D2.2 SURVEY OF EU SYSTEMIC PRACTICES IN RESPECT OF LOW ACHIEVERS IN MATHEMATICS AND SCIENCE

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Deliverable D2.2: General introduction

Deliverable 2.2 addresses the central issue of low achievement in EU countries and aims to provide data on systemic practices concerning low achievers across European Union, with a focus on non-partner countries.

In the **first part** (Paragraphs D2.2.1 and D2.2.2) we briefly refer to the general issue of low achievement, without a specific focus on mathematics and science. We tackle the crucial issues of disadvantaged students and schools, discussing possible causes for such phenomena and systemic practices to contrast them. General recommendations, coming from international studies, are presented, and some relevant examples of specific countries are discussed.

In the **second part** (Paragraphs D2.2.3 and D2.2.4) we focus on low achievement in mathematics (Paragraphs D2.2.3 and D2.2.4) and science (Paragraphs D2.2.5 and D2.2.6). We organize our survey around two leading questions:

- How are low achievers in mathematics and science identified?
- What are the consequent interventions? What are the typical pathways for low achievers?

As regards the first, general part, the survey of systemic practices relies on a variety of documents and sources, mainly OECD reports (OECD 2012a,b,c,d,e,f,g; OECD 2013a,b,c,d), and the Eurypedia Portal (https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php).

The Eurypedia portal (https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php) reports on the situation of the Educative systems in each European country. In the portal there is no section devoted to low achievement or low achieving students, so this information is to be looked for in other sections. In particular, the "Primary Education" section includes two sub-sections that are relevant for our purposes: a) teaching and learning; b) assessment. As a matter of fact, the section "Teaching and learning" includes information on the curriculum, subjects taught (compulsory and optional) and number of school hours. The "Assessment" section describes pupils' assessment in a double sense: as a continuous means in order to evaluate progressive learning and as designed to measure the acquisition of knowledge and skills through the tests and examination. Techniques used by teachers/schools to assess pupils are specified.

Progression of pupils is described by presenting the circumstances under which the decision to allow pupils to progress from one class and/or stage to another is taken. Criteria are presented as well as official regulations and the role of various participants in the decision-making process (in particular, with respect to parents). Potential certification delivered to pupils at the end of primary education, where it exists, is presented with some information concerning the authority responsible for certification, the content and methods. Also other requirements relating to the completion of primary education can exist and are described.

For our focus on mathematics and science we mainly rely on two Eurydice Reports (EACEA/Eurydice, 2011 a, b).

In the EACEA/Eurydice report "*Mathematics Education in Europe: common challenges and national policies*" (2011a) results on students' achievement in mathematics and on possible causes for low achievement may be found. Afterwards, the report discusses national lines of intervention (at remedial or prevention level). Remedial and prevention interventions may be at school system level and/or at classroom level. Concerning prevention at classroom level, the report focuses on teaching practices and methods. This can be clearly linked to the focus of the FaSMEd project, since among teaching practices and methods, formative assessment find its place.

The EACEA/Eurydice Report "*Science Education in Europe": National Policies, Practices and Research*" (2011b) provides an overview on Science Education across Europe.

Both EACEA/Eurydice reports rely on two major large-scale international surveys: TIMSS (Trends in International Mathematics and Science Study), for students of grades 4 and 8, and PISA (Programme for International Student Assessment) for 15 years old students. Last TIMSS survey was carried out in 2011, last PISA survey in 2012. The two assessment surveys serve different purposes (TIMSS focuses on knowledge and curriculum, PISA investigates science and mathematical literacy, comprehending the capacity to use mathematics and science knowledge in everyday life) and provide different additional information. For instance, TIMSS aims at describing also the learning contexts and gathers information also from teachers and school heads. PISA administered questionnaires to teachers and school heads and collected data on the use of technology at home and parents' views about science-related issues and careers.

D2.2.1 Identification of low achievers: assessment practices and educative choices

Low achievement "*refers to student performance that is below the expected level of attainment*" (EACEA/Eurydice, 2011a, p. 83). This definition reflects what is generally meant by low achievement, and points at a crucial related feature, that is *assessment* as a means to identify it.

"Assessment" may include a variety of different practices, related to different goals and means. The Assist-me report (2013) referring to the European report (European Commission, 2004, p. 137) distinguishes between three perspectives:

1. Assessment in a "traditional sense", as the function of evaluating student achievement for grading and tracking, aiming at identifying low achievers with respect to specific cohorts/classrooms;
2. Assessment as an instrument for diagnosis to give students and teachers continual feedback about learning outcomes and difficulties (this is the sense closer to "formative assessment" as intended in the FaSMEd Project);
3. "Systemic assessment", i.e. as a means to obtain broader knowledge about the conditions behind and influences on students' understanding and competence (e.g. in national and international large-scale assessments).

All the three levels are important, since systemic assessment may give general information about the level of attainment of the students of a given country, thus allowing international comparison and national comparison among regions, schools and so on. Results from such a systemic assessment may turn into educational policies. Conversely, individual assessment (both in the traditional sense and as formative assessment practices) may turn into individualized interventions and is deeply linked to teaching practice.

Concerning learning trajectories, countries belonging to OECD have conducted several quantitative studies in order to establish whether specific educative choices have had a positive effect on learning outcomes. The Report "*Equity and quality in education: supporting disadvantaged students and schools*" (OECD, 2012a) begins with a general clear indication: "*The highest performing education systems are those that combine equity with quality. They give all children opportunities for a good quality education*" (p. 3). Data show that in those school institutes disadvantaged for contextual reasons (geographic position, socio-economical factors and so on), *formative assessment* constitutes an encouraging measure towards improving students' achievement (for all students, independently of their performance level) and a greater equity in results.

