DIS-CODE - Disconnected, discouraged, disenabled? Let’s code!

IO1A6 - DIS-CODE Recommendations for Policy Makers

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1. EXECUTIVE SUMMARY

The DIS-CODE project aimed to train students at drop out risk to improve their digital skills and learn maths by studying coding, the 21st century language which is critical in developing transversal skills such as abstract and analytical thinking, logic and problem solving. The used method was mainly the one of the flipped classroom, where the traditional lesson method is flipped, meaning that class lectures is substituted by lessons taken by students at home, and home-work is substituted by activities that take place in class.

The aim of this document is dual; it aspires to collectively review the scientific findings of the project while reviewing the recommended methodology suggested by the DIS-CODE project, and additionally provide the appropriate recommendations addressed at multiple beneficiaries and policy makers.

This document in its respective sections examines the early school leaving phenomenon in the participating to the DIS-CODE project countries, innovative methods to be applied inside the classroom in an attempt to reverse the phenomenon; and lastly the policy recommendations that should be taken into consideration in order to mark a lasting change for the vulnerable students at risk of dropping out that are affected the most.

2. INTRODUCTION

Early school leaving from education (ESL) according to Eurostat[1] is defined as *"a person aged 18 to 24 who has completed at most lower secondary education and is not involved in further education or training; the indicator 'early leavers from education and training' is expressed as a percentage of the people aged 18 to 24 with such criteria out of the total population aged 18 to 24"*.

In countries of the European Union the Labour Force Survey (LFS) [2], a survey by the National Statistical Institutes covering all the citizens residing in private households, is conducted in order to estimate and classify the employment status of citizens in three categories : employed persons, unemployed persons and economically inactive. Eurostat using LFS data for statistical purposes, defines as early leaver from education using two criteria: people who have not pursued higher education after the lower secondary education, and people who had not received education, non-formal or formal training in the four weeks preceding the survey.

As of 2017 *"12.1 % of young men and 8.9 % of young women in 2017 in EU were early leavers from education and training".* Furthermore, 10.6 % of the 18-24 olds in the EU in 2017 had completed at most a lower secondary education and were not in further education or training ('early leavers'). Those statistics reflect a variety of structural problems in various EU countries, ranging from access to materials and resources, socio-political and economic reasons, marginalization and problems within the domestic sphere, that eventually lead to lack of motivation to carry on and lead to youngsters abandoning their education.

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Early_leaver_from_education_and_training
[2] https://ec.europa.eu/eurostat/web/lfs/overview

Adding to that, the financial recession that has severely impacted the educational sector in multiple if not all EU countries during the past decade, has contributed to the phenomenon and the results are evident now.

3. EARLY SCHOOL LEAVING IN EUROPE

3.1 ITALY

The statistics concerning Italy are encouraging as they demonstrate that the ESL rates are dropping. The percentage of young people between the ages of 18 and 24 who abandoned school early, without obtaining second degree diplomas or vocational training certificates, dropped from 19.2% in 2009 to 15% in 2014. At this point, Italy reaches its national target of 16%, while remaining far from the European target of 10% by 2020[3], according to the preliminary results of DIS-CODE.

Lack of funding for ICT investments may be identified as one of the causes, though of course this is hard to demonstrate. Particularly in Italy, ICT-driven innovatory policies cannot be adopted, for the lack of funding as opposed to various other European countries. However, important steps and initiatives have been planned in order to proceed. For instance, the initiative ***La Buona Scuola,*** which is part of the political reform of the Italian Educational system, identified the main challenges in education today and concluded that radical changes should be implemented in order to revolutionize schools, incorporating innovatory methods such as the flipped classroom and the same time promote personalized, independent study according to the needs of each student.

The recent financial hazards have also shifted the attention on the economic resources and the actual potential and consequent cost of such reforms. Therefore, the participation and support of the industrial section and the cooperation between companies and schools or Universities is seen as a necessary step to consider in the near future.

When it comes to mathematics in particular, traditionally a subject that discourages students from getting more involved in science and technology, and a major challenge for students already on the verge of thinking to give up on their education, the ***Piano Nazionale Scuola Digitale*** aspired to eliminate the stereotypes surrounding mathematics and other STEM courses. Consequently, we begin to visualize a new era for education where soft skills and numeracy skills merge resulting in overall academically strong students.

3.2 BELGIUM

Whereas the ESL rates are relatively low in Belgium, it remains a challenge. The Flemish region has achieved to mark a lower rate comparing to the European average since 2006 (currently at 6.8%), while the Walloon Region currently rates at 10.6%, slightly overcoming the expected target rate. The most

inconsistent rates are observed in Brussels-Capital Region, however it has significantly dropped from 2000 to 2016 going from 20.7% to 14.8%.

The overall image of students who choose to drop out of school points out to certain characteristics. The rate is higher among boys than girls, and the Brussels region and the French-speaking areas are more affected. The main reasons are usually associated with socio-cultural and family problems, but also a collective lack of engagement from school activities that eventually becomes too big of a factor resulting in students giving up.

Belgium, has implemented specific strategies to reverse this trend. One of them is to provide more specialized support to students who need it in an attempt to lower grade repetition. The individual learning plan (**PIA – "plan individual d'apprentissage"**) has been set up, and supplementary classes are available for students who need it. Additionally, a system for identifying students demonstrating early warning signs has been designed, both in order to indicate and face learning difficulties, but also to involve the parents in this procedure by reminding them their duty as guardians, monitoring the attendance of their children which is compulsory. Lastly, actively involving students in the decision-making procedure and the same time ensuring that adequate healthcare, concerning both their physical condition but also mental and emotional state is being provided, has been set very high in the agenda.

3.3 CYPRUS

The reasons that trigger ESL in Cyprus are complex and linked to various problems: socio-political since an important part of the country has been occupied since 1974; and economic as the country is currently going through financial recession which leads to extremely high unemployment rates, affecting severely even STEM graduates. The later, adds to the problem as a career in science does not equal prosperity or professional success. Most importantly, students in Cyprus are often considered overwhelmed, as they are provided with additional courses as a form of support, adding to their overall fatigue and not guaranteeing success, which is an outcome of the shortcomings of the educational system in the country.

