Unlocking Potential

Key barriers and opportunities in teaching math in technical and vocational schools

Research Report

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Introduction

Introduction

The mathematical performance of 15-year-old students in Europe has shown a clear downward trend since 2003, as evidenced by successive PISA measurements. This decline has accelerated significantly since 2022. At the same time, not only is the level of performance declining, but so is the students' confidence in their own mathematical abilities.

The question of why mathematics is an important thing to learn is being asked increasingly often.

However, numeracy skills are and will remain closely linked to the potential growing inequalities. Today's teenagers will grow up in an increasingly uncertain world, in which individual life and financial decisions will require complex analytical skills and the ability to draw conclusions from seemingly contradictory data. Understanding mathematical concepts is indispensable in many areas of life: from spatial planning, time management, and financial planning, to art, music, and virtually every professional practice. The ability to think logically, which is strengthened through practicing mathematics, is essential for the critical analysis of information, and abstract thinking (also strongly linked to math) is key for finding unconventional solutions.

The Erasmus+ project "Maths Is Everywhere. Added Value - Level Up!" (AV+) project is a response to these challenges. Being a spin-off and continuation of the hugely successful Added Value project (2018–2020), which was focused on promoting STEAM education in primary schools, AV+ focuses on older students – mostly those attending technical and vocational schools.

The starting point of the project is an investigation of the current state of mathematics education in 3 countries (Poland, Spain, and the Netherlands), with a particular focus on the situation in vocational and technical schools, with the goal of creating a solid foundation for creating innovative educational tools that will support teachers in showing that math can be valuable and relevant in everyday lives. We believe all students should be allowed to have a good, meaningful, challenging, and positive experience when learning math and using mathematics to better understand the world and solve practical, everyday problems.

The research provides a contextual overview and analysis of education in three countries and brings together three sources of information: PISA 2022 results, additional national and international studies, and the experiences of mathematics teachers and experts, collected through interviews and focus groups. Together, this data paints a picture of the challenges and opportunities within current mathematics education in Poland, Spain, and the Netherlands.

The ultimate goal of this research is to contribute insights necessary for the creation of a comprehensive toolkit that will truly meet the needs of teachers and help students learn mathematics in a way that is meaningful, motivating, and future-oriented.

Based on the conducted research (comprehensive desk research complemented with data and findings from in-depth interviews and focus groups conducted in all 3 countries), it can be concluded that the **educational experiences of students and teachers in technical schools and vocational training institutions in Poland, Spain, and the Netherlands are surprisingly similar, despite the differences between the education systems in these countries**.

Methodology

Methodology

The research included desk and qualitative research, interviews, and focus groups with secondary school mathematics teachers (47 people interviewed in total).

The desk research included three main sources of information:

1. contextual overview and analysis of the education systems in the three participating partner countries,
2. a brief analysis of the PISA 2022 results per partner country,
3. an analysis of the literature and research on teaching and learning mathematics in the Netherlands, Spain, and Poland, with a particular emphasis on vocational schools.

The existing sources of information analyzed within the desk research l**acked comparable data on the everyday teaching practice and experiences of teachers and students related to teaching and learning mathematics in vocational schools**. The existing data focused more on results than on the challenges and the teaching practice – which may vary depending on the country and type of school. Therefore, in order to better understand the specific needs and problems of vocational and technical school students and their teachers, the in-depth interviews and focus group discussions with teachers specifically explored those challenges.

For the qualitative part, a jointly developed interview script was used. This served as a guideline for the interviews with teachers and provided space for both structured questions and open reflections. Emphasis was placed on the experiences and perspectives of the teachers themselves, as their practical knowledge forms an essential starting point for developing innovative approaches and tools. The complete questionnaire that we used can be found in Appendix 1.

The main themes of the interviews:

1. Daily teaching practice – what is a typical school day like, what works well, and what challenges do the teachers encounter?
2. Teaching methods and innovation – what didactic approaches and tools are used, and how is mathematics linked to practice?
3. Challenges and pain points – what obstacles do teachers and students experience when learning and teaching mathematics?
4. Perspectives on students and performance – how do teachers view their students and how do they assess their learning outcomes?
5. Student motivation – what stimulates or hinders motivation, and what strategies do teachers use to engage students?
6. The role of the teacher – how do teachers view their own role, what motivates them, and what qualities do they consider important in their work?

The interviews lasted an average of 60 to 120 minutes. The collected data is analyzed and presented with the aim of formulating insights and recommendations for the development of materials and interventions that strengthen mathematics education in vocational and technical schools and make it future-proof.

Overview of the Interviews

Respondents per Partner:

Partner	Participants in group interviews	Participants in individual interviews	Subtotal
NHL Stenden	23	2	25
Smilemundo		10	10
THINK		6	6
School with class		6	6
		Total:	47

Limitations of the Research

The research team is aware that no definitive conclusions can be drawn from the research presented here about mathematics teaching in vocational schools in Spain, Poland, and the Netherlands. For practical reasons, the number of teachers interviewed is limited and may not be fully representative. Comparisons between countries and generalizations should be treated with caution and can only be discussed taking into account the limitations of such an analysis.

At the same time, the qualitative approach brings a different kind of value than the quantitative methods: it captures the complexity of the teachers' lived experiences, the nuances of classroom realities, and the meanings that participants attach to their practices.

The findings can be considered key guidelines that will help develop a set of educational tools on these topics, and the teacher's perspective can be brought into the discourse on teaching and learning mathematics in vocational schools.

Undoubtedly, the topic of teaching mathematics in technical and vocational schools is very broad and it has definitely not been exhausted by our qualitative research. We encourage other educational institutions, as well as education policymakers, to investigate this topic and conduct further research.