D2.2.2 Disadvantaged students and schools

From a systemic point of view, the issue of low achieving students is connected to the broader issue of *disadvantaged* schools and students. OECD reports signal this strict relationship in several specific cases (e.g. the case of Roma students in Czech Republic, see below) and devote a specific report in 2012 on the issue: "*Equity and quality in education: supporting disadvantaged students and schools*" (OECD, 2012a). This document tackles the crucial issue of reducing school failure and drop-out, by promoting equity and quality in education.

It is important to point out that there is not a common agreement on the definition of a disadvantaged school, since each country may adopt different criteria to identification, from student outcomes to student socio-economic characteristics, to geographic areas or the presence of specific ethnic groups that are "traditionally" considered as disadvantaged. From a comparative study on systemic practices, the report lists a series of systemic practices that may help avoiding or reducing students and school failure. Among them we cite:

1) *eliminate grade repetition*, since it is costly and ineffective in raising educational outcomes; more efficient measures consist in preventing school repetition by intervening earlier (during the school year) on difficulties;
2) *avoid early student selection*, since assigning low performing students to lower tracks intensifies inequity, without raising average performance; on the contrary, comprehensive schooling, with the same track for all students, should be promoted for primary and lower secondary school. More in general, ability grouping should be limited to some subjects and to some periods.
3) *allow parents to choose the school for their children*, so as to promote equity and avoid segregation by ability and/or socio economic background. This goal may be obtained also by providing some incentives or vouchers.

Moreover, the report lists five recommendations to support low performing disadvantaged schools:

1) *strengthen school leadership*, by providing school leaders coaching and creating networks, as well as good working conditions and incentives. Moreover, the report points out some "extreme" measures such as splitting low performing schools, merging small ones and closing those that are recurrently failing
2) *attract high quality teachers* by means of incentives and promote the professional development of young teachers by means of mentoring programmes
3) *foster the links* between schools, parents and communities
4) *create a good school climate and learning environment*. It is important to "*promote the use of data information systems for school diagnosis to identify struggling students and factors of learning disruptions; adequate student counselling, mentoring to support students*" (OECD, 2012a; p. 11), to set up "*alternative organisation of learning time*" (OECD, 2012a; p. 11) and, in some cases, to create smaller classrooms, so as to promote student-student and student-teacher interactions create effective classroom strategies so as to support low performing students. For instance, the Report (OECD, 2012a) recommends a balance of student-centred instruction and assessment practices, and a regular use of formative and summative assessment so as to monitor children's understanding and progress.

In the following, we illustrate relevant cases within the EU countries.

The first example is the case of ***Czech Republic*** (OECD, 2012c, 2013a). Learning outcomes in the Czech Republic are around or slightly below the OECD average (although have shown a serious decline in recent years). Secondary-school attainment continues to be high, as in the past: in 2008, the proportion of adults aged 25-64 who had attained at least upper secondary education was 91%, the highest figure in the OECD area (against an OECD average of 71%). The equivalent proportion for adults aged 25-34 reached 94%. By contrast, tertiary educational attainment is very low by

international comparison, although increasing enrolment rates suggest that the situation is gradually improving. However, this positive situation contrasts with strong *social selectivity and inequities in the education system*. Inequalities relate mainly to two problems:

1) The *misplacement of some students in special schools*: in the Czech school system a good proportion of students who attend special schools do so as a result of learning difficulties and/or a social disadvantage and not following the identification of a learning disability. This is particularly the case of Roma children whose attendance of special schools is still very high in spite of the decision to progressively integrate disadvantaged students into mainstream schools. There is also little evidence that Roma students have equal access to and information about the provision of pre-primary education opportunities. The policy of not admitting children to school if they are not deemed "ready", but then providing no extra input to ensure they are given extra support to promote school readiness, means that Roma children are more likely to enter school late, and they also are less likely to have experienced pre-primary education. This tends to perpetuate inequality from an early age.
2) *Both performance and choice of educational track are strongly influenced by family background.* An issue often debated is the fact that the 6- and 8-year *Gymnasium* has potentially far reaching effects on equity as it tends to favour a minority of students into elite publicly-funded schools. Studies based on the PISA 2003 results show that family background matters more than academic ability in explaining access to a 6- or an 8-year *Gymnasium* and that parental education is the most powerful determinant of access to *Gymnasia* in the Czech Republic.

Along with these problems of social and sociological origins, the OECD report signals that *there is no integrated evaluation and assessment framework*: "*the different components of evaluation and assessment have developed independently of each other over time and there is currently no policy document on the overall framework for evaluation and assessment in the Czech Republic. There are provisions for student assessment, school evaluation, teacher appraisal and system evaluation, but these are not explicitly integrated or aligned*" (OECD, 2012c, pp. 32-33).

For what concerns the initiatives to strengthen the evaluation and assessment framework, "there is clearly the perception in the education system that the evaluation and assessment framework needs to be strengthened and that there needs to be a greater focus on improving student outcomes. This is reflected in current initiatives. However, at the present time, there is no integrated evaluation and assessment framework – it is not perceived as a coherent whole and it does not visibly connect all the different components" (p. 130). It is noteworthy to remark that discussing the key components of the evaluation and assessment framework that are considered still underdeveloped the OECD report signals as the first point a *lack in the formative assessment practices*: *"The formative assessment of students by teachers is underdeveloped as a result of the focus placed on marks and classroom practices which are still very traditional. The formative use of assessment information seems to be increasingly displaced by the generation of summative results"* (OECD, 2012c, p. 33).

