educate STEAM-education were low. Two primary schools and one secondary school were involved.

In Flanders, nearly all schools are public. An average class consists of 20-25 pupils and one teacher. The average Flemish school in terms of ICT-materials is reasonably well equipped. Although, Internet connections are not always reliable, and just because ICT resources are available, it doesn't mean they are really used as part of the hardware is outdated. This further affirms the need to include computer science and computational thinking on the curriculum and

5 https://ec.europa.eu/info/sites/info/files/file_import/european-semester_thematic-factsheet_youth_employment_en.pdf

6 https://ec.europa.eu/info/sites/info/files/european-semester_thematic-factsheet_early-school-leavers_en_0.pdf

not just materials, teachers and schools need guidance to integrate technologies into a classroom. While teachers consider both their own and their students' computer skills to be adequate, students themselves are less confident in their skills compared to five years ago.

In primary education in Cyprus, there is no subject that implements computational thinking or even basic computer skills, with the exception of some (non-compulsory) afternoon schools that have computer lessons in the afternoon. Despite this, all schools have a computer lab and broadband access to the Internet. Therefore, teachers are free to organise and integrate computational thinking and other related subjects in the curriculum of lessons such as Mathematics, Science, Design and Technology, even English or Music, as they see fit. Although approved by the Cyprus Ministry of Education, the experimentation took place on weekends.

Educational competences are transferred to federal states in Germany. The Standing Conference of the Ministers of Education and Cultural Affairs plays a significant role as an instrument for the coordination and development of education between federal states and on a national level. In 2016, the Standing Conference agreed on a strategic concept for the future development of education in Germany "Bildung in der digitalen Welt"[7] (Education in the digital world), with two key topics: the integration of a binding competences framework in all subjects an not by introducing a specific subject, and the incorporation of digital support for learning and teaching. The CODINC project was combined, in Germany, with nationwide coding initiatives like Code your Life for stakeholder and multiplier involvement through CODEaffair Berlin 2018 and IdeenExpo Hannover 2019 conferences.

Compulsory education in Italy lasts for ten years, from 6 to 16 years of age, and includes eight years of the first cycle of education (five years of primary school and three years of secondary school) and the first two years of the second cycle.

The competences for education in Spain are transferred at regional level; the experimentation took place in Barcelona and within the Catalan public-school system. The Catalan school curriculum includes digital competences directed towards a user level knowledge of the digital world for secondary school, but does still miss computational competences, although various non-profit initiatives are working in the field of introducing computational competences in the public-school curriculum. Catalonia has a segregated school system with huge differences between schools, especially between public and private schools. The unequal distribution of pupils and students from families with a not Spanish or Catalan mother language has created a strong ghettoization effect on public schools in the Raval neighbourhood, where we find public schools with up to 90% of students/pupils from migrant background. All public schools in Raval are declared "maximum complexity" schools by the Ministry of Education and receive special resources for social workers as support staff in school.

Selection Criteria

Staff selection

Training professionals from the project partners were responsible for coordinating the project with schools and implementing the experimentation including assessments, students training and peer-learning workshops for pupils. The partner organizations selected qualified trainers on their team based on the project's methodology and toolkit, and shared recommendations for staff selection.

[7] Strategy paper "Bildung in der digitalen Welt" https://www.kmk.org/fileadmin/Dateien/veroeffentlichungen_beschluesse/2018/Strategie_Bildung_in_der_digitalen_Welt_idF._vom_07.12.2017.pdf

All trainers participated in the two days staff training organized in Barcelona, a face to face training for going through all energizers, online and offline activities provided in the toolkit.

In Brussels the trainers were staff from the local partner, experienced in coding training young people. They were chosen for their computational thinking knowledge and experience in pedagogies for computational thinking training with students and pupils. The Brussels' partner worked with three trainers since primary schools participated with three classes each.

The trainers for the Cyprus' experimentation were selected based on their experience in programming and robotic training, and both trainers participated in the staff training in Barcelona.

In Germany the participating trainers have many years of experience in the implementation of coding projects and are familiar with the social requirements of the school environment, they assisted the staff training.

Trainers in Italy were selected based on the type of activities provided, the professional background, the experience in the school and the relevance of the curriculum with the aims and objectives of the CODINC project, staff was selected through a public call with evaluation of titles and interview at the University.

The staff in Spain was selected between the team members of the implementing partner, 2 trainer (1 male, 1 female) organised and implemented the project, both have training and experience in teaching computational competences, coding and robotics to pupils and students, and in working with schools in the Raval neighbourhood.