For this reason, Cyprus has been taking steps into addressing the aforementioned issues and improving education overall. An update of the school curriculum is currently developing, whereas efforts are being made to supplement schools with Educational technologies and advanced equipment.

The ***"Strategic Plan for the System of Technical and Vocational Education and Training 2015 - 2020"*** has been designed for this purpose, aiming to approach and make an impact on students of all ages enrolled in different establishments, having different needs and following different paths. Examples of such would be the Upper Secondary Technical and Vocational Education schools, the Evening Schools for students in need of further assistance, as well as the various apprenticeship schemes.

3.4 PORTUGAL

Early school leaving is definitely an issue that needs to be addressed in Portugal. It has been observed that thousands of students choose to interrupt their mandatory education for reasons that relate to their personal dissatisfaction or lack of motivation, parental and family problems, the country's recent developments during and after the recession which is a social problem collectively; and lack of access to information. That being said, a highly skilled student population that pursues higher studies most certainly has bigger chances to contribute to the economy, adding skilled workers to the Portuguese labor force and leading the country to the future in confidence.

The ***National Program for the Promotion of School Success*** has been implemented in Portugal and aspires to assist at first students during their early years in education in order to set a base. For students who has demonstrated a lack in will to study as they have lost their motivation or do not hope to a better future, Professional Education has been deemed as an alternative path, and in combination with the ***School Social Action*** the support of students of weaker social background or students coming from disadvantaged households has been reinforced.

In order to engage as many students as possible, several extracurricular activities that combine study with entertainment related to theater or other **activity clubs** have been launched by the **Vila Nova de Famalicão Municipal Council** in several schools in the region. Gradually, other subjects like maths are incorporated into the extracurricular activities, for instance some tasks require students to formulate their own actions and plans. This action falls within the innovative curriculum update that aspires to be inclusive for all students, including those in imminent risk of dropping out of school.

3.5 CZECH REPUBLIC

Czech Republic has one of the lowest rates of ESL. The reasons are mainly affiliated with the difficulty that the system presents in not allowing dropping out of school easily. Those who are mostly affected belong to specific social groups, for example they belong to certain schools or areas in which students have limited mobility options that traditionally faced this problem. Other factors that affect school performance relate to poverty; for instance students dropping out in order to work and assist their families. Preventing ESL is not a priority in Czech Republic mainly due to the fact that it is not a pressing issue yet, and the aforementioned reasons behind ESL are mainly social.

Czech Republic has a tradition in teaching mathematics and engaging students in this subject. Education is also supported overall with special evening courses, supplementary courses provided by **NGOs, libraries or volunteers** who ensure that students won't fall behind.

Research has shown that mathematics is largely disliked among students, and in an attempt to reverse this trend Czech Republic has adopted the scheme-based method of Professor Hejný to teach mathematics in particular. Professor Hejný and his team reached to the conclusion that persistence in arithmetic results in students being bored and looked for more creative ways to introduce them to mathematics, like the use of schemata which means information gathered in functional units that

relate to a specific meaning and are easy to remember and comprehend[4]. The preliminary results of this method show that students enjoyed more mathematics taught this way rather than the traditional way. It was therefore, a successful example of engaged teachers actively looking for ways to transform their lessons.

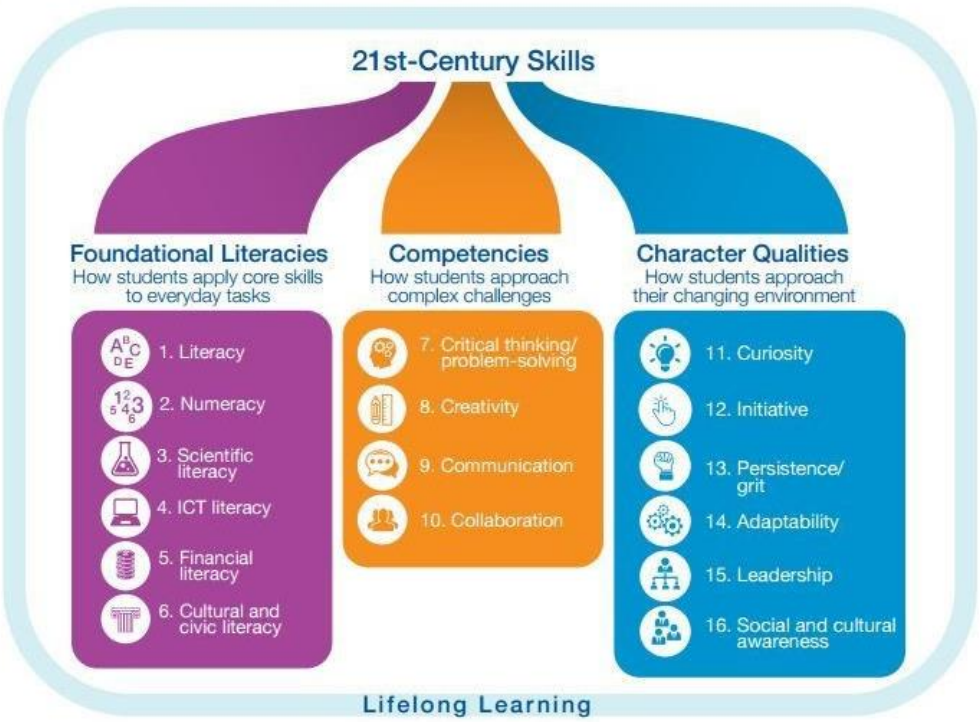
4. INNOVATIVE TEACHING FOR THE 21ST CENTURY

The focus of this study has been the phenomenon of early leavers from education and examples of successful initiatives implemented in various countries in order to prevent it and decrease the percentage of students who feel demotivated enough to give up on their education.