Similar problems are faced by Greece and Spain. In **Greece** a new policy initiative currently underway establishes Zones of Educational Priority (ZEP). ZEP areas are identified using social and educational indicators. The focus is shifted from targeting designated populations (Roma, immigrants and Muslim minority) to targeting whole areas. Disadvantaged schools within poor regions are included and social and regional inequities should be contrasted. The policy initiative is led by the Ministry of Education together with the Ministries of Employment and Justice. As a matter of fact, in ZEP areas, support is given to students and schools, but also targets parents.

In **Spain** we signal the *Organic Law for the Improvement of Educational Quality* (2013), which establishes a series of prevention measures to contrast inequity and dropout:

- more autonomy to individual schools as regards schedule, content and pedagogical approaches
- a new selection process for school leaders, that are required a do a training course and can be chosen also from a different school
- a new preventive diagnostic testing in primary school
- exit exams (external assessment) in lower and upper secondary schools
- vocational pathways (starting from lower secondary school).

Still in Spain, the National Strategic Plan for Childhood and Adolescence 2013-2016, the National Action Plan for Social Inclusion 2013-2016 and the Programmes for Reinforcement, Guidance and Support provide resources to schools so as to address inequalities and social exclusion. The Program to reduce early dropout in education and training (2008) and the National Reform Plan (2013) provide funding to prevent dropout; the objective is to reduce dropout rates to 15% by 2020.

The relationship between students' performance and their socio-economical background is not restricted to some specific countries. On the contrary, it appears as a general phenomenon, well-documented not only in the OECD reports. We stress that this phenomenon is not limited to countries in which learning outcomes are below the OECD average. We find it (though reduced) even in top-performing countries like **Finland**.

Finland is well-known to be one of the top performers in the PISA tests since 2000: students have high performances in reading, science and mathematics. The rate of year repetition is very low (2.8%), most of the variance lies within schools rather than between schools, showing that schools have all similar achievements levels and that there is no selection by ability. The prevention from low achievement and failure is positioned as one of the two main principles around which the Finnish educational system is organized, the other being promoting equity and quality. However, even in this context and even if the influence of socio-economic background on the performance is much lower than the average, students with immigrant backgrounds are found to be at a higher risk of lower performance than the others. Moreover, boys have a higher risk of lower performance than girls.

Differently from the majority of countries, Finland devotes a great effort in the prevention of failure, and in helping students from immigrant backgrounds. Concerning the prevention of failure, the approach combines early recognition by teachers and support given by the school and social welfare staff. Schools and teachers are responsible for identifying students at risk and give them additional support for remedial instruction, with the help of teacher's assistants and special needs teachers (if required). The Ministry is funding a web-based service (www.LukiMat.it) for learning difficulties in learning and mathematics: the service provides information on students' learning, students' difficulties and how to manage them. Concerning students from immigrant backgrounds, the Ministry of Education Strategy 2015 (2003) turned out two specific initiatives:

- The National Core Curriculum for Instruction Preparing Immigrants for Basic Education (2009)
- The Action Programme for Equal Opportunity in Education (2013), aiming at helping disadvantaged students and to reduce the impact of gender and socio-economic background.

Another example of top performances on average in international tests contrasted by worrying inequalities is constituted by the **Flemish Community of Belgium**. Indeed, 15 year-old students in the Flemish Community of Belgium have consistently performed above average in the OECD Programme for International Student Assessment (PISA) surveys since 2000. Flemish students rank as the top performers internationally in the mathematics assessment, as well as in the science and reading assessments. Compared to other OECD countries, the Flemish Community is more equitable in terms of limiting the proportion of low-skilled students: results on reading performance in the 2009

survey showed both a greater than average proportion of top performers and a lower than average proportion of low performers. However, the OECD report "OECD Reviews of Evaluation and Assessment in Education. School Evaluation in the Flemish Community of Belgium" published in 2012 highlights some worrying inequities within the Flemish Community:

- *Socio-economic factors* strongly influencing student performance. Differences in student socio-economic background explained a slightly higher proportion of the variance in student reading performance than on average in the OECD and the most advantaged quarter of Flemish students outscored the least advantaged quarter by 100 score points, indicating a significant educational gap.
- *Performance differences among schools are related in part to socio-economic differences*: socioeconomic differences among students and schools account for nearly twice as much of the observed between-school performance differences in the Flemish Community, compared to on average in the OECD. In particular, students with an immigrant background were in schools with a significantly less advantaged average socio-economic composition.
- *Major performance disadvantage on average for students with an immigrant background*. The disadvantage is mainly referred to in reading performance, where the proportion of low performing students from an immigrant background is nearly three times larger than the proportion of low performing native students. This significant educational gap cannot be fully explained by student socio-economic background or the language they speak at home. Indeed, it remains more pronounced than on average in the OECD even after accounting for these factors.

To address these concerns, there has been significant political focus on equity of educational opportunities, including local consultation platforms for agreements on student intake policies among schools and additional funding for schools to implement equal opportunity policies.