Overview of Vocational Education in Poland, Spain, and the Netherlands

Overview of Vocational Education in Poland, Spain, and the Netherlands

The desk research was carried out by our partners in their own countries. Existing national and international studies were used for this purpose. Since the situations differ per country, the content of the research varies from country to country.

Characteristics of the Education Systems in Poland, Spain, and the Netherlands

The table below summarizes the characteristic aspects of the education systems in Poland, Spain, and the Netherlands, with a particular emphasis on the secondary schools. Later in the report, we will discuss the characteristics of these systems that are relevant and important for our research in the field of vocational education.

Aspects	Poland	Spain	the Netherlands
Stages of education / structure	Szkoła podstawowa (primary school, 8 grades) > Szkoły ponadpodstawowe (Secondary schools)	Educación Primaria (primary school, 6 grades) > Educación Secundaria Obligatoria – ESO (compulsory secondary school) > Bachillerato / Formación Profesional (upper secondary education)	Basisonderwijs (primary school, 8 grades) > Voortgezet onderwijs (secondary school)

Aspects	Poland	Spain	the Netherlands
Types of secondary schools	• Liceum ogólnokształcące (general secondary school) • Technikum (technical secondary school) • Szkoła branżowa I i II stopnia (first- and second-level sectoral vocational school)	Bachillerato (general education) Formación Profesional (vocational)	VMBO (pre-vocational) HAVO (general secondary education, gives access to technical universities) VWO (preparatory for university studies)
Typical age of entry into a given stage of education	• Primary school: 7 years • Secondary school: 15 years	• Primary school: 6 years • ESO: 12 years old • Bachillerato, FP: 16 years	• Primary school: 4 years • Secondary school: 12 years
Duration of each stage	• Primary school: 8 years • Secondary school: 4 years • Technical school: 5 years • Sectoral Vocational schools: Stage I 3 years, Stage II 2 years	• Primary school: 6 years • ESO: 4 years • Bachillerato/FP: 2 years	Pathways at the post-primary level: • VMBO – 4 years, • HAVO – 5 years, • VWO – 6 years
Final exams at the end of each stage	Exam at the end of primary school After high school: matura – the final exam After technical school: matura and technical exams After first-level sectoral vocational school: vocational exams After second-level sectoral vocational school: high school diploma and vocational exams	After ESO: ESO completion certificate, After Bachillerato: university entrance exams (EVAU)	After primary school: Cito evaluation test (optional, but important and most often conducted in schools), After secondary school: internal exams depending on the type of secondary school

Aspects	Poland	Spain	the Netherlands
Compulsory schooling	up to 15 years of age, compulsory education up to 18 years of age	up to 16 years of age, but extended to 18 for students who haven't finished ES	Up to 16 years of age for full-time schooling. Between 16-18, children must stay in education until they have a basic qualification
Additional comments	Sectoral Vocational schools have a two-stage system (Completion of the second stage gives the opportunity to pass a technical exam and/ or high school diploma exam).	3 levels of vocational school: • FPB – Formación Profesional Básica – Basic Vocational Training for students who haven't completed ESO, leads to ESO certificate and the option to continue to Grado Medio FP. • Grado Medio – Intermediate level for students who have completed ESO, leads to the title: Técnico, allows access to employment or Grado Superior FP • Grado Superior, Higher level – requires Bachillerato or Grado Medio FP, leads to the title of Técnico Superior, can give access to certain university programs. The final grade for university admission is a combination of the final grades from Bachillerato and the EVAU exam (60% + 40%).	Early selection – decisions about the educational path are made at the age of 12. Possibility of accelerated completion of the higher stage after completing the lower stage (e.g., after completing VMBO, you can go on to the last two years of HAVO and receive a diploma).

Spain

The Structure of Vocational Education

Spain's **Formación Profesional (FP)** – vocational education and training – is divided into several levels. This overview focuses on two key stages within upper secondary education:

- Formación Profesional Básica (FP Básica / FPB)
- Formación Profesional de Grado Medio (FP Grado Medio / GM)

Both of these pathways serve different student groups, with distinct educational needs and approaches to mathematics.

Aspect	**FP Básica (FPB)**	**FP Grado Medio (GM)**
Target students	Students who *did* not complete ESO (Compulsory Secondary Education)	Students who *did* complete ESO
Typical age range	~15–17 years old (can be older, sometimes up to 20)	~15–20 years old (many start right after ESO)
Academic background	Often, there are significant learning gaps; history of school failure; sometimes newly arrived migrants	ESO graduates; more stable academic base, but still varied levels and gaps
Math	Yes, 2 hours per week included in the Applied Sciences module	No stand-alone maths subject; only maths elements within specific vocational subjects
Classroom dynamics	Small groups, frequent behavioral or attention issues, need for considerable adaptation	Broader range of skills, slightly more academic focus, more self-direction expected

Student Profiles and Learning Context

Students in FP Básica often come from diverse and challenging backgrounds. Many have experienced failure at school or disengagement during compulsory education, while others are recent migrants still adjusting to the language and system. Their levels of mathematical knowledge vary widely, and gaps in basic numeracy and problem-solving skills are common.

In FP de Grado Medio, most students have successfully completed ESO and therefore enter with a slightly stronger foundation. However, teachers still face heterogeneous classrooms, where differences in ability, motivation, and personal circumstances are significant. Many of the students deal with cognitive or behavioral challenges – such as ADHD or emotional difficulties, which are often undiagnosed or unsupported. In addition, some lack stable guidance or family support, which can hinder academic persistence.