Innovation in education in the 21st century largely depends on taking full advantage of students' potential and skills. However, despite education being today more accessible than ever, there is still an alarming number of students that either choose to give up their education, or passively attend school with no further motive to improve academically or acquire more skills, that also often lead to early leaving from education.

Innovative educational approaches drifting away from the standard approaches that have been applied for decades in the past, have been introduced. Those approaches take into consideration the collective skills of an individual in combination with the rapidly changing landscape of the job market, and aspire to assist students from an early age to fully realize and exploit their personal and academic potential; but also the value of collaboration and other often overlooked within the educational context qualities like creativity, cultural agility and resilience. As shown in **Graph 1**, several of the skills that WEF defines as mandatory fall under the SEL spectrum.

[4] Hejný, M., Slezáková, J., & Jirotková, D. (2013). Understanding Equations in Schema-oriented Education. *Procedia - Social and Behavioral Sciences*, *93*, 995–999. https://doi.org/10.1016/j.sbspro.2013.09.317



Graph 1: Students require 16 skills for the 21st century (source: WEF[5])

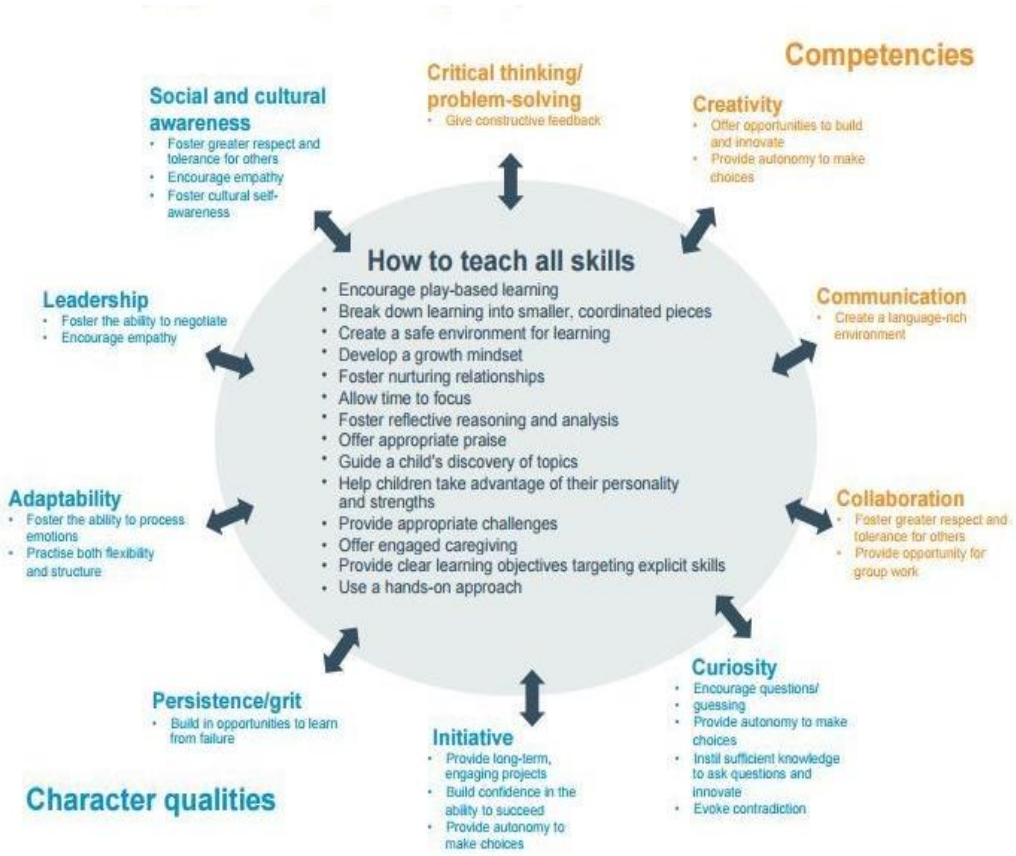
In addition to digital or numerical competencies, several theories and educational approaches emphasize on the need for students to acquire the so called Social and Emotional Learning skills (SEL), and the new tendencies in education confirm that. When it comes to technology in particular, the World Economic Forum has conducted research on the ways digital economy transforms the workplace, and the results demonstrate that whereas mechanization and automatization have been dominating the field creating new needs and even professions, social and emotional skills are a prerequisite for success and the use of new media like video games in the classroom, often enhance them.

The new developments in education and technology have highlighted the need to incorporate innovative teaching approaches in the classroom like **Project-based learning (PBL)**, as well as instructional strategies concerning the most efficient way to proceed with school assignments for all students, like **flipped classroom**. Additionally, the update of the school curriculum with the addition of programming, which is deemed as a necessity for the 21st century school, combined with problem-solving methods like computational thinking, are considered mandatory mainly because they illustrate how numerical skills and creativity are combined, resulting in students becoming aware of their individual qualities and strengths.

Most importantly however, the developments in the fields of technology and new media, demonstrated that the previously overlooked or perceived with suspicion application of games or entertainment in education, is in fact beneficial at least to some extent. Research on gamification and edutainment has shown that the use of games and interactive, participatory activities in class result in

[5] The World Economic Forum

increased inclusion, and enhance students' motivation to remain attentive in class. Play-based learning, collaboration, critical thinking and problem solving mutually influence each other as shown in **Graph 2**. This means that individual character qualities and strengths if identified within school can be cultivated to a great extent, making a huge difference to students' lives in the long term.



Graph 2: A variety of general and targeted learning strategies foster social and emotional skills (source: WEF)

4.1 CODING AND COMPUTATIONAL THINKING

The teaching of programming in schools, particularly in Europe where the education landscape remains fragmented with various countries setting different priorities that are determined by national policies, is being treated as a priority by the European Union mainly as a countermeasure to the growing number of unfulfilled jobs in the field of technology. Competency in programming languages is a rather empowering and sought after skill for employees, and this demand is naturally reflected in the multiple initiatives in various European countries as the preliminary results of the DIS-CODE project have shown.