A fifth example is offered by **Denmark**. The Danish Government's competitiveness strategy, combined with the average low performance of Danish students on international assessments, has increased the policy focus on improving student learning outcomes. To this end, there have been sustained central efforts since 2006 to stimulate evaluation and assessment activities in compulsory education, including new national bodies to monitor and evaluate quality in compulsory education, new national measures on student outcomes in compulsory education and requirements for municipalities to produce annual quality reports on their school systems. Over a short period of time, Denmark has introduced new national bodies to monitor and evaluate quality in compulsory education, new national measures on student outcomes in compulsory education and requirements for municipalities to produce annual quality reports on their school systems. International evidence shows that Denmark has comparatively fewer weaker performers than in the past. This result may appear to reflect the emphasis of public schools (*Folkeskole*) on equity and inclusion in education. However, there is evidence of significant performance disadvantage for *some* students. In particular, Denmark is well aware of the challenge of increasing the academic performance of students with a migrant background. For example, the School Council judged that the aspect of teaching Danish as a second language was not adequately included as a dimension of the Common Objectives across different subjects. The report (OECD, 2012d) published in 2012 affirms that that "the *Folkeskole* lacks ability to cope with all children, especially those from socially disadvantaged family backgrounds" (p. 56). The national tests serve as one tool to check that students have gained the basic skills in key subjects, however – beyond the special test offered for Danish as a Second Language – they may not give an accurate diagnosis of bilingual students' cognitive ability. For example, although students may have mastered mathematical concepts, they may have difficulty understanding some of the more linguistically complex mathematics problems in the national tests. Research shows that teachers can assess these students' content knowledge by simplifying the linguistic features of mathematics problems. Such careful modifications can also provide similar advantages to students

with disabilities" (p. 56).

Not all disadvantaged students are doomed to fail in schools. OECD studies show that school success is possible for socio-economically disadvantaged students. *Resilient students*, i.e. those who succeed at school despite a disadvantaged background, are a common feature in some educational systems (OECD 2011b). "These individuals show what is possible and provide students, parents, policy makers and other education stakeholders with insights into the drivers of skills and competencies among socio-economically disadvantaged students. While the prevalence of resilience is not the same across educational systems, it is possible to identify substantial numbers of resilient students in practically all OECD countries. Using a comparable definition, in Australia, Canada, Finland, Japan, Korea, New Zealand and Portugal, close to one-half of disadvantaged students exceed an internationally comparable performance benchmark and can be considered successful from a global perspective. In other countries, the proportion is more modest" (p. 3). We remark that whereas the male component is bigger in disadvantaged students, no differences in gender appear for what concerns resilient students.

PISA results indicate that many disadvantaged students do not benefit as many opportunities to learn *science* at school as their more advantaged peers. "*On average, across OECD countries, disadvantaged students spent 20% less time learning science at school than their more advantaged peers. Among disadvantaged students in countries like France, Germany and the Netherlands, resilient students spend over one hour and 45 minutes more learning science at school than disadvantaged low achievers. The evidence in PISA suggests that investing into learning time is even more important for disadvantaged students. Opportunities to learn science at school, measured in courses and hours, allow some disadvantaged students to close the performance gap with their more advantaged peers*" (OECD 2011b, p. 3). In other terms, on the base of results it is suggested of "*taking more science courses benefits disadvantaged students even more than it does their more advantaged peers. Therefore, exposing disadvantaged students to science learning at school might help close performance gaps*" (*ibid*., p. 11). In general, time spent learning science is one of the correlates of better performance that benefits the most disadvantaged students.

Positive approaches to learning are associated with better performance for all students. High levels of self-confidence or interest in science across disadvantaged students are good predictors of student resilience. However, the evidence from PISA shows that the association between performance and positive approaches to learning is stronger for more advantaged students than for disadvantaged students. In some cases, like in Germany, this association simply disappears among disadvantaged students; in other cases, such as in New Zealand, it is halved. A possible interpretation is that more advantaged students probably enjoy a supportive household environment that makes their confidence and other positive approaches to learning more effective. The evidence shows disadvantaged students do not enjoy this extra boost on positive approaches to learning. This evidence suggests that from an equity perspective, targeting disadvantaged students when implementing policies aimed at fostering positive approaches to learning among students is necessary to avoid widening the performance gap between disadvantaged students and their more advantaged peers.

Finally, the report "*Against the Odds: Disadvantaged Students Who Succeed in School*" (OECD, 2011b) underlines the fundamental role of the *teacher* as a key-factor in improving student performance. "Policies and programmes designed to enhance and expand teachers' use of effective instructional techniques may prove useful to promoting resilience. A meta-analytic review of a decade's worth of teacher effectiveness literature offers some guidance to countries and schools. The review identifies the following strategies as having the strongest positive effects on "motivational-affective outcomes" (*i.e.* on those outcomes most similar to the student approaches to learning factors measured in PISA): subject domain-specific activities for processing information (*e.g.* mathematics problem solving, science inquiry), social experiences (*e.g*. cooperative learning, student discussion), time for learning, and regulation and monitoring (*e.g.* providing feedback and support, teaching students strategies of self regulation and monitoring) (Seidel and Shavelson, 2007). Encouraging

teachers to use these instructional strategies could help to improve students' motivation and confidence and, by extension, student resilience" (OECD, 2011b, p. 82).

D2.2.3 Identification of low achievers in mathematics in EU

D2.2.3.1 Low achievement in mathematics: definition

Since 2003, in the OCSE-PISA survey six levels of proficiency are outlined. Students not reaching Level 2 in PISA are considered low achievers. Students who only reach level 1 or are below it as a *potential risk group*, since they will likely have difficulty in the transition from education to work. A student reaching Level 1 is able to: a) answer questions involving familiar contexts, where all relevant information is present and the questions are clearly defined; b) identify information and carry out routine procedures according to direct instructions in explicit situations; (c) perform actions that follow immediately from the given stimuli. Students below Level 1 are able to perform only very direct and straightforward mathematical tasks, so that the selection criteria are clear and the relationship between the chart and the aspects of the context depicted are evident, and performing arithmetic calculations with whole numbers by following clear and well-defined instructions.