Mathematics in Vocational Training

Mathematics instruction in FP Básica is explicitly included in the Applied Sciences module, focusing on functional and applied skills – for instance, using numerical reasoning in everyday and professional contexts. In FP Grado Medio, mathematics is not taught as a separate subject; instead, it is embedded within the vocational modules, such as accounting, construction, or technology. As a result, the extent and quality of mathematical learning depend heavily on the teacher's initiative and the nature of the vocational program.

Dropout Rates and Challenges

Spain's vocational education faces significant dropout rates, especially in the lower levels. According to a study by CaixaBank Dualiza and the University of the Balearic Islands:

- In FP Básica, around 41.7% of students drop out within four years, 49.3% graduate, and 8.8% remain enrolled.
- In FP de Grado Medio, approximately 30.7% drop out, 61.6% graduate, and 7.7% continue studying.
- In FP de Grado Superior, the dropout rates decrease to 18.8%, with 73.8% graduating and 7.6% still enrolled.[1]

These figures highlight the **vulnerability of FP Básica students**, who often require more individualized attention, social support, and motivational strategies to persist in education.

The Netherlands

Overview of the Dutch Education System

The Dutch education system offers different types of schools designed for learners of various ages, abilities, and educational needs.

Secondary Education (VO)

Students usually enter secondary education at around the age of 12. There are four main pathways, each preparing students for different types of further education or careers:

- Practical education (PRO): for students who learn best through hands-on activities and need a highly individualized approach.
- Preparatory secondary vocational education (VMBO): provides a combination of general and vocational subjects, leading to entry into vocational training (MBO).
- Higher general secondary education (HAVO): a more academic track preparing for higher professional education (HBO).
- Preparatory scientific education (VWO): the most theoretical track, preparing for university study.

[1] Estudio sobre el abandono de los estudios de Formación Profesional en España, https://www.caixabankdualiza.es/estudio-sobre-el-abandono-de-los-estudios-de-formacion-profesional-en-espana/, accessed 25.10.2025

Students who have attended special primary education (SBAO) often continue in VMBO or PRO, while those from special secondary education (SO) move on to specialized secondary education (VSO) or PRO.

Secondary Vocational Education (MBO)

After VMBO, students can enter MBO (middelbaar beroepsonderwijs – secondary vocational education). MBO prepares students directly for specific professions. There are four qualification levels:

- **Level 1** – Entry-level training
- **Level 2** – Basic vocational training
- **Level 3** – Vocational training
- **Level 4** – Middle management or specialist training

Students can choose between two types of MBO programs:

- **BOL (school-based learning)**: most of the time is spent in school, with internships as part of the program.
- **BBL (work-based learning)**: at least 60% of the program takes place in the workplace, with students employed while studying.

Each MBO program follows a **qualification file** that specifies learning outcomes and professional competences. The schools have flexibility in how they implement these requirements, design lessons, and assess students – through written exams, oral tests, or practical demonstrations.

Student Diversity

There are significant differences between students across the Dutch secondary and vocational systems:

- **Support needs**: In VMBO, students requiring extra support can be placed in smaller LWOO classes (learning support education). MBO lacks a comparable structure.
- **Background and achievement**: Students from non-Western migrant backgrounds or lower-income families often face more educational barriers, especially in HAVO and VWO.
- **Age**: Secondary students are typically 12-18 years old, while MBO students are older and more diverse in age (16-25+ years).
- **Diversity in MBO**: The MBO student population varies widely in background, motivation, and learning pace.

Mathematics in Vocational Education (MBO)

Mathematics – or arithmetic/numeracy – is a compulsory component of all MBO programs. Since 2022, updated national arithmetic requirements have been introduced to better match the students' levels and vocational practice.

These new standards emphasize numerical reasoning rather than purely technical calculation. The focus is on using mathematical thinking functionally – applying numbers and reasoning in realistic professional, educational, and social contexts. Mathematics in MBO therefore contributes to the threefold mission of vocational education:

- Qualification (preparing for a profession),
- Socialization (preparing for participation in society), and
- Personal development.

This shift from arithmetic to **numeracy** reflects international educational trends that recognize **literacy, numeracy, and digital competence** as essential 21st-century skills.

However, many students face challenges such as **math anxiety** and previous negative experiences. To overcome these, teachers need to help students experience success, see the relevance of mathematics in authentic contexts (workplaces, internships, and daily life), and break the cycle of fear and failure.

Poland

The Structure of Secondary Education

In Poland, there are three main types of secondary schools, each leading to different qualifications and career or study pathways:

- General secondary school (*liceum*) – 4 years
- Technical secondary school (*technikum*) – 5 years
- Sectoral vocational school (*szkoła branżowa*) – divided into two stages: Stage I – 3 years and Stage II – 2 years

Students in liceum and technikum typically prepare for the Matura exam, which is the national school-leaving examination and a prerequisite for university admission. In larger cities, taking the mathematics Matura is considered the norm, and schools and teachers strongly encourage students to sit this exam. For many, it is viewed as a gateway to technical universities and higher technical studies.

In vocational schools, however, the Matura exam is not compulsory. Students can choose to complete only Stage I, which prepares them for a profession, or continue to Stage II, where they can obtain the qualifications required to take the Matura and thus pursue higher education. However, students at first-level vocational schools follow a curriculum that prepares them for the high school graduation exam. This creates tension between their actual needs and cognitive abilities, and the necessity of completing the curriculum.

Polish vocational school teachers struggle most with teaching in multi-vocational classes. Groups of students representing different professions miss classes due to specific vocational courses. Each profession has a course at a different time, which results in various gaps in math knowledge, which are obstacles to effective teaching, especially because only 1-2 hours per week are devoted to mathematics.