Coding, apart from being highly relevant and useful, is approachable by different types of learners inclined towards different subjects and not only computer science as it is commonly thought. Coding can trigger digital creativity, teach how systems and networks are built, and provide a thorough understanding of how automatization works. Within this context, students who comprehend how machines are built and operated, can also comprehend what are the skills that they themselves should exercise as they are not possible to automate. This could be summarized as breaking a problem down

to smaller pieces in order to decode it, understand it and solve it; which brings us to our next area of focus, computational thinking.

Computational thinking has been linked but also differentiated from computer science as the combination of *"solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science"*[6]. If we were to define computational thinking, we would say that it is more about building the tools that we will use to create a solution, rather that create the solution itself. This is where critical thinking and analytical skills come into the picture, skills that according to experts on the topic are of equal importance to basic literacy and arithmetic.

4.2 PROJECT-BASED LEARNING

Project-based learning (PBL) as an approach is very much aligned with the notions of creativity, team work, cooperation and the development of organizational skills; it is therefore a learner-centered instructional approach. Consequently, planning, mapping out priorities, studying for the research and eventually presenting the results are required. It is a procedure during which the students are free to explore their options and strategically break into pieces the presented problem before solving it.

Project-based learning has been defined as an "*instructional model based on having students confront real-world issues and problems that they find meaningful, determine how to address them, and then act in a collaborative fashion*"[7]. PBL is not a new development in education, however it has been receiving increasingly attention during the recent years as educators are seeking ways to combine the mandatory 21st century skills a student should have in terms of collaboration, while integrating in the classroom new technologies.

A more in-depth analysis entertains the connection between the school curriculum and later success in life, by saying that school should be perceived as a safe space for students to flourish and explore their potential, unique skillsets, strong and weak points; and therefore the ability to cooperate with others is a strong indicator as well as the reason PBL and collaborative activities should be integrated in the curriculum. [8]

As part of the DIS-CODE project, a series of Open Day Coding Jam events were organized at the Future Classroom Lab in Brussels, reaching out to more than 200 students and their teachers. The students were extremely diverse in terms of learning styles, linguistic background, previous experience with coding and new technologies, and academic performance. Therefore, collaboration was essential for the success of the activities. Some of the most distinct comments and feedback the organizers received from the teachers were that the activities were even 'life-changing' for some of them. The combination of innovatory educational activities, students of mixed abilities and interests working in groups and explaining the rationale of why robotics and new technologies are relevant for all resulted in multiple successful events.

[6] Wing, J. (2006). Computational thinking. COMMUN. ACM 49, 3 (March 2006), 33-35. DOI: https://doi.org/10.1145/1118178.1118215

[7] Bender, W. N. (2012). *Project-Based Learning: Differentiating Instruction for the 21st Century*. Corwin Press

[8] Leat, D. (2017). *Enquiry and Project Based Learning: Students, School and Society*. Taylor & Francis

Naturally, all the students had worked in groups before, however very much like the literature review suggests, project-based learning blends particularly well with new technologies and tools that are not often used in class. The notion of inclusion empowered students in thinking that they can innovate and experiment equally; but also more familiar with those technologies or academically stronger students significantly assisted their groupmates to understand, complete and present a project. This was particularly reflected during the final phase of the Coding Jam events when the students had the so called ''Elevator Pitch'' phase explaining to everyone what they did, which activities were the most pleasant or challenging, and how they tackled the challenges.

PBL foresees other skills that prepare students for their future lives next to academic study and research. Time management, high degree of adaptability and team work are few of those; all skills that relate to students' social skills. In addition, PBL provides flexibility during the selection of topic or research question explored, often validating students' opinion and preference in choosing them. Consequently, the project is relevant to them and this entails larger possibility of success, preparing them the same time for meaningful tasks and the real world.[9]

As mentioned earlier, PBL has been popular since the beginnings of 20th century when the educational reformer John Dewey suggested his popular "learning by doing" belief. It was however further supported by the leaders of the Constructivist movement who suggested that individuals construct their knowledge by interacting with their external environment but also with each other, and emphasized that despite being exposed to the same experiences each learner eventually forms their own perception because they already build on knowledge that pre-existed.

It is undeniable that team members largely differ from each other and this is in a way the added value each one contributes, so PBL fosters this and teaches young learners the importance for individual contribution in combination with group work in order to achieve better results.[10]

4.3 FLIPPED CLASSROOM

The flipped classroom method has been gradually applied in the classroom in order to better serve students' needs. This method is especially appealing to the "Millennial" students commonly referred to also as digital natives; as they are able to reverse or as it name suggests to flip, the assignment duties.

A prerequisite for flipped classroom as defined by Reidsema et al., is for students to prepare themselves for their lecture with material they find online as they have to *"engage in or complete some form of preliminary learning online in preparation for a structurally aligned learning activity on campus with their instructors and peers* (p.6). [11]

[9] Krajcik, J., & Blumenfeld, P. (2005). Project-Based Learning. In R. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (Cambridge Handbooks in Psychology, pp. 317-334). Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511816833.020

[10] Grant, Michael. (2002). Getting a grip on project-based learning: Theory, cases and recommendations. Meridian. 5. Retrieved October 20, 2018 from https://www.researchgate.net/publication/228908690_Getting_a_grip_on_project-based_learning_Theory_cases_and_recommendations

[11] Reidsema, C., Kavanagh, L., Hadgraft, R., & Smith, N. (2017). *The Flipped Classroom: Practice and Practices in Higher Education*. Springer

As homework, students watch online the instructor's lecture in a procedure that reminds us the MOOCs. While in class, instead of passively attending the lecture, students interact and cooperate engaging in participatory learning, finding solutions together; trying to advance concepts, meaning improve the already suggested solutions to the research question or problem they are working on.