School Selection

CODINC partners approached schools in districts with a higher percentage of disadvantaged families. The role of school principals was fundamental in promoting digital education at school[8], as well as the teacher's support. All CODINC partner selected participating schools according to the criteria general criteria of "schools in disadvantaged areas" established in the project proposal. Partner organizations brought in their expertise on regional and national education policies regarding social inclusion, which effectively show broad differences in how social exclusion is defined and measured, and what mitigating strategies are put in place.

In Brussels schools rely on either the Flemish or Walloon educational system. The schools for the pilot in Brussels were chosen using the government's Equal Opportunities in Education indicator (in Dutch Gelijke Onderwijskansen known more often by the acronym GOK) to measure the rates of disadvantaged youth in school, established by the Equal Opportunities for Education (GOK)[9] policy issued in September 2002.

[8] Eurydice Report: Digital Education at School in Europe. 2019. Page 20.

[9] The equal educational opportunities policy (GOK) https://eacea.ec.europa.eu/national-policies/eurydice/content/support-measures-learners-early-childhood-and-school-education-3_en

The schools receive additional resources to develop an equal opportunities plan based on four criteria amalgamated when looked at the school population level. The GOK criteria evaluates1) Whether the students' mother completed secondary education; 2) Whether the students received a scholarship the year prior; 3) Whether the student speaks Dutch at home; 4) and whether the student lives in a disadvantaged neighbourhood[10].

When selecting the secondary schools for the CODINC project the partners had difficulties to assign 30 hours from the school curriculum. As the schools are already identified as disadvantaged and may risk losing governmental funding, there was an effort to ensure all students met the assigned criteria as indicated by the national curriculum. Schools were unsure due to these pressures whether they could afford the flexibility to take 30 hours away from the students to participate in the project. This furthermore highlights the need to target disadvantaged schools, and find appropriate and tested methodologies to teach digital competences like CODINC, because these schools feel the most pressure to meet the minimum criteria according to the curriculum and have the least opportunity to engage with new methodologies. Each specific subject has to achieve a lot of specific lessons that they have to follow. In all participating schools the GOK-indicator was between 80 and 100, which means a very high rate of disadvantaged indicators.

Similar to Brussels, the GOK-Indicator was also used in Ghent for school selection as they are in the Flemish jurisdiction for education. The GOK indicator was used in combination with other criteria such as location in disadvantaged neighbourhoods, relative number of migrant populations in the neighbourhood, proximity of the selected secondary and primary schools, and motivation of the school and the teachers involved. The partnering secondary school is located in a neighbourhood with a 32.3% percent migrant population, and offers ICT specific training so the involved students had previous knowledge and interest in ICT. The primary school was in walking distance of the secondary school, and pupils had taken part in the Hour of Code initiative through Ghent's CodeCity project. All activities were developed during school hours.

In Cyprus the experimentation took place in Nicosia. The schools where the project was implemented are located next to a refugee settlement, established in 1974 after the Turkish invasion in Cyprus and the area is considered to be underprivileged. In the participating primary school almost one third of the students have at least one parent from an Eastern European or Asian country, while almost 20% of the students receive a free meal every day[11]. The secondary school is situated next to the primary school. According to the principal of the school, the vast majority of students come from rural areas near Nicosia and from the refugee settlement (families with low income).

[10] Disadvantaged neighborhoods are identified by determining the percentage of 15-year-olds who are two or more years behind in school.
[11] According to school records.

In Germany the experimentation involved two secondary schools, located in districts with high unemployment and high migration rate. In Leipzig the training was implemented in school premises, and the school in Berlin implemented in the partner's premises. The participating secondary schools were selected based on interviews with school management and teachers. The experimentation in Berlin involved teachers from natural science background and educators, and social educators.

The Italian partner implemented the CODINC project in Naples. Two geographically close schools participated in the experimentation, both schools located in a disadvantaged area with high risk of social exclusion in Naples. The school selection criteria included such as the level of risk of social exclusion and the high school dropout rate. The interest and motivation of the school, the willingness of teachers to integrate the activities of the project into their teaching path, the proximity between the two educational institutions to be involved were also factors in school selection. In particular, the neighbourhood of the schools has the highest rate of school dropout in the city of Naples. Many students come from families with economic difficulties and encounter problems of legality, marginalization, unemployment and the malaise of daily life due to a state of social distress. There is also reported to be bullying among students.

