Literature Review

Artificial Intelligence for Early School Leaving

PROGRAMME: ERASMUS+
KEY ACTION: COOPERATION PARTNERSHIPS IN SCHOOL EDUCATION
REFERENCE NO: 2021-1-MT01-KA220-SCH-000024247

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AI4ESL

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Project Brief

The United Nations Children's Fund (UNICEF) estimates that 617 million children and adolescents around the world are unable to reach minimum proficiency levels in reading and mathematics, even though two-thirds of them are in school. Such low levels of academic attainment put students at a learning disadvantage and hence at a higher risk of leaving school early. Early school leaving is associated with a wide range of economic and social disadvantages. Those who leave school early are more likely to come from non-working households, vulnerable groups and minority or migrant backgrounds. The main focus for this project is to address the needs of the groups identified above, particularly Roma communities, asylum seekers, immigrants and those from rural areas by addressing the barriers they face in accessing high-quality learning environments.

In response to addressing the needs identified above, the project's objectives are:

- to identify the needs of students and teachers regarding personalised and adaptive learning, with an emphasis on learning disadvantage
- to design and develop a Digital Learning Platform powered by Artificial Intelligence (AI) aimed at tackling learning disadvantage, early school leaving and low proficiency in basic skills
- to populate the AI-powered Digital Learning Platform with literacy (including media literacy) and numeracy content
- to pilot the content of the AI-powered Digital Learning Platform with students and teachers
- to analyse the quality and impact of the AI-powered Digital Learning Platform through a summative evaluation of the content and instructional design underpinning the system
- to write a short recommendations document on AI for early school leaving

In terms of the project's expected impact, it is envisaged that the results will yield a high-quality AI-powered Digital Learning Platform, based on the needs and requirements of students from disadvantaged groups with fewer opportunities. It is also expected that the Platform will give teachers access to the monitoring, identification and prevention of students at risk of leaving school early. Further, teachers will be better equipped to manage the shift towards digital education and a personalised, higher-order approach to teaching, which is inclusive and equitable. In addition, the resulting digital teaching and learning ecosystem will ensure continuous access to adaptive, personalised content which will address the longer-term challenges associated with marginalisation, diversity and inclusion.

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1. Introduction

This report focuses on the ongoing problem of early school leaving (ESL) in European countries and considers the extent to which digital technologies and Artificial Intelligence may be used to improve this situation. A significant number of young people in Europe, 9.7 %, do not attain an upper secondary level of education and, as a result, lack the basic competences and qualifications sought by the labour market. As a result, many young people have problems finding stable and satisfying employment and are more at risk of poverty and social exclusion. The pandemic has heightened this issue leading certain groups to become more vulnerable to ESL. However, the pandemic has also illuminated how digital technologies can be used to compliment traditional pedagogical methods leading to a consideration of if and how they can be used to reduce the rate of ESL in Europe. The report is divided into two sections. Part (i) considers the role of learning disadvantage in ESL before providing an in-depth analysis on ESL and the factors that contribute to this phenomenon including low proficiency in basic skills. Part (ii) considers recent developments that the European Union has implemented to increase digital citizen's competence considering the role of Digital European Frameworks on Digital Education, including the Digital Education Action Plan (2021- 2027), SELFIE tool and JRC Science for Policy Reports.

2. Learning Disadvantage

Various definitions of educational disadvantage exist but at its most basic it refers to a situation where some individuals in society derive less benefit from the education system than their peers (Combat Poverty Agency, 2003). Several factors contribute to learning disadvantage and these are related to socio-economic, cultural, and/or linguistic factors (SALTO, 2018; Chircop, 2021). The COVID-19 pandemic has highlighted how access to the internet, computers and related electronic devices, and digital competence are essential for educational attainment outside of the traditional school setting. The pandemic has also illustrated the enormous digital inequalities that are taking place not only between Northern and Southern Europe, but within different countries and regions of Europe (Cabrera, 2020).