Examples of key tendencies in Polish vocational and technical schools:

- Priority of vocational subjects: Students pay more attention to subjects directly related to their future profession, particularly in vocational schools, where mathematics may be seen as less relevant.
- Work experience and independence: Once students start working, many prefer to gain professional experience, earn money, and build independence rather than focus on academic study.
- Effort guided by necessity: When a mathematics exam or skill is clearly required for their development or qualification, students become more motivated to study and attend classes.
- Responsiveness to relevance: When mathematics lessons include practical examples or real-life applications that relate to their field or daily experiences, students become noticeably more engaged and willing to participate.

Educational Context

The Polish education system differs considerably from the Spanish and Dutch systems. The fundamental differences do not stem from the organization of education, but rather from the commonly accepted pedagogical theories and philosophies that determine everyday teaching practices and the roles of students and teachers.

In the Polish education system, there is a visible tension between teaching theory and teaching practice. The core curriculum is written in line with the contemporary trends in teaching and aims to replace the theory-based model with, among other things, the concept of problem-based teaching, multilateral education, and a focus on developing key competences.

Despite modern assumptions, education in school practice is still strongly influenced by traditional teaching based on the 19th-century theory of Jan Fryderyk Herbart.[2] The rigid organization of the teaching process, the passive role of the student, and the dominant role of the teacher result from the assumption that education is a one-way transmission of knowledge (teacher to student).

Other OECD countries,[3] including Spain and the Netherlands, are much more advanced in their modern thinking about education. Their education systems are based not only on theory but also on teaching practice, and on progressive teaching theories (e.g., the Dalton method is widely used in the Netherlands), promoting student autonomy and individualization. Teaching problem-solving, practicing creativity, focusing on holistic development, and learning to work in groups help to better prepare students to function in the modern world.

The current state of the three education systems explains why certain issues have been noticeable in Polish studies. These include **high technological optimism and the opposition between acquiring practical skills and learning theory**.

[2] A. Murzyn, Filozofia nauczania wychowującego J. F. Herbarta, Kraków 2010

[3] Porównanie systemów edukacyjnych państw OECD, Instytut Badań Edukacyjnych 2024, https://ibe.edu.pl/images/badania/Profil%20Absolwenta/Publikacje/Porownanie-systemow-edukacyjnych-panstw-OECD.pdf, accessed 14.11. 2025

Technological Optimism

Excessive technological optimism in education is often manifested in the belief that artificial intelligence (AI) and related digital tools can replace human reasoning in solving complex tasks such as mathematics.

This overreliance reflects a broader cultural tendency to attribute exaggerated capabilities to technology, where the focus shifts from understanding processes to simply obtaining answers. This tendency is further reinforced by the traditional grading system (summative assessment), which often rewards the correct final result more than the process of reaching it. In mathematics education, this approach risks undermining the development of problem-solving skills, logical reasoning, and the ability to evaluate the correctness of solutions.

According to interviews with Polish teachers, students tend to go for the "easy solution" by relying on technology (calculators, the Internet, or applications) instead of developing their own problem-solving skills:

> *Not to mention ChatGPT, which is not very good at math problems. It often spits out university-level solutions with terms that no one would know. I always check and ask what it means. (...) I say, tell me how you did it? What is this formula? (...) Now solve this example using the same method. And at this point, it's impossible to repeat if someone doesn't know it.*
>
> (teacher, Poland)

The impact of artificial intelligence on learning and teaching mathematics is extensive and continues to be intensively researched. On the one hand, AI can increase barriers by encouraging reliance on ready-made solutions and exacerbating digital inequalities, but on the other hand, it offers significant benefits by personalizing learning, expanding the practical applications of mathematics (e.g., in data analysis), and supporting teachers in automating routine tasks.

Practice Over Theory in Math Learning

Excessive emphasis on theory may lead to another danger, and have the opposite effect of negating the need to learn theory. Practicality-oriented thinking privileges immediate applicability, efficiency, and visible outcomes over abstract or theoretical reasoning. In mathematics education, this often translates into a focus on "usable" skills such as calculating percentages for invoices, using spreadsheets, or applying formulas in vocational contexts. While such orientation can increase motivation among students who appreciate relevance to everyday life, it also risks reinforcing the perception that theoretical knowledge is unnecessary or irrelevant.

> *But these are such unrealistic, purely theoretical issues (...) because each of them knows why they have to calculate this by hand when programs do it anyway.*
>
> (teacher, Poland)

However, one must be careful not to fall into the trap of practicality. This involves reducing mathematics solely to a tool that is useful in everyday situations - calculating bills,

percentages, or taking measurements. In this approach, mathematics loses its abstract dimension - students learn that the value of mathematics is related to its direct application, rather than to the development of more complex mental operations or logical reasoning skills. However, this should be the starting point for developing abstract thinking and smuggling in theory. In this sense, practical examples should serve as bridges to abstraction, not as ends in themselves - otherwise, mathematics risks being reduced to something merely useful, losing its formative and intellectual potential.

The Social and Cultural Context of Vocational Schools

The Social Perception of Vocational Schools

In Poland and Spain, attending vocational school is often considered an educational failure by the external environment, even when the students themselves do not feel this way.[4] These schools are regarded as inferior to high schools and technical schools. For some students, attending a vocational school reinforces their belief that they cannot achieve success.

> *Many students say they're in vocational training because they couldn't do anything beyond that, because they can't do anything.*
>
> (teacher, Spain)

Sometimes, families can also view vocational education as a type of educational failure. According to Recepción de la juventud sobre la Formación Profesional en España[5] (Madrid, Centro Reina Sofía de Fad Juventud), seven out of ten young people consider Vocational Education and Training (VET) to be a complete and high-quality option, highlighting its ability to specialize or learn a trade quickly and efficiently. However, their families still tend to view it as a less ideal choice. "There is a certain hypocrisy with Vocational Education and Training: everyone says it is very good, but they don't want it for their own children," said sociologist Aina Tarabini, researcher in Educational Policies at the UAB, in El Periódico.[6] Few families value this educational path: only 23% want their children to study VET, compared to 57% who prefer university, according to the II Estudio sobre la percepción de la Formación Profesional de madres y padres.