The schools in Raval neighbourhood, Barcelona, Spain were "maximum complexity schools" a criteria used by the Catalan Ministry of Education for defining schools with a high percentage of students with special social and educational needs, applying further criteria such as previous collaboration experience and staff motivation (involved teachers, principals). The logistics of fitting the workshops within school hours was complicated in one secondary school and in all primary schools; the other secondary school had a foreseen timeframe for project based learning where CODINC was included.

Service Learning and Peer Learning Methodologies

The CODINC methodology engages in peer-learning and service-learning methodologies. Service-learning methodologies are based on the needs, problems or real challenges; it begins by analysing and developing interventions needed in communities. This report has already described needs and challenges faced in communities. Service learning is a methodology that is not only limited to identify the needs and acquire knowledge but provides a service to the community. CODINC was developed by partners involved in their communities and was developed by civil society organizations. Peer learning is a method wherein students learn from and with each other. The case for peer-learning in CODINC aims to position older students as a teacher and empowers them with a curriculum which they deliver to young people, making it more structured than many peer-learning methodologies. The CODINC methodology eased the burden on the teacher to direct the learning of the students and merely facilitated the interactions between students and peers. What distinguishes CODINC is how it used a best practice from non-formal education and structured it in a formal methodology that allows it to be easily adapted into a variety of school systems.

Assessment through standardised questionnaires

The CODINC project was based on a good practice that clearly had an impact and wanted to develop a method to support these claims to impact. There is a need for researchers to work together with non-formal education providers to have a more scientific view on impact measurement. The CODINC methodology evaluation concerns the collection of data to measure the impact and effectiveness of an action or of a project. The idea of impact assessment and how an activity can be effective brings up a number of questions such as how you can tell if an activity is actually good or which are the dimensions you want to explore. These questions were brought up for instance in the context of the CODINC project.

CODINC is a project where several dimensions come together:

- Acquisition of knowledge (hard skills – learn how to code),
- A strong social aspect due to the interaction of the students between them and their teachers, and a personal dimension as well (soft skills).

Here is an overview of the tools used to measure the impact of the CODINC project. The first tool used was the sociometric test, which was aimed at measuring the social relationship within the group. This approach is then characterized by an affective-relational aspect which refers to the relationships that have been established between the members of a group and a functional aspect which is related to the organisation of the group and is aimed at understanding the relationship established with the aim of achieving a common goal.

The second tool tested was the self-efficacy scale. The idea behind it is that if you get better at doing something, this may have an impact on the personal perspective. Self-efficacy is, therefore, not a measure of the possessed skills but the belief that the person has in what he/she is able to do in different situations with those skills. This test, however, didn’t give many results in the context of the CODINC project and therefore it was ruled out.

Finally, the TATS Scale (Teachers' Attitude Toward Students) was used to assess the relationship between teachers and students. The TATS measured the democratic or authoritative attitude of teachers towards students.

Experimentation

CODINC's primary goal is to foster social inclusion through teaching basic coding and programming through an innovative peer-to-peer learning methodology. Six partner organizations followed in their experimentation a methodological framework based on good practice project "Capital Digital", a detailed toolkit with on- and offline activities on computational competences, which together build the CODINC curriculum.

	Sep' 18	Oct' 18	Nov' 18	Dec' 18	Jan' 19	Feb' 19	Mar' 19	Apr' 19	May' 19	Jun' 19	Jul'1 9	Aug' 19	Sep' 19	Oct' 19
WP3 CODINC Experimentation														
Production of Piloting Guidelines														
Selection of participating schools and staff														
Pre-assessment														
Phase 1: piloting with **secondary** schools														
Phase 2: training **primary** school teachers														
Phase 3: **peer-learning** coding weeks														
Post-assessment														
Production of National Reports														
Production of Experimentation Report														

Experimentation guidelines established an overall framework for implementation, defining experimentation phases and internal deadlines, providing guidance for strategic questions and challenges in experimentation, and necessary template documents for the work with schools, students and pupils.

All partner brought in experience in working with public schools, and it was clear from the beginning that the schedule would undergo certain adaptations required for local experimentation, in order to fit in selected schools' organization and calendar.

Adaptability proved to be a huge strength of CODINC, the training with secondary school students was given by one partner in a two day workshop, while another partner implemented the same training over four months. The total experimentation duration from pre-assessment to post-assessment was between three weeks and twenty weeks. The toolkit provides the basic activities with detailed instructions for primary and secondary school using the same exercises with differences in learning goals and additional pedagogic training for students on how to teach coding, and some partner added complementary activities with tangible interfaces, which also are available as complementary references to the online version of the CODINC toolkit.