This method is largely preferred by students who are keen on using technology and digital media in class, which on the one hand is in line with the current developments; on the other hand however requires reflection and considering again ways to manage the already limited available time for a lesson. In addition, since students learn by demonstration, thinking critically and by exchanging views it promotes deep learning which replaces the superficial one-way instruction we have seen so far; therefore flipped classroom belongs to the more progressive learner-centered instead of teacher-centered approaches and methods that started to be implementing in the mid-20th century.[12]

4.4 EDUTAINMENT AND GAMIFICATION

Gamification and edutainment have recently entered the education landscape, as methods used to make lessons more appealing for students. The rationale behind this is that students on the verge of quitting their education have already demonstrated lack of interest for studying as we know it, so more creative ways need to be designed and adopted. However, there is an important distinction between the two: a) gamification refers to teacher-initiated choices in choosing and using the most appropriate games, whereas b) edutainment relates to various media used in education. This requires the involvement of professionals in the field.

For instance, if Microsoft did not choose to enter education by conceptualizing, designing, testing and releasing Minecraft as part of its edutainment-related policies, teachers would never be able to use this game as part of their lesson applying gamification in their class that way. Gamification applied in education as an educational approach, has been regarded as a successful way to trigger students' interest and attract more participation. In addition, gamification can take multiple forms in the classroom and be adapted according to the teacher's available means and experience; as well as the students' level and expected outcomes.

A key element in successfully implementing gamification in the class, is the creation of interactive activities employing games but also participatory activities that will engage in the learning process as many students as possible. Even since the late 1980s media companies, researchers and educators had identified video games like SimCity, but also later on Minecraft, as an educational tool that through simulation had educational value for players. The use of video games like Minecraft provide opportunities for collaborative activities between teams, familiarize students with digital technologies and programming, and allow the creation of projects related to every school subject.

[12] Roehl, A., Reddy, S.L. & Shannon, G.J. (2013). The Flipped Classroom: An Opportunity to Engage Millennial Students through Active Learning Strategies. Journal of Family and Consumer Sciences. 105 (2), pp. 44-49. Retrieved October 20, 2018, from https://www.learntechlib.org/p/154467/

Furthermore, it provides the opportunity to explore other areas for interest for an educator such as digital citizenship with projects that permit students to reflect on social issues and create projects about the environment within the context of science education for instance, achieving this way the triple goal of studying and researching for a project, acquiring digital skills and becoming socially aware.[13] It is noteworthy that the use of video games has gradually extended in other forms of education and training including military, civic and business education.

Today, with the use of new media, social media and technologies like GPS or augmented reality we could claim that the game experience is not only more enriched than ever, but also highly inclusive providing the opportunity to students of all levels and competencies and socio-cultural backgrounds to participate [14], transcending geographical boundaries. Nowadays, multiplayer games are incorporated at large in education, whether we are talking about video games or activities that require players' physical presence. As an example of such is the Code Hunting Games organized annually within the context of EU Code Week, in which players in multiple cities and more than one countries compete having formed teams in coding competitions.

Educational entertainment or as it is commonly known by the portmanteau *edutainment* is the use of various media in the classroom in order to attract students' interest by incorporating the interactive element games and media offer. [15] In order to be able to talk about edutainment we need to have video, sound, images and texts mixed and combined; meaning media. These media combined trigger the emotions and reactions of students, aspiring to enhance their learning experience. While the role of the teacher is crucial here, we should not fail to observe that teachers themselves will probably not be able to produce this material themselves, something that brings companies and media professionals into the picture.

[13] Colling Gallagher, Minecraft in the Classroom; Ideas, inspiration and student projects for teachers

[14] Borys, Magdalena & Laskowski, Maciej. (2013). Implementing game elements into didactic process: a case study. Retrieved October 20, 2018, from https://www.researchgate.net/publication/260060814_Implementing_game_elements_into_didactic_process_a_case_study

[15] Aksakal, N. (2015). Theoretical View to The Approach of The Edutainment. *Procedia - Social and Behavioral Sciences*, *186*, 1232–1239. https://doi.org/10.1016/j.sbspro.2015.04.081

5. RECOMMENDATIONS

Policy makers should ensure that schools and learning environments provide a stimulating learning climate for all students. As simple as it may sound, this decision entails a number of priorities that need to be set in order to meet this goal. Access to good quality early childhood education and care, engaging curriculum, flexible educational pathways; and a strong and well-developed guidance system, are some key elements to be considered towards increasing the motivation of pupils to fully develop their strengths and talents. All the aforementioned goals can be achieved if changes in a few areas are made. Those areas would be educational reforms, the creation of a support network for teachers, ensuring familial balance to the maximum degree, and considering every potential space or technology before using it unreservedly.

RECOMMENDATION 1 – INNOVATIVE TEACHING APPROACHES TO ADDRESS EARLY SCHOOL LEAVING THAT EMPHASIZE ON COLLABORATION

Policy makers in cooperation with educators and experts should develop successful strategies to prevent early school leaving. Successful strategies include and greatly rely on innovative teaching approaches, as they provide the means for interactive student-centered learning projects that boost students' transversal skills, the skills that learners need to develop to be able to adapt to changes and to lead meaningful and productive lives.