D2.2.3.2 Low achievement in mathematics: diagnosis

Systemic assessment is based on results coming from PISA and TIMSS surveys and/or national assessment programs. Such studies link low achievement to a variety of factors, from linguistic issues to home background. Indeed, EACEA/Eurydice report (2011a) points out that understanding causes for low achievement is a crucial step in order to plan interventions: "*In order to be successful, strategies to address low achievement need to be embedded within all aspects of learning and teaching, including curriculum content and organisation, classroom practices and teacher education and training. Moreover, a comprehensive approach would comprise measures that are suitable for all students, but benefit underperforming students in particular; it should also include arrangements for providing targeted support for students with individual needs both inside and/or outside the normal classroom*" (EACEA/Eurydice, 2011a, pp. 83-84).

Concerning the diagnosis of low achievement in mathematics in single students, analysing and comparing documents from different countries we find three main categories. In fact, *the identification of low achievement may be carried out on the base of*

- *results from the national standardised assessment*: based on national tests, administered at different ages. **Cyprus**, **Bulgaria** and **Sweden** belong to this category.
- *the teacher's diagnosis* (based on the teacher's marks in tests): the identification of low achievers is entirely left to the teachers' responsibility. Teachers analyze students' performance in everyday classroom activities, identify students with difficulty and write reports suggesting remedial interventions. Such reports are further discussed at school level and remedial interventions are put into action. Examples of countries belonging to this category are **Portugal** and **Turkey**
- *a combination* of both methods. For instance, **Spain** belongs to this category.

D2.2.3.3 Low achievement in mathematics: causes

Systemic assessment may turn into remedial systemic interventions if there is a careful study on causes for low achievement. Among causes for low achievement the report lists *systemic* factors, such as educational systems and school organization, "*social*" factors such as home environment and language, *individual* factors such as attitude to mathematics. Interestingly, "gender differences seem to be not straightforward" (EACEA/Eurydice, 2011a, p. 21).

EACEA/Eurydice report (2011a) points out that most European countries do not conduct any national survey on low achievers. Even less common are independent evaluations of support programmes for low achievers (EACEA/Eurydice, 2011a, p. 83).

Here is an overview of results concerning some European countries.

- In **Belgium - Flemish Community** there is a Periodical national assessment of performance (Periodieke Peilingen); as regards causes, low achievement in mathematics is linked to the home language, to low motivation, to socio-economic background.
- In **Spain** the first General Diagnostic Evaluation was carried out in 2009 with students in the fourth year of primary education. Results show a link between low achievement and extra-school factors such as: parents' level of education and occupation; the number of books at home; and the availability of other resources at home such as a quiet place to study and an internet connection.
- In **Romania** a national survey shows a link between low achievement and systemic factors such as the fact that students of mixed age are grouped into the same class (in primary school) and the fact that teachers have inadequate qualification and low social and financial motivation. Starting from 2010, some systemic remedial initiatives were carried out (professional development for teachers and less mixed age classes in rural schools).
- In **Sweden** assessment is carried out by the Swedish National Agency for Education. Low performance results are thought to be influenced by structural factors (decentralisation of school management, resource allocation and streaming) and in-class factors (peer group effects, teacher expectations).

D2.2.4 Typical trajectories for low-achievers in mathematics in EU

The EACEA/Eurydice report (2011a) points out that some countries with higher numbers of poor results in international comparisons, have new benchmarks to be attained:

- For **Italy** the target is to reduce the number of low achievers in mathematics (defined as level 1 and below in OCSE PISA test) from 25% to 21%.
- In **Spain**, the Ministry of Education's Action Plan 2010-11 set 12 major goals in education, addressing low achievement. The Plan states that in primary schools a support for low achievers must be activated as soon as difficulties are detected. Such support consists in curricular adaptations, individual tuition, flexible grouping. In lower secondary school, measures focus on individualization: offer of optional subjects, reinforcement, curricular adaptations, flexible grouping, splitting classes.
- In **Poland**, a programme of student support (started in 2010) encompasses early diagnosis of difficulties in pre-school and primary school, remedial and compensation classes, individualised paths.
- In **Portugal**, measures focus on social causes for failure, as well as on school organization factors. Subsidies (such as books, meals, laptops) are provided to students from disadvantaged backgrounds; moreover, there is a great effort on teacher professional development and a national plan for the evaluation of schools and teachers.
- In **Turkey** the intervention is at systemic level and school organization level, with the introduction of new curricula and further resources for school infrastructure, libraries, ICT, reduced class size. Moreover, there was a revision of teacher education programs.

Most European countries do not provide national guidelines to help teachers assessing and helping low achievers. Nevertheless, there are various forms of support for teachers. Most European countries set up measures to help schools and teachers addressing low achievers. Such central-level measures may be different:

- In **Finland**, national guidelines refer to a general support for all students. There are teacher

professional development programs and online resources to give teachers information and support in helping low achievers. Teachers may also purchase from private companies tests for the diagnosis of learning problems (e.g. dyscalculia).

- In **Belgium- Flemish community** there is a national program of "equal opportunities", which is carried out by each school with a good degree of autonomy, but the outcomes are centrally monitored.
- In **Czech Republic, Latvia, Hungary, Sweden** and **Iceland**, on the contrary, each school/municipality is responsible for setting up measures for low achievers.