The teacher training took place in different moments of the experimentation, while one Belgian partner introduced teacher training at the very beginning, most of the partner implemented the teacher training sessions at the end of the experimentation process. Teachers have seen their training as a motivation to introduce STEM learning tools in the classroom, and they have learned practical skills on how to use the CODINC toolkit and related technologies for learning. Teachers trained before the workshops with their classes generally were more actively involved in the project.

Experimentation Process

Belgium

In Belgium CODINC was implemented by two project partners in Brussels and Ghent. In the Brussels experimentation participated one secondary and two primary schools from Jette and Anderlecht. The training for secondary school students took place in six weekly two-hour sessions using time from different subjects and teachers, so students could repeat their practiced skills. During the training with secondary school students, teamwork was introduced with the Scratch Cards focusing on building diverse teams. At the end was introduced a session to better prepare students for the peer-learning activities with pupils, where students had to present to their teachers how they were going to explain the assigned activity to pupils.

The peer-to-peer activities took place in four sessions with the two primary schools. An extra qualitative evaluation showed that 98% of the pupils wanted to follow more coding and programming workshops in the future and they all loved Makey Makey the most.

Secondary school students were nervous before the first piloting in primary school. This was somewhat expected as they would practice being a teacher and teach their younger peers, but they took their responsibility without requiring any involvement of teachers or trainers. It was clear that the students grew in confidence throughout the piloting in primary school. At the last session almost all students stayed longer because they wanted to say goodbye to ‘their’ students.

The CODINC experience also improved the teacher-student relationship in the classroom as teachers had the chance to see students engaging in education in a different way and experiencing a different role. This also helped to raise the level of cooperation and social cohesion in the classroom.

In contrast, the experimentation in Ghent was implemented over months. The training with 23 secondary school students took place in two days from 9 to 17h outside school premises, and the peer-learning workshops for 69 pupils were implemented three weeks later and also in two full days. Pre- and post-assessment were done right before and after the workshops.

The secondary school students were a little insecure at the beginning, unsure of what to do with the responsibilities they were given. Literally there was a distance between them and the pupils, and they even forgot to introduce themselves to their pupils. By lunch time, names had been exchanged, and students were walking around the tables, crouching next to the children as they explained how to tackle a certain issue. The primary school children were very excited to start the project, as evidenced by the fact that one boy, who’d been ill the day before, insisted on coming to school even though his mother wanted to keep him home to get well a little longer. By the end of the project, the secondary school students realized it was the first job experience for them, something they would include in their CV.

During the workshops primary school teachers tended to treat student “teacher” like pupils which caused awkward moments and visible loss of confidence in students. Otherwise, secondary and primary school teachers were unfortunately not very involved in the training, which can be either seen as a strength or as a failure of the CODINC methodology: a strength in providing an experimentation methodology and toolkit without requiring teacher involvement, or as a failure in motivating and involving teachers and helping them to gain valuable knowledge to pass onto future kids on how to code.

Cyprus

Cyprus’ education system is more bureaucratic, approval from the Ministry was needed, the activities could take place on school premises but outside school hours. The students workshop took place over a time of five weekends, organized in learning sessions of three hours. The primary school workshop took place 1.5 month later on one weekend and in the same school premises with teams of three secondary school students training groups of five primary school pupils.

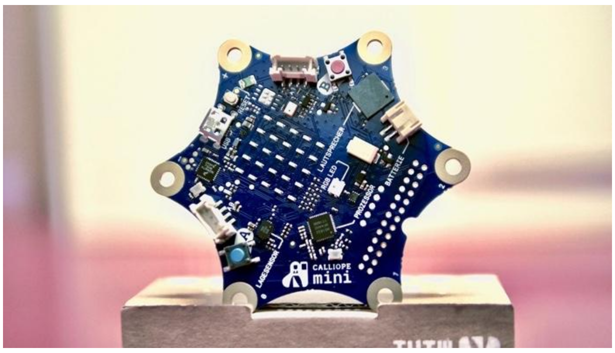
Secondary school students overcame initial expectations of how to train pupils, since they proved to have full control of their groups. Even though secondary school students had expressed doubts about their ability to work with primary school pupils, they proved themselves capable of working effectively in training them, especially after the first day of workshops. Primary school pupils, even though large in numbers, were very engaged in all the activities. There were no cases where the (adult) trainers had to be involved to resolve issues, and all activities were completed on time.

The biggest challenge was the busy time schedule of secondary school students, to find time outside of school time for 30 hours of workshops, which was solved doing the student’s training Sunday afternoon and the workshops with pupils during the Easter Holidays.