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On average, across the Organisation for Economic Co-operation and Development (OECD) countries, 9% of 15-year-old students do not have a quiet place to study in their homes (Chircop, 2021). In the EU, 15.5% of people live in overcrowded homes, and among these there tend to be students from the most disadvantaged backgrounds (Chircop, 2021). Research shows that students from low-income and single-parent households tend to have significantly lower performance during both primary and secondary schooling (OECD, 2018). These students often have less access to learning materials such as books and electronic devices at home. However, according to the OECD, schools with students who come from disadvantaged backgrounds have a higher proportion of computers per student than schools with advantaged populations. However, in disadvantaged schools, computers are less likely to be portable, so they cannot compensate for the lack of privately-owned materials for distance learning (Chircop, 2021). In the 2018 PISA (The Program for International Student Assessment) test which accesses student's capacity in reading, maths and science, one in ten disadvantaged students was able to score in the top quarter of reading performance in their country/economy thus complicating any straightforward link between educational attainment and poverty.

Research conducted by PISA (2018) shows that principals of disadvantaged schools were significantly more likely than those of advantaged schools to report that their school's capacity to provide instruction is hindered by a lack of or inadequacy of educational material; and in 31 countries and economies, Principals of disadvantaged schools were more likely than those of advantaged ones to report that a lack of teaching staff hinders instruction. In Argentina, Bulgaria, the Czech Republic, Hungary, Peru, the Slovak Republic and the United Arab Emirates, a typical disadvantaged student has less than a one-in-eight chance of attending the same school as high achievers (PISA, 2018). Certain researchers (Rodrigues, 2018, Chircop, 2020) suggest that children from immigrant backgrounds who face language and/or cultural barriers are particularly at risk of being disadvantaged within the educational system. Digital technologies may help reduce these gaps by, for instance, facilitating the learning of the language of the host country and allowing access to educational material in native languages (Rodrigues, 2018). Other research suggests that Artificial Intelligence may benefit students

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with special educational needs who represent some of the most disadvantaged learners (Drigas and Ioannidou, 2012; Tuomi, 2018). AI-based approaches have shown potential, for example, in the early detection of dyslexia. AI-based systems have also been successfully developed for the diagnosis of autism spectrum disorder and attention deficit hyperactivity disorder (ADHD) (Tuomi, 2018).

3. Early School Leaving

Early leavers are defined as individuals aged 18-24 who have completed at most a lower secondary level of education (European Commission, 2022). The EU set an EU-level target stipulating that the share of early leavers from education and training should be less than 9 % by 2030 (Eurostat, 2022). According to Eurostat (2022), in 2021, 9.7 % of 18–24-year-olds in the EU had completed at most a lower secondary education and were not in further education or training. Despite the implementation of national interventions to decrease ESL rates below 10% throughout Europe during the past decade, there have only been slight increases in the numbers of students staying in school (Donlevy et al. 2019). Particularly vulnerable groups are most at risk of becoming early school leavers. This includes care givers, teenage mothers, people who have been in the care system, people with special educational needs and those who come from a low-socioeconomic background (SALTO, 2018).

Early school leaving is influenced by educational factors, individual circumstances, and socio-economic conditions. It is a process which often starts in primary education with first experiences of failure and alienation from school (SALTO, 2018). Whilst much of the literature concludes that immigrants are particularly vulnerable to early school leaving (the European Commission et al, 2014), when controlling for individual and school characteristics, immigrant students do not structurally differ in their expected early dropout probability from natives across Europe (Hippe and Jakubowski, 2018). In other words, the reasons why students expect to leave school early are the same for both immigrant students and natives. Findings imply that it is more important to focus on the common factors that are associated with expected early school leaving. These include, at the students' level, the socio-economic background of students, their epistemological beliefs and grade repetition, while, at the school level, the

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most consistent factor is the school's mean expected early school leavers rate (Hippe and Jakubowski, 2018).

The pandemic has heightened the likelihood of early school leaving for these at-risk groups. After protracted periods of closure, dropout rates tend to rise, as some children and young people do not return when schools reopen (Chircop, 2020). Students who risk poverty and social exclusion are more likely to underperform and drop out of education early (Chircop, 2021). Research suggests that early school leavers have reduced earning potential throughout their lifetime compared to those with higher levels of education and on average, individuals who stay longer in education have higher job satisfaction, take better informed decisions for health, social life, etc. and increase their non-cognitive skills (Hippe and Jakubowski, 2018). Early school leavers become generally disadvantaged socially and economically in later stages in life, so it is important to better understand the motivations for leaving school and provide adequate policy solutions (Hippe and Jakubowski, 2018).