Many methods are recommended in addressing low achievement in mathematics. In the subsequent subparts, we provide some information about categories of interventions: curricular adaptations, teaching methods, tuition.

D2.2.4.1 Curriculum adaptations

In some European countries, low achievers may be helped with a more individualized curriculum.

- In **Spain**, low achievers may have a curriculum adapted for their specific needs: this means that the curriculum, while maintaining the same objectives and content, has a different level of difficulty. This is possible for all subjects at primary and lower secondary school level. Moreover, there is a Curricular Diversification Programme for lower secondary school, a two-year programme for students who have not achieved the general objectives of the third year of lower secondary education or for students who, having finished the second year, are not ready for promotion to the third year and have already repeated a year once. In such a programme mathematics and science are taught together with a special method and ability grouping is employed.
- In **Malta**, low achievers are identified during the first three years of primary school; the Core Competences program gives them support to fill the gap with their peers. In secondary school, the curriculum is different according to four different levels of ability.
- In the United Kingdom (**England**, **Wales** and **Northern Ireland**) the programme is the same for all students, but teachers are expected to differentiate their teaching according to the needs of their students. As a consequence, usually lower secondary schools differentiate groups or classes according to the ability levels.
- In **Scotland** all students have the same curriculum, but the level of challenge and pace of learning is varied. The teachers make their decision according to their students' individual needs and difficulties. Usually, for low achievers the teaching puts less emphasis on "theoretical" contents, such as algebra, and more emphasis on contents that are linked to everyday life, such as money and time.

D2.2.4.2 Teaching methods

In some countries there are recommendations concerning the teaching in the classroom (among them, ability grouping, individualised teaching, use of teaching assistants) and outside the normal class work (peer-assisted learning, group collaboration, individual support). For both kinds of measures, EACEA/Eurydice report (2011a) points out the need for a continuous assessment process, so as to monitor progress at the end of any period of support.

Some measures concern the teaching methods. Such measures may be in terms of remedial but also of prevention towards low achievement. Such measures are usually aimed at changing (improving) teaching methods for all students.

- In **Estonia** teachers are encouraged to underline the link between mathematics and nature,

arts and so on.

- In **Poland**, the curriculum recommends connection between mathematics and everyday life.
- In **Greece**, teachers have at disposal resources (manuals and curriculum guidelines) that suggest different teaching methods, to be chosen according to the needs. Among the recommended methods we find active learning via exploration, visits to social/cultural destinations, discussions between teacher and pupils, use of narration, group cooperative learning.

D2.2.4.3 One to one and small group tuition

Support to low achievers may exist in different forms of tuition. Two main features characterize the forms of tuition: it is possible to have one-to-one or group tuition, and such a support may be provided during the school hours or outside school hours.

- In **Greece** low achieving students have up to six hours per week of individual tuition.
- In **Romania**, individual tuition is provided in recovery programmes for rural schools.
- In **Spain**, group tuition is provided to students starting from grade 4. Such support is given outside of school hours, and the tutors are mathematics teachers or university students.
- In **Slovenia**, support may be in the form of individual or group tuition, within normal classes or at the end of regular lessons.

Less common strategies are the use of a teaching assistant in the regular lessons or the intervention of a specialized teacher (a mathematics teacher o a teacher with a specialization in learning difficulties). Specialized teachers are used in **Estonia**, **Ireland**, **Spain**, **Malta**, **Austria**, **Slovenia**, the **United Kingdom** and **Norway**.

The EACEA/Eurydice Report (2011a) points out that "The majority of countries provide some national guidelines to address student difficulties in mathematics. However, effective guidance for schools and teachers and systematic support for students may require more targeted programmes, including the use of specialised teachers" (EACEA/Eurydice, 2011a, p. 11).

D2.2.5 Identification of low-achievers in science in EU

D2.2.5.1 Low achievement in science: definition

In the OCSE-PISA survey, six levels of proficiency are outlined. Students not reaching Level 2 in PISA are considered low achievers. Students at Level 1 have a limited scientific knowledge and are able to apply it to few familiar situations. Students under Level 1 are unable to demonstrate basic scientific competences in situations. This lack of competence may have significant negative consequence in their future participation to society life.

D2.2.5.2 Low achievement in science: diagnosis

In 2009, according to the PISA survey 17,7% students of EU-27 were low achievers. European targets require a decrease under 15% before 2020. At present, only a few countries (Belgium- Flemish and German communities, Estonia, Poland and Finland) have already achieved the benchmark. Conversely, Bulgaria and Romania have a proportion of low achievers of about 40%.

As regards cross country comparison, the benchmark is the average level of EU. Countries whose level is under the EU average are Bulgaria, Romania, and Turkey. Anyway, the EACEA/Eurydice Report (2011b) points out the importance of taking into account variation within a country, which is an indicator of equity in educational outcomes.

Different situations (low average score and/or high standard deviation within country) have different meanings in terms of efficiency and equity. Consequently, different interventions are needed.

Countries with high average results and low standard deviation within country, such as Belgium (Flemish Community), Estonia, Poland, Slovenia, Liechtenstein and Finland are considered efficient and equitable systems.

Countries with low average results and high standard deviation within country, such as Belgium (French Community), Bulgaria, and Luxembourg, need interventions which focus on low achievers, so as to decrease the deviation and increase the overall performance.

On the contrary, countries with low average results but low standard deviation within country, such as Greece, Spain, Latvia, Lithuania, Portugal, Romania and Turkey, need to address all the students in order to increase the average results.