Germany

In Germany the experimentation involved two secondary schools with different project progress and outcome. While in the first school in Leipzig the experimentation took place in school hours and premises, the second school in Berlin came to the partner’s premises for the workshops. Teacher involvement was different as well, while in the first school teachers left the classroom in the second school, they supported the project actively. Students preferred tangible interfaces for programming over screen-based interfaces.

The workshops in Leipzig involved 15 students over two months and 45 pupils over four days. Students could also test Calliope mini (see figure), a German robotics tool, and included the tool in their activities with pupils. The training activities took place in school time and within school premises. All students said it was difficult for them to explain the activities and to guide the pupils.



The workshops in Berlin involved 26 students over one month approximately, and 46 pupils over 4 days, both students and peer-to-peer training were implemented outside school premises but within school time. Additional resources like Turtle Coder were introduced both students and pupils training. The involved school in Berlin is interested in implementing CODINC project next year.

Italy

The piloting with secondary school in Naples, Italy, was divided into 5 two-hour sessions, using the multimedia laboratory and the teaching room in alternation. At the beginning, the secondary school students were nervous because they had no previous experience with coding, but once started the activities their fears disappeared quickly. Students were always interested in activities, they collaborated in harmony. The possibility of being able to carry out teamwork activities and being the centre of their learning process has led to a constant increase in motivation in students. Feedback from the teachers involved also confirmed the enthusiasm of the class group.

Working with primary school brought up some challenges, the logistics and organizational overhead with coordinating two schools is complex. Pupils were motivated towards the activities, but students had difficulties in managing the groups. The decision to implement the experimentation in disadvantaged areas with higher risk of social exclusion involves working difficult realities, pupils and students facing multi-dimensional problems involving family, school, social context, etc. CODINC was an excellent educational and personal growth opportunity for high school students, not only for enriching their cultural background but even more for strengthening the level of self-efficacy and cohesion within a workgroup. To simplify the logistics, we would advise to review the target and propose working with two different years within one school.

Participating schools where equipped with at least one multimedia laboratory sufficient to accommodate an entire class, some also had an ILM (Interactive multimedia whiteboard). Despite the infrastructure available, there were no teachers introducing computational thinking or coding in the classroom. Students are not provided with these competences in school, only through external projects and in after-school hours.

Spain

In Barcelona the piloting took place over a timespan of seven months, 75 secondary school students from two schools were trained in 15 weekly sessions, and 97 primary school pupils participated in peer-to-peer learning workshops over 4 weeks. The logistics of fitting the workshops within school hours was complicated in one secondary school and in all primary schools, the other secondary school had foreseen a timeframe for project-based learning where CODINC was included. We respected as much as possible the school terms and internal planning to make it easier for schools. A third secondary school could not participate for school internal planning reasons but will implement the CODINC project during 2019-20.

The workshops with secondary schools worked very well, the CODINC project was presented in connection to a locally well-known methodology of service-learning ('aprenentatge-servei'[12] in Catalan), which is already part of the Catalan public-school curriculum, and principals

[12] https://aprenentatgeservei.cat/

and teachers were familiar with. The offline activities were very much appreciated, as a funny and creative way to introduce computational thinking concepts in group activities and dynamics.

In one secondary school there were initially two groups of 15 students each receiving one-hour training per week by staff trainers from the local CODINC partner. But their technology teacher simply decided to replicate the CODINC project with 2 more groups. All four groups worked out really well and the feedback from teachers and students was very positive. The other secondary school was more complex in terms of logistics, because of school planning the participants rotated every two months, therefore we worked with eight different students every two month.

Organization with primary schools presented other difficulties. Both secondary schools offered to select primary schools themselves based on shared criteria, which first seemed efficient both for schools and for the local partner, but schools were very slow in organizing the peer-learning. The service-learning workshops where implemented in three different primary schools, in one school over a period of three months, and in the other two schools over a shorter time frame.

Common elements in experimentations

In all aspects of the CODINC experience, it was clear there was a manifest improvement of social relations (and social skills) among students regardless of how long or short the experimentation process was. The improvement was supported by results from the evaluation surveys and was observed by the trainers as noted by the confidence and excitement the students had in the programme. The secondary school students who learned how to be a teacher to their younger peers enjoyed the CODINC project the most having first learned from the trainers the exercises and then delivered them themselves.