4. Low proficiency in basic skills

The World Economic Forum estimated that following the outbreak of the COVID-19 pandemic, there were 1.2 billion children out of school in 186 countries. It is predicted that by not being in school half of them will not achieve basic literacy and numeracy skills (Montero-Sieburth and Turcatti 2022). The 2020 education and training work programme (ET2020) strategy set a target of reducing low achievement on the PISA test to not more than 15 %. Results on this target have worsened, as the rate of low achievers is over 20 % for reading, maths and science, therefore the target for low achievement has been maintained until 2030, and with it the same percentage target has been added for digital skills (Chircop, 2021). The 2018 Programme for International Student Assessment (PISA) results show that more than one in five pupils in the EU has insufficient proficiency in reading, mathematics or science. According to PISA, in 2018, the underachievement rate stood at 21.7% in reading, 22.4% in mathematics and 21.6% in science. Over the 2009-2018 period, performance in science and reading deteriorated at the EU level, while remaining stable in mathematics (European Commission). In 11 countries and economies, including Denmark, Estonia and Finland, average performance was higher than

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the OECD average, while the relationship between reading scores and socio-economic status was weaker than the OECD average (Chircop, 2021).

At the November 2017 Gothenburg Summit, the Commission presented the Communication 'Strengthening European Identity through Education and Culture', that set out a vision for a European Education Area and announced a dedicated Digital Education Action Plan, which aims to foster digital skills and competences for all citizens (Tuomi, 2018). Whilst much of the literature on the 'digital divide' relates to economic disparity and access to digital devices, several researchers suggest that the issue of digital proficiency is also crucial (Coleman, 2021; Tuomi, 2018). Students whose parents do not have the digital skills and time to support them in digital remote learning are more likely to be digitally excluded (Coleman, 2021). Educators also play a vital role in supporting student's digital proficiency. Children who attend schools which lack appropriate infrastructure to support digital remote learning may be more digitally excluded, as compared to their peers in better equipped schools. Similarly, teachers' access, skills and usage of digital technologies will impact the methods they choose for digital remote education which may have undesirable outcomes for students (Coleman, 2021).

5. European Frameworks on Digital Education

In their cross-sectoral research review of future skills frameworks, such as, skills vs competencies and classifications, Kotsiou et al. (2022) conclude that digital literacy represents one of the shared core categories of the various models, along with higher-order thinking skills, lifelong learning, leadership, flexibility, enterprise skills, self-management, STEM literacy and dialogue skills. Digital competence is one of the eight attributed key competences for successful lifelong learning as part of a European-led consensus. The key competencies are listed below:

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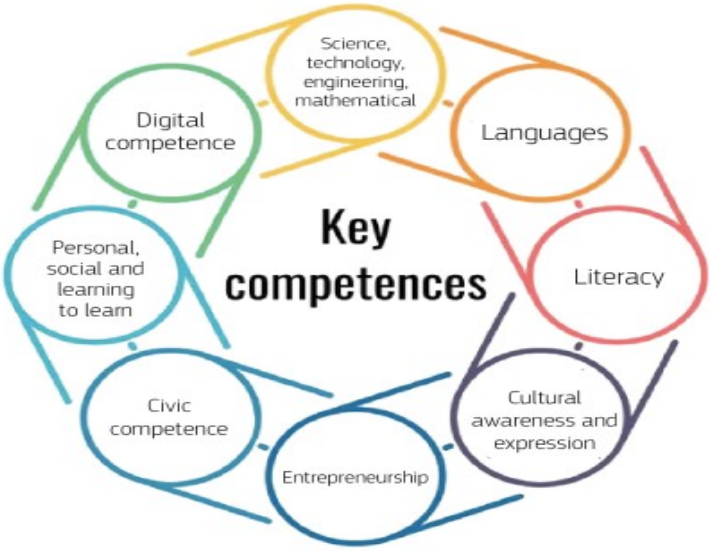

Figure 1: Key Competences Framework (Vuorikari, Kluzer and Punie; 2022, p. 5)

Digital challenges and infrastructural accessibility (Tzafilkou, Perifanou and Economides, 2022) has been intensified by the Covid-19 epidemic regarding the consequent mandatory transition to virtual collaboration and teaching/learning tools, which in turn has accentuated student capabilities in preparation for the future of work (Kotsiou et al., 2022; Perez-Sanagustin et al., 2022). The Covid-induced emergence of remote learning and the hybridisation of educational methods has a significant impact on teachers and students alike to remain on track and/or ahead of the curve considering the dynamics of the contemporary environment (Tzafilkou, Perifanou and Economides, 2022). On the flipside, Hall et al. (2022) summarise how the post-Covid transition "… represents a unique opportunity for both students and educators to reflect on the future of education… Many educators and students have realised that it is possible, and sometimes desirable, to do things differently which opens the door to new alternatives and provides the potential to radically reform education" (p. 3).