The Experience of Migration

Providing valuable education to people with migration and refugee experience is becoming an increasing challenge in all three countries. This is because the number of such people is constantly growing, and they face numerous cultural, material, and family-related challenges, and often also trauma. In addition, they come from education systems that differ significantly from those of the host country and often have significant gaps in their knowledge due to interruptions in their education. Teachers are not prepared to deal with such complex problems.

[4] Płachecki T., Kłobuszewska M., Humenny G., Stasiowski J., Sitek M., Płatkowski, B. (2023). Uwarunkowania ścieżek edukacyjnych i zawodowych absolwentów branżowych szkół I stopnia i techników., t 2. Losy Absolwentów - Monitorowanie, Publikacje, Analizy (LAMPA), Instytut Badań Edukacyjnych, Warszawa

[5] See: Recepción de la juventud sobre la Formación Profesional en España, Centro Reina Sofía de Fad Juventud (2025), https://www.centrore-inasofia.org/publicacion/jovenes-formacion-profesional-espana/.

[6] See: El Periódico (2024), 9.10.2024. https://www.elperiodico.com/es/sociedad/20240912/aina-tarabini-plazas-fp-abandono-escolar-orientacion-hipocresia-108000765.

[7] See: European Commission (2024), https://education.ec.europa.eu/pl/focus-topics/improving-quality/inclusive-education/migrants-and-refugees.

In Poland, schools lack psychological support and intercultural assistants who can help students with migration experience with communication, language, etc. This has been of paramount importance since 2022, due to the massive displacement and subsequent arrival of refugees caused by the war in Ukraine.

In the Netherlands, children who do not have a sufficient command of the Dutch language can be placed in a transition class,[8] though parents must give their consent for this. In a transition class, extra attention is paid to language teaching. This can be during primary school, secondary school, or vocational education. When it comes to other forms of educational disadvantage, there is no additional help or support available within the education system. Since the introduction of "appropriate education",[9] these pupils have had to participate in mainstream education. Within appropriate education, there is always some room for individual support for pupils who need it.

Spanish teachers shared that it is common for students who have recently migrated from other countries to face specific challenges — particularly linguistic and cultural hurdles that can cause them to fall behind academically, even though they are often motivated and capable learners.

The Spanish educational system sometimes lacks the flexibility to accommodate the adaptation period these students need, which results in them entering vocational training (FP Básica) not due to choice or a lack of ability, but because of age and time constraints.

> *So in the end you can meet really lovely boys. They have adapted to the language, and the educational system gives them no room to maneuver, and that's how they ended up here. It's not that they were bad students in their home countries — it's that they faced a cultural and linguistic change that doesn't give them time to adapt.*
>
> (Teacher, Spain)

In Poland, Spain, and the Netherlands, there is a gap between the results of people with and without migration experience (newcomers achieve weaker results).[10] Language problems are often the cause of poorer results, including in mathematics.

In technical and vocational schools, difficulties may arise due to a lack of knowledge of the language of instruction (despite communicative language skills). Understanding more complex mathematical concepts or terms related to vocational training is often a challenge. Often, language skills are not sufficient to properly understand a text-based task, which leads to errors in the solution.

The experience of migration has not been highlighted as a separate barrier in this report, as it is a phenomenon that combines biographical (family, economic, and educational), psychological, and systemic aspects, affecting both individuals and the education system as a whole.

[8] See: https://dutchforchildren.nl/transition-class/.

[9] See: https://www.government.nl/topics/appropriate-education.

[10] OECD (2023), PISA 2022 Results (Volume I): The State of Learning and Equity in Education, PISA, OECD Publishing, Paris, https://doi.org/10.1787/53f23881-en, accessed: 25.10.2025

PISA Math Results Overview

PISA Math Results Overview

This chapter provides a brief overview of the performance of 15-year-old students in the Netherlands, Poland, and Spain in mathematics. From the perspective of this report, this is important data, as 15-year-old students in all three countries are already in secondary schools (including technical and vocational schools) or will be attending them in the near future.

Education Systems by Country for 15-Year-Olds

The PISA study focuses on 15-year-old students. What type of education are they in?

	The Netherlands	**Spain**	**Poland**
Education type at 15 years	Secondary education (VO)	Final phase of secondary education (ESO)	Final phase of primary education (“klasa 8”) or first year of secondary education (liceum/ technikum)
Level	VMBO, HAVO, or VWO	Generic	Primary Education: Generic
Continued 16+ years	**VMBO** >Secondary vocational education (MBO) **Air** > Higher vocational education (HBO) **VWO** >Scientific education/ University	**Formación Profesional** (Basic, Middle Grade, and Superior Grade), secondary vocational education **Bachillerato** (general upper secondary education, preparatory to university)	**Liceum** (preparatory for university) **Technikum** (technical education, higher vocational education) **Szkoła branżowa I stopnia** (secondary vocational education)

Average Math Scores in PISA for 2018 and 2022

All three countries show a decline in math performance between 2018 and 2022 (which is in line with the international trends – the OECD average score dropped from 489 (2018) to 472 (2022)). The sharpest declines can be seen in the Netherlands and Poland.

Country	2018	2022	Difference
The Netherlands	519	493	-26
Poland	516	489	-27
Spain	481	473	-8

Explanation of the table: the average score for a 15-year-old in PISA is approximately 500 points with a standard deviation of 100 points. The average score increase between 14- and 15-year-olds is about 20 points[11] (20% of the standard deviation), and the growth in the score between 15- and 16-year-olds also averages 20 points.