Differences in experimentations

Some partners had a very short time to pilot and others a very long time, despite this the impact was measurable and observable whether the fifteen hours of intervention took place in two days or over the course of months. It shows that the CODINC project can be applied in a variety of times and circumstances. The project was piloted both during and outside of school hours and in and outside of classrooms depending on the local circumstances and needs. There was a lot of complexity and challenges to have the schools accept the intervention and budget their time to allow the CODINC project to take place.

Challenges

While the CODINC project was overall short, taking just fifteen hours for training secondary school students and 15 hours for workshops with secondary and primary schools, and it can be implemented in any schedule structure, 30 hours is still a longer time to take secondary students away from classes than many teachers or schools they feel they can afford.

Furthermore, there is a challenge with regards to having defined learning goals. The focus of CODINC is on promoting inclusion, and the purpose of having a defined outcome for coding is a consequence of CODINC but it is not measured.

While CODINC aims to promote inclusion in disadvantaged areas there was still a high dropout rate from schools and from the programme. While the targets were reached, the intervention was not enough to reverse cases of young people planning to leave schools once they had the chance.

The CODINC project was piloted by actors in the non-formal education sector, and the evaluation of the CODINC project did present many challenges in both communicating the need to conduct the evaluation, the relevance of it, but also to deliver clear instructions so partners could implement a rather scientific evaluation by partners who are not used to doing such surveys. Furthermore, some young people found it challenging to answer the questions, in the case of a sociometric test they would look to see who else in the class is in attendance sometimes forgetting to include names for students who may not be in school that day due to illness.

In Brussels there were reports that students did not fully understand the questions and students would respond based on their circumstances of the day. In Ghent the feedback on assessment was also on the difficulty of the questions both for primary and secondary schools alike. A different evaluation for both target groups, focusing on the different goals that are set for each group, would allow a broader and clearer evaluation. The German partner had difficulties with the assessment. Due to the lack of support from the participating schools, pre- and post-evaluation tests could not be carried out in Leipzig. In Berlin, it was not possible to carry out the survey for the pupils and the teachers were worried that the pupils would be overwhelmed.

Strengths of the CODINC model

The strengths of the CODINC model are the adaptability of the model, where there are many different ways to apply the 15 hours of training. In some cases, the pilot happened in just two days while still being fun and impactful. It is good to refer to the toolkit for different activities as some students and some schools may already have experience with some coding and Scratch exercises. Overall students who had experience in coding do appreciate the CODINC project as the offline exercises helped experienced coders better understand the relationship between the elements, they were coding. CODINC provided an innovative way to deal with serious issues, helping bridge the gap between students from underprivileged areas (and families), with students with access to more opportunities (i.e. afternoon robotics classes). The teachers did confirm that students learned much more than to code or computational competences, they learned soft skills in a practical way through teaching pupils.

Lessons Learned

A few practices could be improved with some of the lessons learned from the different in piloting in the different partner countries. it is better to deliver the teacher training before starting the sessions with students and pupils, teachers who understood what the students were doing were more interested in the activities and supportive of the CODINC experience.

Assessment and evaluation results

Students and pupils loved the program, our "extra qualitative evaluation showed clearly that 98% of the pupils wants to follow more coding and programming workshops in the future"[13].

Improve self-confidence

CODINC aimed to empower disadvantaged young people in the development of science capital and collaborative competences as well as problem solving, self-confidence and creativity through a peer-learning training programme on coding.

In Brussels and Barcelona the enthusiasm of teachers and students exceeded the expectations, and all participating partner schools reported exceeded expectations for student engagement with the project and especially with the service-learning and peer-learning workshops. Once the project started, CODINC was immediately perceived by schools as an opportunity for students, both to acquire and/or strengthen skills in coding and computational thinking but even more as a possibility of personal growth. You could feel and see the students grow in self-confidence during the piloting in primary schools.

Changes in classroom relationships

CODINC "also helped to raise the level of cooperation and social cohesion in the classroom. [...] You could see the students grow closer to their teachers during the training, because they started on the same level. Most of the teachers of the secondary school weren't familiar with coding and programming so like the students they started from zero. It was interesting to see students explaining scratch to their teachers. [...] They had more respect for the job as a teacher since they were in the shoes of a teacher".

Impact on teacher capacity to foster STEAM education

Although CODINC implemented teacher training workshops during the project, it was clearly shown that the foreseen time was too short as teacher training was a secondary goal in the project. A teacher training session before the workshops with students and kids works well to motivate and engage teachers for an inclusive approach on STEAM learning. Teacher training sessions and working in the classroom with secondary and primary school teachers also have shown the need for teacher training on STEAM education and STEAM tools like robotics, codinc or maker technology, combined with specific methodologies for project based learning.