Skantz-Åberg et al., (2022) elucidate further on the role and responsibility of educators, encompassing not only their own abilities, but the pedagogical dimension of effectively guiding/mentoring and facilitating the mastering of student application and comprehension. Joshi, Neupane and Joshi (2021) highlight additional facets for teachers to adopt: "… The role of tutors is also transmitted as a facilitator, content expert, managerial, pedagogical, and

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social personality, assessor, researcher, and evaluator" (p. 109). Furthermore, Skantz-Åberg et al. (2022) summarise elements from a multilayer of research publications centred around developing portfolios and areas of teachers' professional digital competence deemed essential to fulfil their commitment towards accommodating 21st century learning. These include: technology application to innovate/empower, content knowledge, attitudes towards using technology, pedagogy, cultural awareness, critical approach and professional engagement. Much of the current literature pays overt focus to the integration of technology in both hypothesised and established pedagogic frameworks.

Ramirez-Montoya et al. (2021) expand upon the transformational requirements and advancements in professional development of the general teacher profile within education to align more efficiently with the new student profiles of Gen-Z (those born between 1997-2012) who already bear a great proximity to technical devices. According to Tzafilkou, Perifanou and Economides (2022) there is a substantial research gap on the actual utilisation and transferability of contemporary students' digital affinity in their social lives that is independent of teachers' roles as guide/mentor/facilitator (Castaño Muñoz et al., 2021) that translates into academic and vocational proficiency and performance. The following diagram offers a summary of teacher/educator-induced factors that impact upon students' acquisition of learning via digital technologies:

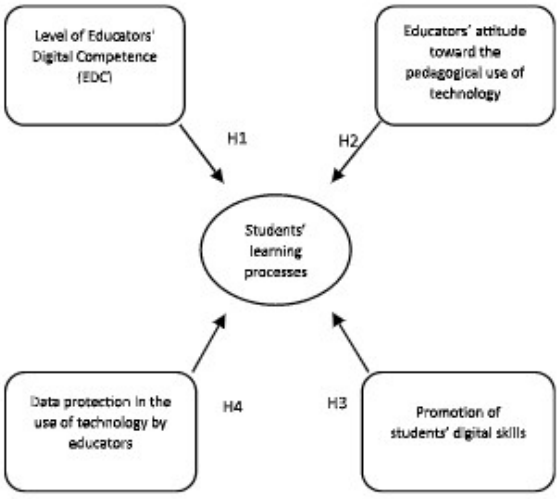

Figure 2: Student Learning Factors (Núñez-Canal, de Obesso and Pérez-Rivero; 2022, p. 6)

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Teacher training programmes in Europe bear a great degree of fragmentation with regards to organisational structuring and holistic embedding of technology within educational curriculum and culture. According to Villar, Herrero and López (2022), the execution of technology is "shrouded in indeterminate and generic formats with no reference to the meaning of digital innovation or how to construct and direct learning outcomes toward real situations" (p. 26). Perez-Sanagustin et al. (2022) highlight how technological attitudes (see appendix 1) and approaches must be embedded into an institution's strategic aims and objectives in order to establish a sustainable approach, thus eliminating the risk of a randomised approach to remote education. The figure below visualises necessary building blocks which will be expanded upon in consecutive chapters (see appendix 2 for a granular breakdown of level attributes):