Examples of such innovative approaches are the Project-based learning method and the Flipped Classroom approach. Both depend on students collaborating with each other as interaction is the key element for acquiring new knowledge. Collaboration might be met with indifference or denial; however in the long term it is the more realistic and pragmatic way to acquire and process information. It promotes inclusion as students are naturally inclined to learn alongside their classmates and friends, and it has the additional but great advantage of mixing students of various levels in a way that allows academically weaker students learn from others. Evidence suggests that when students were asked to collaborate and solve math-based problems when a student *"generated the first idea"* the rest followed up easier and far more ideas were produced comparing to similar settings where the teacher provided examples or solutions. [16] The main conclusion from this research resulted in a

[16] Mercier, E., Vourloumi, G., & Higgins, S. (2015). Student interactions and the development of ideas in multi-touch and paper-based collaborative mathematical problem solving. *British Journal Of Educational Technology*, *48*(1), 162-175. doi: 10.1111/bjet.12351

discussion as to how educators should perceive collaboration as a must-have skill that should be taught. [17]

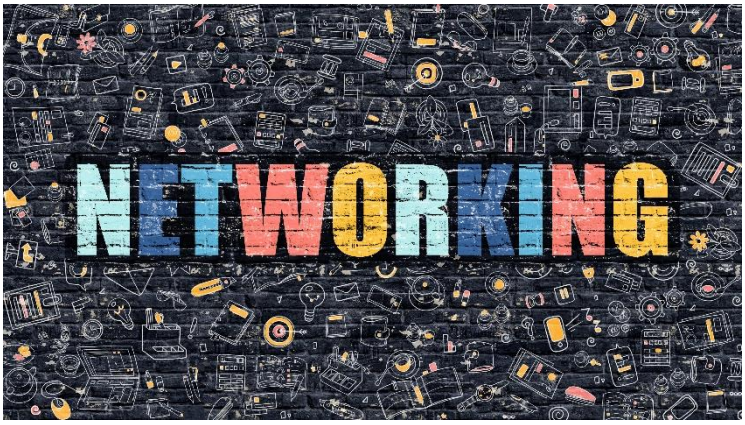
As an extension of this, peer-feedback might also be applied. In this procedure students in pairs or groups assess each other's assignments giving feedback, something that greatly benefits everyone because argumentative discussion takes place; challenging their critical abilities.

An additional, great advantage of PBL and the flipped classroom is that they can be applied in every subject. Whether we are talking about STEM related subjects with more standard results and outcomes to expect, or subjects with more abstract interpretations like art and literature; students can be benefited by instructions, cooperation, interpretation and different perceptions provided by their peers.

RECOMMENDATION 2 – PROMOTING NETWORKING OPPORTUNITIES FOR TEACHERS, ESTABLISHING COLLABORATION ON EUROPEAN LEVEL, AND REWARD ACTIVELY INVOLVED TEACHERS

Policy makers should promote the establishment of teacher communities of best practice to develop, evaluate and share new pedagogical methods and experiences for the reduction of early school leaving.

The preliminary results during the DIS-CODE project, as presented in the *Needs and Existing Situation Analysis European Report* highlighted related activity in Belgium; where lectures organized by Universities, formal initiatives and mathematics competitions take place in order to trigger student motivation in participating to events related to mathematics. In addition to preventive measures and educational reforms initiated by the government, the Free University of Brussels offers a series of lessons in mathematics in the form of 50-minute long sessions, where experienced faculty members assist students enrolled in secondary school, upon the agreement with their teachers. This is an example that illustrates the importance of teachers seeking to enrich their courses by involving other methods applied in higher education; but also Universities moving towards becoming actively involved in their respective communities. None of this would have been possible without the contribution of the teacher community and the collaboration among its members, on a school or higher education level. Additionally, teacher communities like eTwinning are necessary, as within its context projects are designed to be carried out, workshops where the participants' physical presence is required takes place, and all-year round support is provided.



[17] https://www.edweek.org/ew/articles/2017/05/17/children-must-be-taught-to-collaborate-studies.html

Teacher collaboration should be perceived exactly the same way students' collaboration is. Individual learning might lead to good results faster but it is a solitary path and lacks input and challenge from others. Teachers often fall in the trap of being possessive with their material or refuse to let go of tried and established patterns of teaching, as a direct outcome of long-term stay in education. However, as much as collaboration and exchange of ideas is promoted for students; teachers should form their own networks of collaboration in order to mutually support each other. Combined with life-long training and learning, a necessity for our era, regular contact and exchange between teachers can help to face and solve common challenges.

This is especially the case with teachers in areas or schools where the drop-out rate is very high but have managed to either eliminate or face it successfully; surely their input and feedback would be very helpful for other colleagues. While discussing about disconnected and affected students, it is important to consider teachers who despite their efforts achieve lower results due to the lack of resources, geographic isolation and limited funding. In those cases, collegial support can be of massive importance for both professional and personal progress. During the meetings that took place within the context of the DIS-CODE project it has been noted that there is a significant lack of dialogue on European level between teachers. This particularly affects teachers in remote or disadvantaged areas who could benefit tremendously from the use of materials such as lesson plans and tutorials created by other teachers, that could be adapted to their lessons in their language and in line with their students' needs. Constant support is mandatory for teachers as much as for students, in order to foster in them a constant quest of knowledge and will to improve, by adopting innovative methods in their teaching.

However, the crucial question on how to motivate teachers giving them reasons to get involved remains. Teachers who choose to regularly attend training activities and even more so, seek to participate with their classes in pan-European or international initiatives, competitions and educational activities opening new avenues of exploration for their students, should be heard and rewarded. Visibility and having their voice and concerns heard should be a priority for policy makers in order to signal and ensure that engaged teachers have their own platform, with established online communities providing network and tools like massive open online courses (MOOCs); as well as frequently organized events and meetings. When it comes to teachers who devote significant amount of extra time in preparing for and participating to Erasmus+ programs giving this way the opportunity to their students to attend exchange programs, an official recognition system in the form of credits and certificates should be considered, but teachers' commitment and hard work should be also rewarded internally at school level, with time off and extra flexibility.

RECOMMENDATION 3 – PARENTS AND FAMILIES AS FACTORS OF STABILITY

Policy makers should encourage effective family-school partnerships and offer opportunities for parents' education. Raising the educational level of parents and involving them in the schooling of their children may be constructive ways to prevent early school leaving. The results from the preliminary research for DIS-CODE in countries like the Czech Republic demonstrated that students dropped-out of school in order to enter workforce early on and contribute financially to their families. Whereas pragmatically very little can be done about poverty, initiatives like the *centres psycho médico sociaux* (CPMS) in the French-speaking community in Belgium, assist students at the risk of dropping out and

their families and provide support and health care. Very often parents wish even with their limited resources to help their children but are not aware of how to do this. For this reason, free of charge consultation is provided to families by psychologists, nurses, social workers and doctors.