Assessment results

The assessment and evaluation consisted of 4 different scales, both administered pre- and post-experimentation. Secondary school students were administered 4 assessment scales:

1. Moreno sociogram regarding the relational aspect
2. Moreno sociogram regarding the group work appearance
3. Self-efficacy rating scale
4. Teachers' Attitudes Toward Students (TATS)

Teachers were administered two assessment scales to investigate the level of self-efficacy and the ability to integrate technology into teaching:

1. Teacher Self-Efficacy Scale (SAED)
2. Intrapersonal Technology Integration Scale (ITIS)

Teachers and pupils at the primary school were also administered all the scales above, with the exception of TATS, which was not offered to students.

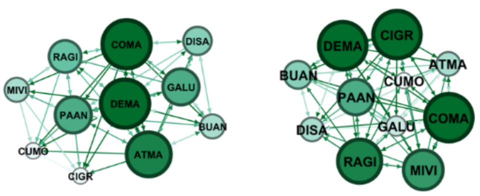
Here are some results shown by a sociogram, a graphical representation of the affective-relational aspect in secondary schools before and after the test was taken. This is composed of nodes and

[13] Maks VZW "Brussels - Codinc report". November 2019.

lines. Nodes represent the members of a group, while lines indicate the relationships (positive or negative) between the members.

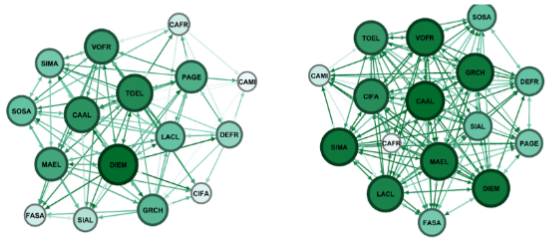
The sociogram shows in an immediate and visual way if the cohesion, the relationships and therefore the dynamics of the class group have changed. This, however, doesn't probably tell much of the impact of the project carried out because after five months students would get closer anyway.
This is the reason why a control class was used, where both tests were applied but without undertaking any activities.

Sociogram Affective pre and post test Secondary
Control



	Nodes	Edges	Average	Density	Coherence	Positive	Negative
Pre test	11	66	6	0,6	0,73	59	7
Post test	11	72	6,5	0,65	0,64	65	7
		+ 9%				+ 10%	=

Sociogram Affective pre and post test Secondary
UNINA

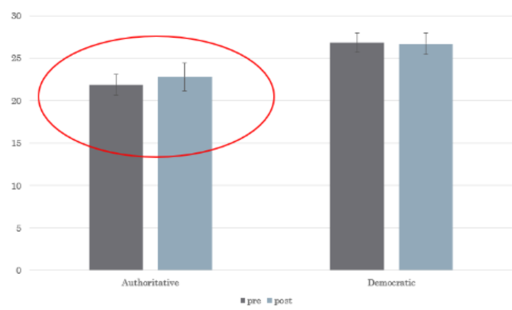


	Nodes	Edges	Average	Density	Coherence	Positive	Negative
st	16	123	7,7	0,51	0,68	73	50
	16	189	11,8	0,79	0,74	162	27
		+ 54%				+ 122%	- 46%

The evaluation methodology here shows it is therefore possible to think that a more quantitative approach can be used to measure the impact of an action even on social relationships. However, we also stress that doing this is not an easy task. These analyses were not always taken well from the schools, so it is important to find a balance between the different needs. The evaluation conducted in CODINC proved challenging for a number of reasons. Firstly, the partners collecting the data were not scientists or academics, they needed to be trained and informed how the data should be collected, and recorded. After that partners had to also ensure schools, students and teachers understood and agreed to take part in the research, schedule appropriate times, contact a control class and collect and record the data effectively. Many partners reported big challenges in contacting the control classrooms that were not "compensated" for their troubles (i.e. received no CODINC training).

Interestingly, in the TATS Scale results across the 500 students it was observed that there was a different perspective of the authoritative attitude among students between the pre and post-test. The authoritative approach scored higher for the majority of students after having experienced being teachers.

Teacher Attitude Toward Students



Conclusions

The CODINC project showed that coding can be used to promote inclusion and soft skills. The project is adaptable and stresses the importance of ensuring young people are included in coding activities regardless of the area they come from. The experimentation and the challenges with arranging a schedule and managing compulsory elements of the curriculum required, showed that disadvantaged schools have a harder time offering activities reflecting new competences. More on policy recommendations will be expanded in the policy recommendation report.