Summary Overview, PISA 2022

Indicator	The Netherlands	Poland	Spain
Average score	493	489	27%
% Low performers (< level 2)	21%	23%	6%
% Top performers (level 5/6)	9%	9%	14%
Impact of socioeconomic status on performance	14%	16%	14%
Number of students with >= level 2	79%	77%	73%

Explanation of the Levels

PISA defines 8 proficiency levels[12] in mathematics. Level 2 is considered by PISA as a “functional basic level” for participating in society.

Level	What can the student do?	Interest
<2	Limited skills – risk group	Low performers
2	Basic Functional Level – Minimum Requirement for Participation	Considered an international lower limit
5/6	Tackling complex problems independently	Top performers

[11] OECD (2023), PISA 2022 Results (Volume I): The State of Learning and Equity in Education, p. 156

[12] OECD (2023), PISA 2022 Results (Volume I): The State of Learning and Equity in Education, p. 89

Conclusions

- All three countries show a decline in mathematics performance compared to previous years (especially between 2018 and 2022)
- The impact of socioeconomic status (SES) in the Netherlands, Poland, and Spain is comparable
- Every country has a substantial group of low performers, despite differences in average level.

Differences Between School Types

In Poland, there are significant differences between school types in the PISA results:

- General secondary education (liceum): average of 524 points.
- Technical schools: average 479 points.
- First-level vocational schools: only 394 points.

In vocational schools, 66% of students do not even reach level 2, while the proportion of top performers is virtually zero. Technical schools show a picture that is in line with the national average.

Dutch differences between school types in the PISA results:

- vwo (pre-university education (upper secondary)): average of 600 points.
- havo (senior general secondary education (upper secondary)): average of 540 points.
- vmbo (pre-vocational secondary education): average of 456 points.

In the Netherlands, these differences apply to attitudes toward mathematics as a subject:

- The highest proportion of students who consider mathematics their favorite subject is found in VWO and VMBO-basis (approximately one-third). The lowest proportion is found in VMBO-kader (24%).
- VMBO-kader students are also the least likely to find mathematics easy (40%).
- VWO students score highest in motivation: 91% want to do well in math class. This percentage is lowest among VMBO-basis students (68%), although the majority here also remain positively motivated.

Educational Support and the Learning Environment

According to 69% of **Spanish students**, teachers show an interest in their learning process (OECD: 63%), and 68% feel that they receive extra help when needed (OECD: 70%). Although in Spain, the percentages indicate a relatively high level of support:

- 20% of students feel that their teacher is not at all interested in their learning process
- another 33% experience this only occasionally

- only 44% indicate that teachers explain the material until everyone understands it (OECD average: 60%).

Many students report a learning environment that is not conducive to concentration:

- 38% of students say they do not listen to the teacher (OECD: 30%)
- 33% report being distracted by digital devices (OECD: 30%)

According to the research, **Polish students** experience less support from their math teachers than their international peers.

- teachers ask students to explain their thought processes less often (32% compared to the OECD average of 46%).
- teachers encourage student perseverance less often: 27% of students never hear this, compared to 11–12% internationally.
- almost half of students have never or rarely been given an explanation of the relevance of mathematics to everyday life.

In the Dutch PISA research, there is no reporting on teacher-support indicators specific to mathematics lessons, such as whether teachers show an interest in the students' learning, provide extra help, explain until everyone understands, ask students to explain their thinking, encourage perseverance, or clarify real-life relevance. The Dutch summary covers attitudes to mathematics and aspects of the digital learning environment instead.

On student attitudes toward mathematics, 29% state that mathematics is one of their favorite subjects; 46% say mathematics is easy for them; and 83% report that they want to do well in their math class (with significant gender differences reported in the document).

Math Anxiety and Motivation

The PISA data clearly shows that **Spain** has a significant problem with the students' attitude to mathematics: the country ranks sixth out of the 41 OECD countries where students experience the most math anxiety. No less than 37% of Spanish students suffer from this, more than double the OECD average. Spain is also one of the countries where girls experience anxiety much more often than boys (50% more often). Socially disadvantaged students are also disproportionately affected: in Spain, this percentage is 26% higher than among their more privileged peers, which is in line with the international trends.

The study confirms that math anxiety is prevalent among **Polish** students. They experience feelings of helplessness, nervousness, and fear of poor grades. The proportion of students who feel helpless in math rose from 30–31% in previous editions to 49% in 2022. Anxiety has a clear negative effect on performance.

In addition, students show less commitment and perseverance than their international peers: they listen less attentively, ask fewer questions, and procrastinate more often when it comes to homework. Only 27% say that they always ask questions when they don't understand something (the OECD average is almost 47%). Their confidence in mathematical skills is also significantly lower, both in formal calculations and in practical applications.

On average, **Dutch** students experience less math anxiety than their peers in OECD and EU14 countries. Finland is the only place where the anxiety is lower. Nevertheless, almost half of Dutch students are concerned about poor grades, and 40% are afraid of failing math. Girls consistently report more anxiety than boys, with the biggest differences in concerns about difficulties in class (56% of girls vs. 35% of boys) and fear of poor grades (61% vs. 41%). Differences are also visible in the type of education: VMBO-Kader students experience the most anxiety, while practical education students report the least anxiety.

Conclusion

Mathematics education performance is declining across Poland, Spain, and the Netherlands. This trend is accompanied by an increase in **math anxiety**, a drop in student **motivation**, and a persistent mismatch between the mathematics curricula and student needs. All three countries exhibit a similar pattern: **PISA performance is falling**, and the proportion of students scoring **below proficiency level 2** is simultaneously increasing. This educational decline is not uniform; established disparities persist across **school types, gender, and socioeconomic groups**. Math anxiety is identified as a key mechanism driving this pattern, as it undermines motivation, fosters avoidance behavior, and consequently depresses performance. Significantly, **girls consistently report higher levels of anxiety and lower self-confidence** in mathematics than boys.