School counselors should first and foremost inform parents about the academic path of their children. One they have concluded that a student comes from a family incapable of providing support or is entirely neglected, before suggesting radical measures than can be often prevented with proper guidance, it is useful to consider education programs for parents. Inclusion works this way for parents as well: very much like an indifferent student who has the potential to shine if given proper attention, guidance and validation; parents must become aware of their impact.

The European Commission has previously implemented projects related to parental support.[18] According to previous actions, early support for both parents and children is a priority and falls within the wider context of the Lisbon treaty in 2000 where the future Digital Agenda was drafted and conceived, but also within the Horizon 2020 agenda.

RECOMMENDATION 4 – THE IMPORTANCE OF SETTING A STRONG BASE EARLY ON

Policy makers should reconsider the preschool education and its role in the promotion of school success in the early years of the education path, by providing early detection mechanisms that spot the early signals of disengagement and provide quick responses. The DIS-CODE results in Portugal showed that supporting students very early on is seen as a priority in the country.

Whereas ESL is usually observed after primary school excluding extreme cases and is identified as a problem mainly for teenagers, early guidance can certainly prevent it. For this purpose, personalization is essential to be applied. Early education is a critical period in a student's life and erroneously associated only with superficial educational activities. It is the period during which individual talents can be identified, fostered and encouraged; but most importantly it is one of the few periods in a student's life where time is not a pressing issue. This means that children and their educators can enjoy exploring various subjects while identifying their personal inclinations. Academic failure has been treated and rightfully so as undesirable, especially with age. However, young students should be allowed to experiment and try out new things, explore and define their inclinations. Should this take place early on, children will be given the extra motive to carry on successfully their academic path.

In addition to setting a solid base early, it is important to make students perceive learning as a joyful experience by integrating game-based activities early on. The results of the respective tests in Italy during DIS-CODE were very telling and demonstrated that even students with learning disabilities or students who were lagging behind comparing to their classmates, claiming that they were overwhelmed by mathematics and ICT related subjects, participated at large in game-based activities. The tests were undertaken in classes of the junior and upper secondary school and suggest that the earlier students are introduced to game-based learning, the better results are achieved in terms of

[18] Daly, M. (2013). Parenting support policies in Europe. *Families, Relationships and Societies*, *2*(2), 159–174. https://doi.org/10.1332/204674313X666886

triggering their interest and this mainly affected demotivated or academically weaker students who benefited the most.

RECOMMENDATION 5 – EMPOWERING STUDENTS THROUGH COMPUTATIONAL THINKING

Emphasis on computational thinking as the process that allows to students to design and build solutions for existing problems is particularly important for projects like DIS-CODE, because while contemplating the best strategies to prevent students from leaving education, it is necessary to reflect if those students have been let down by educators or the system collectively, in case their individual skills have been not fully exploited. At this point it is worth mentioning that computational thinking training is being studied and treated as a priority to incorporate in teacher's education training programs, in order to be well equipped before training students in getting calculating thinking abilities.

However, a more decisive approach is needed, especially if we need to empower each student individually with confidence and qualifications on the one hand; but also compete on international level. China has already adopted computational thinking at large in the curriculum with programs incorporated in prestigious projects like "985 project" involving its most reputable Universities; and New Zealand has implemented the CS Unplugged project at the University of Canterbury. [19]

Lastly, if we take into consideration innovation is terms of creating on a more general note, we could say that coding and computational thinking have the potential to empower students in becoming entrepreneurial, by critically analyzing what is missing and finding ways to create it themselves. This has been witnessed particularly in the field of technology during the past twenty five years, as it was programmers and software developers who were confident in combining all the aforementioned skills and create the technology, social networks and enterprises that we use at large today, dominating also the business field. This essentially means that motivational speeches or promoting success stories by entrepreneurs who largely used their digital skills to succeed need to be brought up more often, as they mainly concern every-day people often from humble beginnings who managed to create and change the world as we know it.

RECOMMENDATION 6 – EMBEDDING EDUCATION IN SPACES OUTSIDE SCHOOL

There is the need to fully exploit spaces that could accommodate educational activities and initiatives outside schools, both within the spectrum of traditional education but also extracurricular activities. Examples of such are libraries and other community or cultural spaces. The application of innovatory methods and approaches in education are absolutely compatible with activities taking place in various spaces. The preliminary DIS-CODE results have demonstrated that libraries and NGOs often by the support of volunteers in countries like Portugal and the Czech Republic support students in need of assistance. Policies like this should be taken into consideration because they assist in students perceiving the benefits of education in a more holistic way that exceeds school boundaries. In addition, it mobilizes people who are not directly linked with education, like volunteer teachers or University

[19] Erasmus+ https://repositorio.grial.eu/bitstream/grial/688/1/TACCLE3O5Literaturereview%20-%20final.pdf

graduates resulting in social cohesion. A successful example of this within the context of gamification is the aforementioned Coding Hunting Games organized by Italian team lead by Alessandro Bogliolo.

Another reason to consider hosting educational activities in spaces outside the classroom such as libraries are unprecedented issues or arising problems sometimes difficult to predict. During the final webinar of the DIS-CODE project where the participating teachers had the chance to evaluate the project collectively, valuable feedback related to teacher mobility and the ways it affects student participation. More specifically, a participating teacher from Portugal suggested that whereas her students were initially excited to take part in the International Scratch Jam Competition, eventually they did not manage because they are attending different schools so cooperation was not possible. It is therefore, worth considering that teachers according to what the Ministry of Education in every country predicts, are sometimes obliged to teach in various schools to cover the needs. In cases like this, an activity organized at a space outside school and working hours would be extremely valuable.

The organization of the multiple Open Day Coding Jam events at the Future Classroom Lab in Brussels, proves that students are willing to cooperate with students from other schools and participate in activities outside their perceived "comfort zone" in terms of groupmates and innovatory activities, as long as the objective is clear and motivating.