Education in science, technology, engineering and mathematics has captured the attention of state policymakers who are concerned about preparing students for an evolving workforce. By 2030, Institute for the Future estimates that 85 percent of the jobs that today's students will be doing haven't been invented. The job market will be demanding a workforce that is creative and prepared to respond innovatively to real-world problems. Including the arts in STEM learning can further enhance teaching and student achievement and build upon existing approaches to STEM that encourage students to apply creativity to solving real-world problems.

There is a problem with the given curriculum by the government. Firstly, coding and programming is not at all proportional present in this curriculum, given the needs of the job market in this digital world Flemish and Brussels schools, as well as schools in Barcelona, Berlin, Leipzig, Naples and Nikosia, still follow the same traditional structure of teaching as 20 years ago. The school system and curriculum, particularly in the context of social exclusion, is still very much focused on instruction. A learning path fostering active student involvement is strongly recommended.

By 2030, Institute for the Future estimates that 85 percent of the jobs that today's students will be doing haven't been invented. The job market will be demanding a workforce that is creative and prepared to respond innovatively to real-world problems. Including the arts in STEAM learning can further enhance teaching and student achievement and build upon existing approaches to STEAM that encourage students to apply creativity to solving real-world problems. In contrast there is in Belgium (and also in other participating countries) not sufficient budget to meet the demands. Schools have insufficient digital resources for STEAM training. Although there is motivation in teachers for working on STEAM in classroom, they are drawn back by lack of adequate ICT resources and teacher training.

Training students to pass on their knowledge to their peers can boost their confidence, help them discover new talents, and avoid drop-outs in school. Secondary school students from every area should have the opportunity to become involved in "training to be trainers" activities, either within their own school, at another school, or even at after school activities. Conversely, primary school children from underprivileged areas will benefit not only from being introduced to coding and programming, but also from interacting with their peers, who act as role models.

Bibliography

I. The number of school dropouts is falling, but there's still a long way to go https://www.morningfuture.com/en/article/2018/11/12/school-dropouts-school-data/465/ (Italy)
II. Gone for Good? Determinants of School Dropout in Southern Italy https://core.ac.uk/download/pdf/6293532.pdf, 2007
III. Eurostat Data Explorer: Early leavers from education and training by sex and labor status http://bit.ly/33UlzHB

IV. Statistischer Quartalsbericht Leipzig II/2018 https://static.leipzig.de/fileadmin/mediendatenbank/leipzig-de/Stadt/02.1_Dez1_Allgemeine_Verwaltung/12_Statistik_und_Wahlen/Statistik/Statistischer_Quartalsbericht_Leipzig_2018_2.pdf

V. StatBel Belgium in Figures – Early School Leavers https://statbel.fgov.be/en/themes/work-training/training-and-education/early-school-leavers

VI. EU Cities statistics - you can select specific cities! https://ec.europa.eu/eurostat/web/cities/data/database

VII. EU Cities statistics on early school leavers https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

VIII. EU Cities statistics on population by origin (regions) https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urb_cpopcb&lang=en

IX. OECD Income inequality https://data.oecd.org/inequality/income-inequality.htm

X. OECD Youth not in employment, education or training https://data.oecd.org/youthinac/youth-not-in-employment-education-or-training-neet.htm

XI. OECD Houshold income available https://data.oecd.org/hha/household-disposable-income.htm

XII. EU Definition of risk of poverty and social exclusion: People at risk of poverty or social exclusion are classified in accordance with three distinct criteria, but only need to have one of these situations to be considered as part of this subgroup. The three criteria are:

1. people at risk of poverty — defined here as those with a disposable income that is below the risk of poverty threshold (set at 60 % of national median equivalised disposable income, after social transfers);
2. people who are considered severely materially deprived — defined here to include those people who are unable to pay for at least four out of the following nine items: i) rent or utility bills, ii) adequate home heating, iii) unexpected expenses, iv) meat, fish or a protein equivalent every second day, v) a week's holiday away from home, vi) a car, vii) a washing machine, viii) a colour television, or ix) a telephone;
3. people living in households with very low work intensity — defined here as those aged 0–59 who are living in households where the adults (aged 18–59) worked no more than 20 % of their total work potential during the past year.

XIII. Living conditions in Europe – 2018 edition https://ec.europa.eu/eurostat/en/web/products-statistical-books/-/KS-DZ-18-001

XIV. JAN A. G. M. VAN DIJK: Digital Divide: Impact of Access. 2014 https://ris.utwente.nl/ws/portalfiles/portal/5597980/Digital+Divide-+Impact+of+Access.pdf