As regards TIMSS survey, since only a few European countries took part to the survey the EU average result is significant for comparison; thus, the Eurydice report (2011b) focuses on comparison across countries. Besides, it is important to take into account average results and also standard deviation within a country.

In grade 4, Asian countries such as Singapore, Chinese Taipei and Hong Kong had the highest average scores. Latvia and England were the European countries with the higher average score, but their results were consistently lower than Singapore, Taipei and Hong Kong. Scotland and Norway had the lowest results among European countries.

Similarly, in grade 8 top performers are Singapore, Chinese Taipei, Japan and Republic of Korea; the first European countries are England, Hungary, Czech Republic and Slovenia. Conversely, Cyprus, Turkey, Malta, Romania and Bulgaria had poor results.

Concerning variation within countries, the EACEA/Eurydice report (2011b) points out that in grade 4 there was no significant standard deviation within country. Within Europe, the country with the lowest deviation was the Netherlands in grade 4, while Bulgaria and Malta in grade 8 had the highest range of results.

D2.2.5.3 Low achievement in science: causes

International surveys identify factors that affect performance in science. Such factors may be at systemic (schools and education systems), social (home background) or individual (enjoyment of learning science, attitude towards science) level.

PISA 2009 points out that most variation in performance is related to differences between schools and within the school, rather than to differences across countries. Nevertheless, **systemic factors**, such as the **school and education systems**, may have a role in promoting or hindering good performance. For instance, in countries where more students repeat grades, overall performance is worse. In most countries where students are assigned to different tracks according to their abilities, socio-economic differences are more evident and the overall performance is not higher.

Variation between schools in a country seems to be linked to the following factors: **geographical disparities** (for instance, rural versus urban areas), **social background of the school** (measured as the proportion of socially disadvantaged students or the average socio-economic status), different **quality of the science instruction**.

Concerning **social factors**, both TIMSS and PISA 2006 surveys signal a strong connection between **home background** (spoken language, economic, social and cultural status) and achievement. PISA 2006 also found that many disadvantaged students spent less time studying science in school than their more advantaged peers. Thus, **learning time at school** seems to be a relevant factor and system interventions should take into account.

Concerning **individual factors**, PISA 2006 pointed out that **self-efficacy** in science (the belief about one's capacity of doing tasks and overcoming difficulties) was connected to performance. TIMSS also suggests a link between self-confidence in learning science and achievement (Martin, Mullis & Foy, 2008).

Attitude towards science differs between school grades, with a general decrease from primary to lower secondary school. This phenomenon was especially evident in Italy, where 78% of 4th grade students and only 47% of 8th grade students had positive attitude towards science (Martin, Mullis & Foy, 2008).

The EACEA/Eurydice Report (2011b) also refers results from the international survey ROSE (Relevance Of Science Education) concerning attitude and view of science of 15 years-old students. Attitude towards science is a relevant issue because it influences future career choices and also the personal relationship to science and technology in adult life.

The survey shows that students usually have a positive attitude towards science and technology, while they have a less positive attitude towards school science. The survey also refers to some variation across countries: northern European students are less interested in science careers than southern European students. Also gender is a relevant factor: boys are more interested in technical and mechanical aspects of science, while girls are keener on medicine. Hence, gender differences in motivation and interest should be taken into account.

Gender does not seem a relevant factor in performance, even if results may be affected by the fact that girls attend more than boys' high academically-oriented school programmes. As a result, gender differences are high within schools or programmes, even if small in overall country results.

There are also gender differences in scientific competences: girls are better in identifying scientific issues, while boys are better in explaining phenomena scientifically. Finally, girls have a lower self-confidence in science than boys.

D2.2.6 Typical trajectories for low-achievers in science in EU

The EACEA/Eurydice Report (2011b) points out that only two countries, Lithuania and the Netherlands, established a target for tackling low achievement in science, and no country has set up specific policies in order to support low achievers in science.

In half of the countries, there are general policies of support for low achievers, without any distinction between school subjects.

Bulgaria, Germany, Spain, France and Poland have a national programme of support for low achievers in all subjects.

Only France and Poland also have specific initiatives of support for students who have difficulty in science.

- In **Bulgaria**, within the national Program "Caring for each pupil", additional classes are provided at the end of the school day.
- In **Poland**, three local projects ("Everybody has a chance of success", "Dreams to realise – Equalising educational Chances" and "Raising Educational Achievements of ISCED 1 pupils") set up remedial and compensation classes in science and propose activities to develop skills such as the use of the microscope.

In most countries, school or teachers themselves have the responsibility of identifying and providing support to students who have difficulty in science. Such support varies from country to country and from school to school in the same country.

The EACEA/Eurydice Report (2011b) points out that there are general guidelines that regulate the interventions in any school subject.

For our survey we distinguish between interventions in terms of curriculum adaptations and interventions in terms of strategies that teachers have at disposal (individual tuition; small-groups tuition outside the classroom; support for teachers during class lessons;…).

D2.2.6.1 Curriculum adaptations

- In **Lithuania** assessment is performed at the end of every cycle of two years. Levels of achievement (minimum, basic, higher) are established by teaching and learning guidelines and curriculum content guidelines. Schools and teachers set up curriculum adjustments to meet the needs of specific grades and pupils.
- In the **United Kingdom** the curriculum is adjusted so as to meet the different needs and abilities of students, according to the principle that education should be suitable fro a child's age, ability and aptitude. For instance, in **Wales** the national curriculum states that for students under the expected levels in science, schools should adapt the programmes of study to their needs.
- In **Spain**, each school may set up curriculum adjustments, such as variation in the timings of objectives or the teaching of the subject content. Such modifications should not change the basis objectives, assessment criteria and content of the curriculum.
- **Malta** is the only country where students may be grouped according to their ability level and as a result are taught different subject content.