Other possible spaces that can be used for this purpose are the various Fab Labs or other maker spaces in Europe. Those spaces provide the opportunity to experiment, play and create using technology that is rarely available in public schools. They are also supported by the local community, and this ensures per se the cooperation of people responsible for their function with teachers and educators that are aware about the potential drop-out risk in their school.

RECOMMENDATION 7 – EXPLORING AND ASSESSING NEW TRENDS IN EDUCATION

A lot of discussion took place in an attempt to identify the best strategies about bringing innovation to education and naturally gamification and edutainment were brought upon. However, there is a need for a distinction between the two. In addition, education policy makers should consider discussing how to produce or improve already existing audio-visual material.

Gamification largely depends on each teacher individually; the choices they make for their lesson and students and of course adapted to the policies of each school. Gamifying education[20] has been received both with enthusiasm and skepticism by the education community.

[20] Dichev, C., Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International Journal of Educational Technology in Higher Education*, *14*(1). https://doi.org/10.1186/s41239-017-0042-5

Experts suggest that before incorporating gamification elements in their lesson, teachers should consider a few key points that strongly concern this study and the purpose of DIS-CODE in particular: a) the extent to which gamification affects students' attendance and b) the extent to which game elements influence overall students' overall performance. The outcome of the study demonstrated that whereas games in the classroom do have positive results as they increasing participation and prompt students to undertake voluntary tasks, those results are for the most part short-lived and after a while the need of long-term strategies to keep students actively involved are mandatory.

Edutainment on the other hand is essentially media designed to entertain and educate. This means being exclusively reliant on media and gaming companies and producers of this kind of materials. This policy item is therefore more complex and sensitive in nature as it touches upon other areas beyond education policy like media policy and audio-visual policy. One challenge is the multiple stakeholders involved. A second challenge is the fragmentation on European level in the field of policy in general. However, it becomes apparent that with the majority of students in possession of mobile devices or consuming audio-visual material from the internet and more recently platforms, the need for quality audio-visual material is getting bigger than ever.

Educators as experts could design appropriate, interesting and mentally stimulating material for every subject and promote programs and competitions. This would ensure inclusion for all as they could access this material for free and easily, consuming it in their own time which would be time well-spent. Education would move forward into students' but also parents' agenda because media have tremendous influence per se, instead of sporadically and briefly mention a student competition in the news.

This overlap of media and education policy can only be beneficial and is in line with the recent explosion of new media, social media use and digital technologies that have entered the classroom, like Minecraft that we mentioned earlier. We have observed that software companies and publishing houses have entered the education sector with determination producing video games; or producing and readapting existing written works into the more appealing for the younger generation graphic novels. It is very telling, and in this regard an example to be followed. Apart from the educational benefit, it would result in students becoming critical while choosing the audio-visual material they deserve to consume. Implementation-wise it is definitely possible should it be decided upon. Media content for educational purposes should undergo strict quality controls and ensure that it is age appropriate and it fulfills its mission to educate in an entertaining manner.

RECOMMENDATION 8 – LINK NUMERACY AND MATHEMATICS WITH REAL LIFE SKILLS, DIGITAL COMPETENCES AND ENTREPRENEURSHIP

Mathematics has been traditionally considered a challenging subject for students. This has been taken into consideration by policy makers and educators and as portrayed in the *Needs and Existing Situation Analysis* report during the DISCODE project. Websites, international journals and competitions

dedicated to the promotion of mathematics have been conceptualized; and courses provided by academic for secondary school students have been designed and delivered, which demonstrates that immersing students in mathematics is a priority for the participating to the project countries.

That being said, it is essential to conceptualize and adopt strategies to motivate students understand and get involved with mathematics. The connection of mathematics with computer mediated artistic activities such as 3D printed photographs and the combination of mathematics with other disciplines that vary like theatre or programming should be emphasized in order to convince them that digital creativity and skills are based on being competent in mathematics to some great extent.

In addition, there is a need to make students realize that being competent in mathematics and arithmetic is closely linked with their financial literacy which can be drastically affect their lives. Czech Republic, one of the participating countries in the DIS-CODE project and a country where students achieve great results in mathematics, has been designing strategies and methods to study and teach mathematics for years; most notably the method of Professor Hejný which emphasizes on students understanding of mathematics as one of the principal reasons that determine whether they perceive mathematics as enjoyable or not. Therefore, we can conclude that regular evaluation of their understanding and progress is essential.

Taking into consideration the rapid developments in finance and technology which often overlap, it is particularly important to stress that European competitiveness relies upon entrepreneurship, especially during our times where FinTech (financial technology) startups and digital currencies have entered and changed our lives. We cannot possibly discuss about all the aforementioned if students that will enter the workforce in years to come do not possess numerical skills.

6. CONCLUSION

In this study we have explored a number of factors that trigger early school leaving in various countries in Europe. Additionally, we have identified and listed a number of educational approaches and potential changes in the academic curriculum, but also the role of technology as factors that can affect positively the effort to reverse the trend of ESL.

We have concluded that this problem as multifaceted as it is, needs to be addressed with the same determination by everyone: educators, communities, parents and professionals in the fields of consulting and health care. Therefore, it should be treated as an issue that touches upon education, society as a whole, but also national and transnational policies.

Since DIS-CODE is a project that concerns more than one countries in Europe and the results varied, it is important to acknowledge that fragmentation and the lack of a collective European policy significantly affect the percentages from country to country. In this regard, comparative studies and projects are mandatory in order to keep track of how other European counterparts deal with the phenomenon, in order to avoid unsuccessful policies and similarly get inspired and improvise when identifying solutions that would be beneficial and possible to work.

However, the lack of a common European policy in addressing those issues simultaneously in various countries can be compensated with changes implemented in the national school curriculum of the

countries affected the most; as well as with the research and consultation of independent partners and stakeholders involved like teachers, local governments and organizations.

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