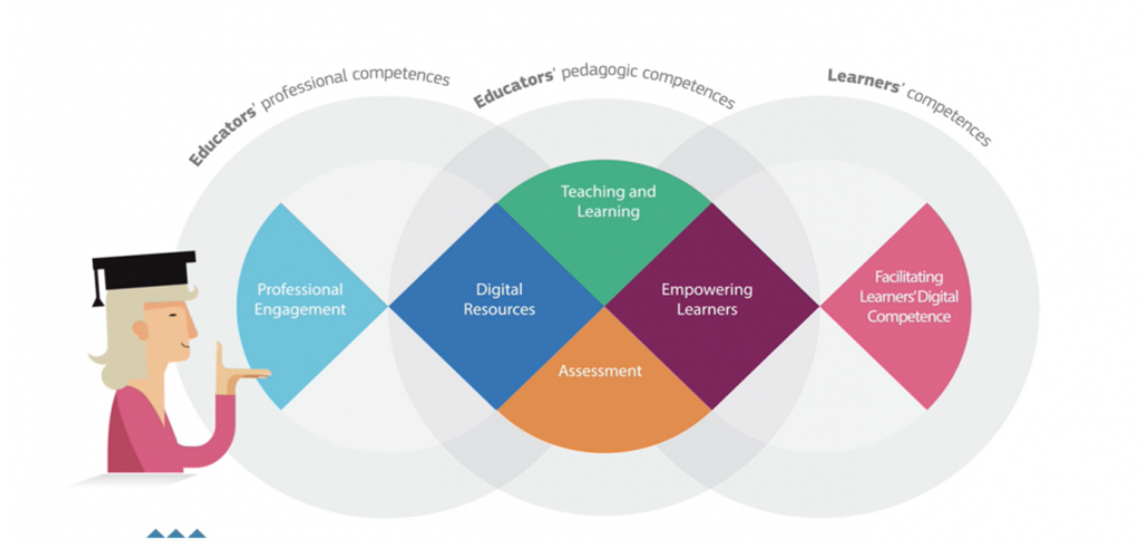

Figure 3: Educator-Student Framework (joint-research-centre.ec.europa.eu, 2022)

Vilppola et al., (2022) express how educators' ICT competence can be improved via individual approaches by honing personality/mindset traits of self-efficacy, experimentation and willingness, but also through collective mechanisms of peer-to-peer support and orchestrating leadership. Prior to the epidemic's vast implications on the educational landscape, in 2018 the European Commission published a plan for digitising education to assist in counterweighing the established deficits of digital skills and technological adoption/adaption (Beardsley et al., 2021).

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6. Digital Education Action Plan (2021- 2027)

The revised Digital Education Action Plan (2021-2027) was published in September 2020 bearing the strategic aim to further solidify the efforts to date of digitising education in the European school system at all levels through means of widening provisional accessibility and learning/reskilling/upskilling opportunities (Ubachs and Henderikx, 2022; Bocconi and Lightfoot, 2021). Additionally, the Action Plan should smooth the path for greater concentration of flexibility, personalisation, creativity and student-centred teaching, all guided by leveraging sustainable mechanisms (Bocconi et al., 2022; Røe, Wojniusz and Hessen Bjerke, 2022; Europa.eu, 2021). The Digital Education Action Plan has established two areas requiring prioritisation (Bocconi et al., 2022; Europa.eu, 2021), namely (i) "Fostering the development of a high performing digital education ecosystem" and (ii) "Enhancing digital skills and competences for digital transformation."

The Digital Education Action Plan was developed in response to educational inequalities in Europe that have been intensified by the Pandemic:

- A 2018 Organisation for Economic Co-operation and Development (OECD) study found that on average less than 40% of educators across the EU felt ready to use digital technologies in teaching, with divergences between EU Member States
- More than one third of 13–14-year-olds who participated in the International Computer and Information Literacy Study (ICILS) in 2018 did not possess the most basic proficiency level in digital skills
- A quarter of low-income households have no access to computers and broadband, with divergences across the EU affected by household income (Eurostat, 2019)
- 95% of the respondents of the Open Public Consultation of the Digital Education Action Plan consider that the COVID-19 pandemic marks a turning point for how technology is used in education and training (Digital Education Action Plan, Open Public Consultation, 2020)

Of course, innovations to expand digital competence within the remit of education were a priority before the pandemic, for example, the TPAC model (see appendix 3). The European Digital Competence Framework for Citizens (DigComp) stemming from the year 2013, offers a

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tool to improve citizens' digital competence. The figure below illustrates the five core competence areas of DigComp which are furthermore fragmented to encompass "… a confident, critical, collaborative and creative way to achieve goals related to work, learning, leisure, inclusion and participation in our digital society" (Centeno, Karpinski and Urzi, 2022, p.15).