D2.2.6.2 School support

- In **Czech Republic** each school organizes forms of tuition (for instance, tutor classes)

- In **Spain,** school may choose to do ability grouping, even if the taught content should be the same.
- In **Sweden** each school uses its budget to provide support to students in difficulty in any subject. Support may be provided by the school teachers or by an external institution.
- In **Greece**, low achiever students are offered a daily remedial teaching programme of 1 to 3 hours in the afternoon. Such a remedial teaching is provided in the form of small group tuition by school teachers or by supplementary specialist teachers.
- In **Cyprus** primary schools have extra taught time at their disposal that can be allocated to interventions for low achievers (one-to-one or small group tutoring). Low achievers leave their regular classes to attend to tutoring sessions. At secondary level, on the contrary, teachers are encouraged to use differentiation, peer instruction, cooperative methods and inquiry based activities.
- In **Slovenia**, the teachers provide supplementary lessons in science to low achievers (45 minutes per week). Moreover, forms of support such as differentiated teaching and peer-assisted learning are present.
- In **Scotland**, teachers set up different forms of support: differentiated materials and ability groupings. For greater difficulties, support teachers work cooperatively with the class teacher.

References

ASSIST-ME Report (2013). *Report on current state of the art in formative and summative assessment in IBE in STM - Part I.* ASSIST-ME Report Series, number 1. ISSN: 2246-2325.

European Commission. (2004). *Increasing human resources for science and technology in Europe: Report of the High Level Group on Human Resources for Science and Technology in Europe, chaired by Prof. José Mariano Gago*. Luxembourg: Office for Official Publications of the European Communities.

European Commission/EACEA/Eurydice (2011a). *Mathematics Education in Europe: Common Challenges and National Policies*. Brussels: Eurydice.

European Commission/EACEA/Eurydice (2011b). *Science Education in Europe: National Policies, Practices and Research*. Brussels: Eurydice.

Greek Ministry of Education (2011). *Overcoming School Failure: Policies that Work, National Report Greece*. www.oecd.org/edu/equity.

European Commission/EACEA/Eurydice (2012). *Developing Key Competences at School in Europe: Challenges and Opportunities for Policy. Eurydice Report.* Luxembourg: Publications Office of the European Union.

Martin, M.O., Mullis, I.V.S. & Foy, P. (2008). *TIMSS 2007 International Science Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

OECD (2003). *The PISA 2003 assessment framework: reading, reading, science and problem solving knowledge and skills*. Paris: OECD Publishing.

OECD (2005). *PISA 2003 Technical report*. Paris: OECD Publishing.

OECD (2007a). *PISA 2006: science competencies for tomorrow's world. Volume 1: Analysis*. Paris:

OECD Publishing.

OECD (2007b). *PISA 2006: Science Competencies for Tomorrow's World. Executive Summary*. Paris: OECD Publishing.

OECD (2009a). *PISA 2006 Technical report*. Paris: OECD Publishing.

OECD (2009b). *PISA 2009 Assessment Framework - Key Competencies in Reading, Mathematics and Science*. Paris: OECD Publishing.

OECD (2010a). *PISA 2009 Results: What Students Know and Can Do – Student Performance in Reading, Mathematics and Science (Volume I)*. Paris: OECD Publishing.

OECD (2010b). *PISA 2009 Results: What Makes a School Successful? – Resources, Policies and Practices (Volume IV)*. Paris: OECD Publishing.

OECD (2010c). *PISA 2009 Results: Learning Trends: Changes in Student Performance Since 2000 (Volume V)*. Paris: OECD Publishing.

OECD (2010). *Group of National Experts on Evaluation and Assessment, 2010. Student Formative Assessment within the Broader Evaluation and Assessment Framework. Review on Evaluation and Assessment Frameworks for Improving School Outcomes.* For Official Use. Paris: OECD Publishing.

OECD (2011a). *PISA in Focus 5: How do some students overcome their socio-economic background?* Paris: OECD Publishing.

OECD (2011b), *Against the Odds: Disadvantaged Students Who Succeed in School*. OECD Publishing.

OECD (2012a). *Equity and quality in education: supporting disadvantaged students and schools*. Paris: OECD Publishing.

OECD (2012b). *Review on Evaluation and Assessment Frameworks for Improving School Outcomes. Country Background Report for Austria*. OECD Publishing.

OECD (2012c). *Review on Evaluation and Assessment Frameworks for Improving School Outcomes. Country Background Report for Czech Republic.* OECD Publishing.

OECD (2012d). *Review on Evaluation and Assessment Frameworks for Improving School Outcomes. Country Background Report for Denmark.* OECD Publishing.

OECD (2012e). *Review on Evaluation and Assessment Frameworks for Improving School Outcomes. Country Background Report for Flemish Community in Belgium.* OECD Publishing.

OECD (2012f). *Review on Evaluation and Assessment Frameworks for Improving School Outcomes. Country Background Report for Hungary.* OECD Publishing.

OECD (2012g). *Equity and quality in education: supporting disadvantaged students and schools*.

OECD (2013a). *Education policy outlook: Czech Republic*. OECD Publishing.

OECD (2013b). *Education policy outlook: Denmark.* OECD Publishing.

OECD (2013c). *Education policy outlook: Finland.* OECD Publishing.

OECD (2013d). *Education policy outlook: Spain.* OECD Publishing.