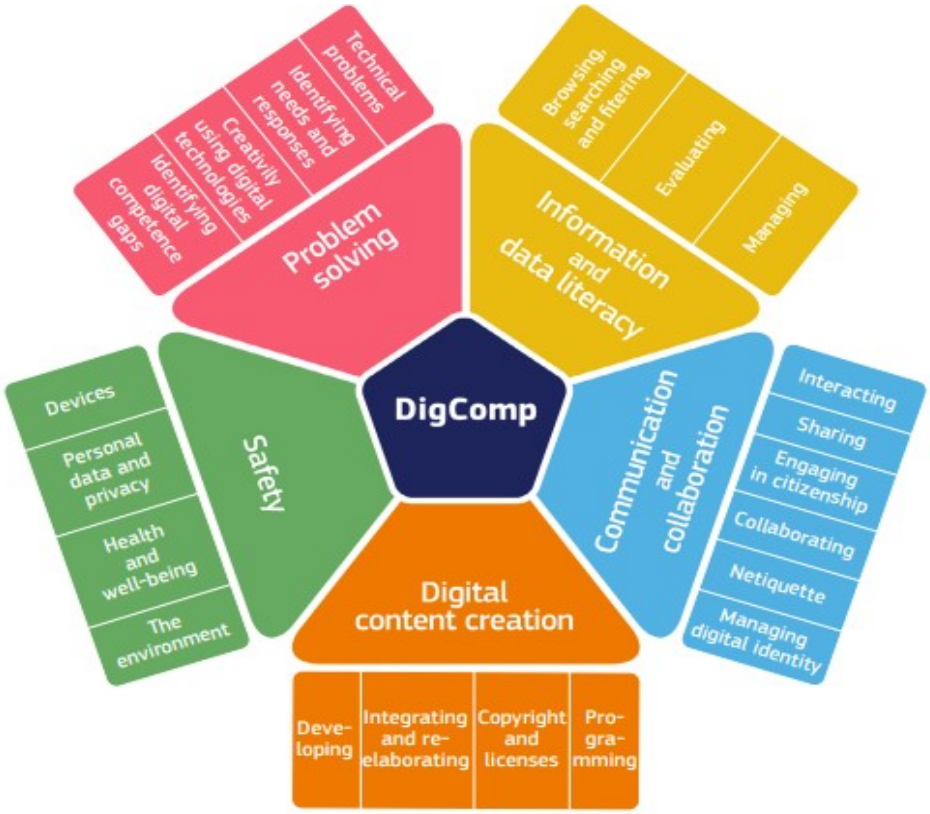

Figure 4: DigComp Framework (Centeno, Karpinski and Urzi; 2022, p. 15)

The table that follows accentuates the disparities and digital divide within specific demographic clusters, which require maximisation of resource investment to reach overarching societal/equitable objectives such as those outlined in the United Nations Sustainable Development Goals.

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Table 1: Demographics of Urgent Digital Skills Gaps (Centeno, Karpinski and Urzi; 2022, p. 5)

Priority target groups for policy action that reported no ICT use or / and below-basic digital skills

Group	Factor	Characteristics
G1	Age & Education level	**Young** 16-24 years old, **with low-level formal education, and NEETs** (aged 16-35 not in employment, education or training)
G2	Age	Individuals **55-64 years old**
G3	Education level	Individuals 25-64 years old **with low-level formal education**
G4		Individuals 25-64 years old **with medium-level formal education**
G5	Employment status	Individuals **unemployed**
G6		Individuals **inactive**
G7	Nationality	Nationals of **non-EU countries**
G8	Place of living	Individuals living in **rural areas**
G9	Employment status & occupation type	Individuals **employed in semi-skilled and low-skilled occupations**

In March 2022, an updated publication, titled "DigComp 2.2", was released following widespread stakeholder consultations on disruptions in the technological-social landscape. DigComp 2.2 "addresses emerging technologies, such as Artificial Intelligence and new phenomena such as misinformation and disinformation. It contains more than 250 new examples of knowledge, skills and attitudes statements on these new topics" (Centeno, Karpinski and Urzi, 2022, p. 1).

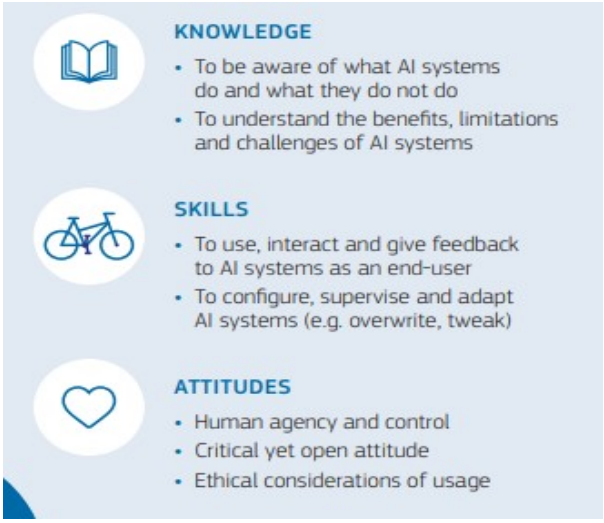

Figure 5: DigComp 2.2 & A.I. (Vuorikari, Kluzer and Punie; 2022, p. 77)

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7. DigCompEdu

An adjacent model to the virtual teaching-learning environment and ecosystem of students (Guitert et al., 2020) is The European Framework of Digital Competence for Educators (DigCompEdu). Published in 2017 by the European Commission's Joint Research Centre (JRC) DigCompEdu targets the initiative and policy-relevant spectrum from a local to a national level (De la Calle et al., 2021; Caena and Redecker, 2019). Using classifications of digital competence listed by the Common European Framework of Reference for Languages (CEFR), the attributed digital competences range from A1 to C2, encompassing superficial to complex integration of digital technologies and student assessment methodologies (Caena and Redecker, 2019). DigCompEdu's shortcomings are derived from its bracketing of subject matter differentiation – the content dimension – and vastly of the technological dimension where it does not correlate with pedagogical considerations, as other frameworks, such as DigComp (Skantz-Åberg et al., 2022; Caena and Redecker, 2019).

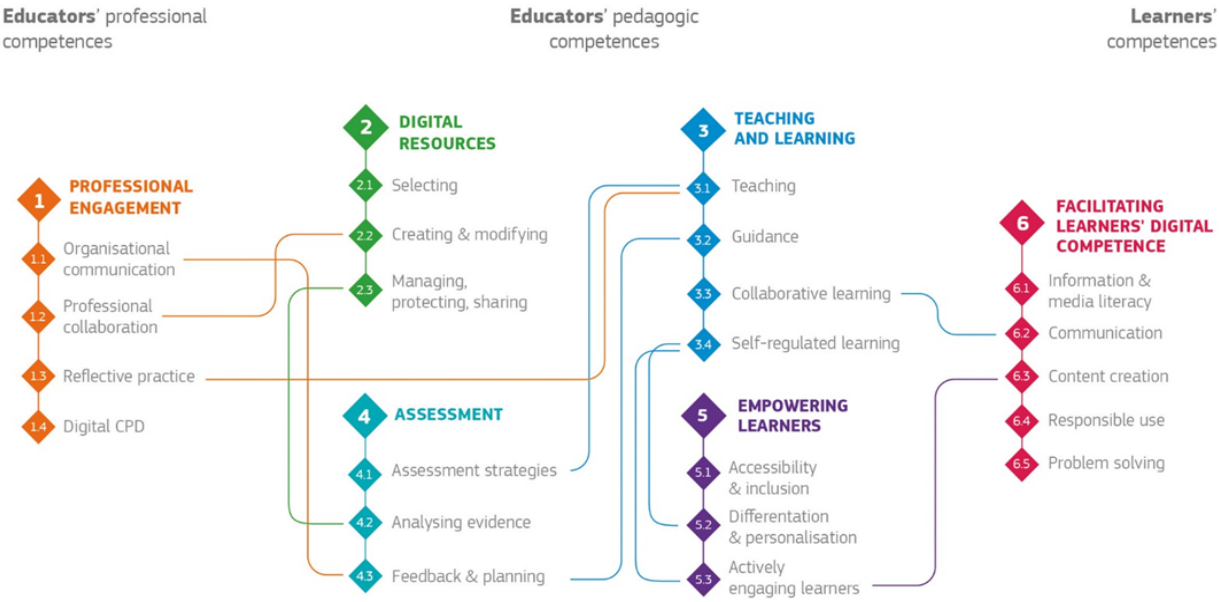

Figure 6: DigCompEdu Framework (Caena and Redecker; 2019, p. 362)

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8. SELFIE tool and JRC Science for Policy Reports

DigCompEdu paved the way for the 2018 European Commission initiated SELFIE tool (Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies). SELFIE is a free online tool for schools' holistic self-reflection on their implementation of digital technologies – segmented into the categories "School Coordinator", "Teacher" and "Pupil" (Beardsley et al., 2021; Bocconi and Lightfoot, 2021; Costa, Castaño-Muñoz and Kampylis 2021; Castaño Muñoz et al., 2021). Using SELFIE, the data collected can lead to actionable insights within the areas of an institution's leadership, teaching practices and professional learning qualities under the supervision of collectively set temporal dimensions to inform future policies (Castaño Muñoz et al., 2021).

Costa, Castaño-Muñoz and Kampylis also (2021) discuss the beneficial outcomes of self-evaluation from a meta-level to include "… building school capacity to respond to and manage change" (p. 3) and how efficacy has been documented to improve when utilising validated theoretical methods/techniques/tools to fulfil and/or facilitate multiple evidence-based viewpoints. Unlike previous tools designed to capture data about a school's digital capacity, SELFIE can be modified/personalised to accommodate an institution's unique cultural and resource-centric characteristics, therefore discarding a one size fits all approach and lending itself as a blueprint for subsequent development to best synchronise with rapid changes in the technological landscape (Bocconi and Lightfoot, 2021; Costa, Castaño-Muñoz and Kampylis, 2021). In October 2021, SELFIEforTEACHERS was launched at the SELFIE Forum, which was designed to specifically target primary and secondary school educators.

Villar, Herrero and Lopez (2022) report on methods to target the deficiencies of the digitisation of the teacher and student-learning dimension in order for increased inclusivity and equity in the learning environment. They note, "in the context of in-service training, strategic frameworks at European and national level, among others, have favoured the design and implementation of specific ICT plans for active teachers" (p. 16). A driving force behind the assessment of the viability and application of widespread digital transformation is the Joint Research Centre's activities – JRC -, which also cover areas further afield of digitisation and

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education (Bocconi et al., 2022). Other areas include (i) LifeComp (Learning to Learn competences); (ii) GreenComp (Competences in sustainability measures) and (iii) EntreComp (Competences in entrepreneurial pursuits).

Figure 7: JRC Competence Frameworks & Tools (Vuorikari, Kluzer and Punie; 2022, p. 61)

The Joint Research Centre (JRC) is the European Commission's science and knowledge service, with a mission to bring science and knowledge into EU policymaking. Over the past years, it has embraced new types of knowledge and practices to increase the impact of research on European policies. JRC Science for Policy reports focus on a diverse range of themes on issues relevant to policy making and the European scientific community at large. Findings from the JRC Science for Policy reports are incorporated throughout this literature review.

9. Conclusion

Reducing the rate of early school leaving in Europe is imperative as ESL is associated with poor outcomes at an individual and societal level. Increasing basic skills in literacy, numeracy and digital skills is a key concern of the European Union as low proficiency of basic skills has obvious limitations on educational and economic outcomes (European Commission, 2022). The European Commission is committed to increasing digital proficiency and capacity in educational institutions through mechanisms such as those detailed in this review, to check how effectively they harness ICT, while links between schools, higher education institutions, research centres and businesses are beginning to influence the teaching of STEM subjects

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(science, technology, engineering, and maths) and find ways to reduce the gender gap in the uptake of these subjects (Coleman, 2021).

The European Council agreed that by 2020, 40% of young Europeans were to have a higher education qualification or equivalent and that 20% of these students were to spend a study period abroad. In 2020, 40.5% of young people were graduates and a new target of 45% was set to be reached by 2030 (Coleman, 2021). Røe, Wojniusz, and Hessen Bjerke (2022) conclude that the realisation of the Digital Education Action Plan can only be achieved through a fusion of active face-to-face learning and the implementation of engaging digital technologies, not merely replicating the content via a different medium or alienating both educator and student from the actual learning process. The online questionnaire will seek to establish the current level of digital competence in both teachers and learners, identify the gaps between the required new digital skills and competences and the demands of teaching, learning and assessment for the contemporary moment.

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