Barriers and Positive Impact Opportunities in Learning and Teaching Mathematics

Barriers and Positive Impact Opportunities in Learning and Teaching Mathematics

Based on the results of the research, the main part of this report is devoted to the barriers hindering the process of teaching and learning mathematics and positive impact opportunities to overcome them. We believe that it is necessary to identify them in order to be able to think more comprehensively about teaching mathematics. While acknowledging some generalizations, this categorization highlights the complex and diverse realities of teaching. Consequently, it remains a valuable tool for analysis and for the reader, despite not representing every individual case.

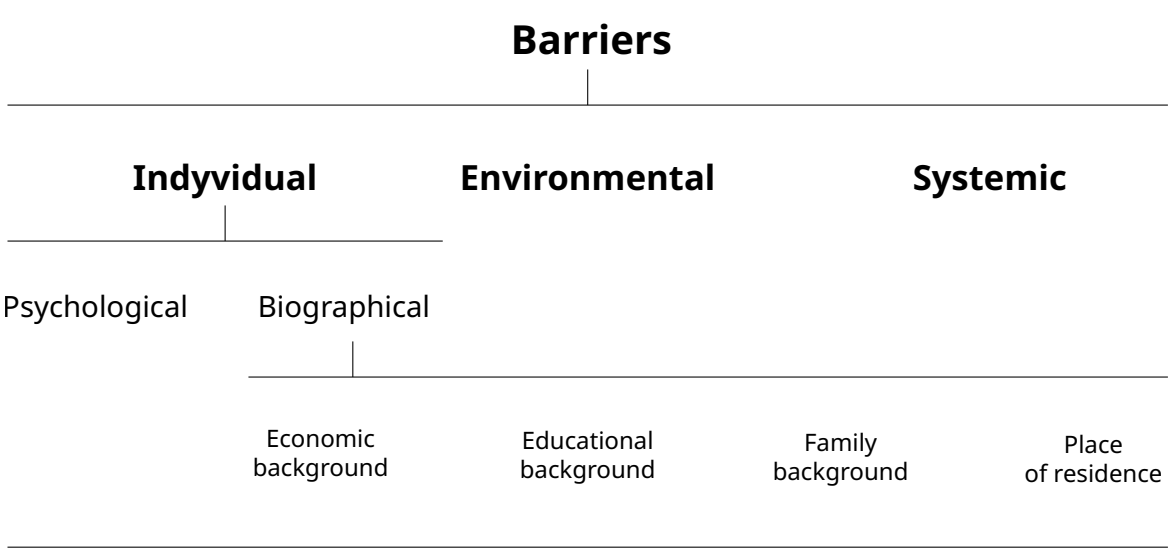
The basic categorization of barriers adopted in this report is based on whether they concern the **individual life trajectory**, the **school environment**, or the **education system**. This structure allows us to highlight what we considered crucial in the collected research material. Teachers, while coping with numerous challenges stemming from **systemic, biographical, or psychological factors**, also identify areas of influence and action that could bring the greatest benefits to students.

The school/teacher might have more influence over some barriers than others. Sometimes this influence is very limited (as in the case of systemic barriers, such as the limited number of hours dedicated to mathematics at schools), while in other cases, it can be quite significant (for example, environmental barriers related to the educational climate of a school or classroom).

Overcoming sets of different interlinked barriers may be extremely difficult. However, it is crucial to identify them in order to understand and plan the best educational intervention.

It is also important to note that actions aimed at overcoming barriers may operate at a different level than the barriers themselves.

The positive impact opportunities cited in this report come directly from teachers (from interviews and focus groups conducted as part of the Maths Is Everywhere project, as well as from articles and studies analyzed as part of the desk research). This list is not complete and comprehensive; it may and should be developed further in future research endeavors.



A. Individual Barriers

Biographical Barriers (Considered in Contexts)

Biographical barriers are understood here as obstacles to education and development related to an individual's life trajectory. They result from previous life experiences or current circumstances and refer to a person's personal biography – family, school, social, and economic background – and how these factors shape the current opportunities and choices. While such barriers may have systemic roots, they are considered here in terms of their direct impact on the individual.

Some biographical barriers, particularly those arising from the influence of the family environment, although seemingly beyond the teacher's direct control, can be mitigated to some extent through individual support, relationship building, and the creation of a safe learning environment. Similarly to the psychological barriers discussed later in this report, teachers can try to help, encourage, and motivate students. Such actions cannot fully compensate for disadvantages rooted in a student's past but can help to alleviate their impact and strengthen the learner's sense of agency and belonging.

Barriers Related to Family Background

Education is Not Treated as a Priority in the Family Environment

Country: Poland, Spain

Description:

In Poland, according to research conducted by the Educational Research Institute,[13] most vocational school students (around 60%) come from families in which parents have vocational or primary education, while only about 7% have parents with higher education. This background may influence the parents' and students' attitudes toward schooling

[13] Płachecki T., Kłobuszewska M., Humenny G., Stasiowski J., Sitek M., Płatkowski, B. (2023). Uwarunkowania ścieżek edukacyjnych i zawodowych absolwentów branżowych szkół I stopniai techników., t 2. Losy Absolwentów - Monitorowanie, Publikacje, Analizy (LAMPA), Instytut Badań Edukacyjnych, Warszawa

and general subjects, as education is not always perceived as a key value within these environments. This tendency is particularly apparent in relation to mathematics in Poland:

> *Sometimes parents need to say, "Okay, I don't know math, but you can do it, you'll manage," and so on. I had a student who said that his mother told him that she didn't know math, so he didn't have to either.*
>
> (teacher, Poland)

> *Many students repeat their parents' words, i.e., if problems arise, "Yes, I remember, I also had problems at school."*
>
> (teacher, Poland)

In Spain, interviewed teachers acknowledge that the parents of vocational training students rarely show much interest in their children's education and often never have. As a result, the students frequently feel as though they are on their own with their studies, which leads some teachers to step in as a support system:

> *It's a challenge, first of all. In secondary, a student with support at home or who pays attention in class and has no learning difficulties can basically do everything on their own. But students without support – who have either never had it or have lost it – are at a disadvantage socially, economically... I like being a support point to help them move forward. That's what education should do – help them not fall behind again.*
>
> (teacher, Spain)

> *Many students lack the environment or support to study at home. Most learning happens in the classroom, which becomes essential.*
>
> (teacher, Spain)

In the Netherlands, teachers have mentioned that parents are sometimes part of the challenge. The parents indicate that they themselves are no good at math or find it too difficult to help. However, this does not seem to be a major part of the problem.

Generational Transmission of a Lack of Belief in Understanding Mathematics

Country: Poland, Spain

Description:

According to Polish teachers, students often "inherit" their parents' aversion to mathematics and the belief that it is a difficult subject, hard to understand and learn.

Parents who had problems with mathematics at school are ready to excuse their children and not be too demanding of them. In this situation, teachers do not feel supported by the parents and feel that their ability to influence the students is limited.

> *Parents are also part of the problem: math is difficult, math is not for girls.*
>
> (teacher, Netherlands)

> *A very large difference was noticeable when children from generations whose parents did not pass their high school exams in math started attending school. (...) the parents said, "You know, I didn't have to either. I was lucky enough to be in the year that didn't have to take math in the final exams, because I never understood math either." If a child hears this multiple times, it probably creates a kind of aversion in them, which is difficult to overcome.*
>
> (teacher, Poland)

Juana Navas, secretary of training activities in the Federation that groups the societies of mathematics teachers in Spain, admits:[14]

> *A lack of mathematical skills is something cultural, almost hereditary in Spain. The fear of mathematics is transmitted through families. Some parents come to see me and tell me that, just like their child, they were no good at mathematics. (...) Learning mathematics is not something genetic. It requires the right attitude from the students and proper teacher training, which is not always present.*
>
> (teacher, Spain)

Barriers Related to Place of Residence

Transportation Exclusion

Country: Poland, Spain

Description:

In interviews with Polish teachers, the topic of challenges that the students have to deal with in relation to their place of residence came up. The need for long commutes means that students are unable to study at home, and teachers realize that the only time they have to acquire knowledge is the time they spend at school:

> *They can have nine, sometimes even ten hours of classes a day if they have extra activities, which is a lot. If they finish classes at 4 p.m., I have a lot of students who commute, and I know that they are not home until 7 p.m. So the time issue is also difficult for them, and we have to realize that they don't necessarily have time for additional learning.*
>
> (teacher, Poland)

> *The truth is that they work long hours at school, sitting there sometimes until 5 or 6 p.m., and they rarely study math at home, so whatever comes up, they learn in class or possibly in remedial classes. I have the impression that for some, this has to be enough.*
>
> (teacher, Poland)

[14] Profesores y padres contribuyen a la ansiedad matemática de los alumnos, COPE (2024), https://www.cope.es/actualidad/sociedad/noticias/profesores-padres-contribuyen-ansiedad-matematica-alumnos-20240212_3137468.

In Spain, vocational training students often do not choose the school profile they're most interested in but the educational option available in their area. As a result, they sometimes don't see the value of what they're being taught, as they aren't even interested in the vocational field they're studying.

In the Netherlands, transportation exclusion is less of a barrier. Schools are becoming increasingly distant (due to schools disappearing in sparsely populated areas), but the travel times are still acceptable.

Barriers Related to Economic Background

In Poland and Spain, there are students, especially those in vocational schools, who take on work while still in school and want to become financially independent quickly. They are often forced to do so by their economic situation. In Poland, for example, this would include students from Ukraine with refugee experience. Some students, even those who are not in a difficult financial situation, want to have their own money as soon as possible. Gaining professional experience becomes more important to them than learning general subjects.

In Poland, students in vocational schools earn money for their work in companies but the wage is very low (8% of the average monthly salary in the first year of vocational school, 9% in the second year, and 10% in the third year[15]).

In the Netherlands, students who are keen to work can follow a work-study program (BBL) in vocational education. These programs are often at a lower level of vocational education, but they do ensure that students continue to attend school.

In Spain, students in all vocational training levels – FP Básica and Grado Medio – participate in mandatory internships (Formación en Centros de Trabajo, FCT) as part of their curriculum. These internships, usually unpaid unless part of a dual FP (FP Dual) program, give students hands-on professional experience and prepare them for the labor market. FP Dual programs, which combine school-based learning with paid company placements, allow motivated students to gain financial independence and professional experience while continuing their studies.

The Desire or Need for Rapid Financial Independence

Countries: Poland, Spain

Description:

According to interviews with teachers from Poland and Spain, students from vocational and technical schools want to achieve financial independence as soon as possible:

> *(...) I think the biggest problem is that they work and they don't give themselves time to be students, children, and so on. Instead, they immediately try to be adults and have their own money.*
>
> (teacher, Poland)

[15] Amount of remuneration and contributions of juvenile employees in Poland, https://wskazniki.gofin.pl/wskaznik/113/ wysokosc-wynagrodzenia-i-skladek-pracownikow-mlodocianych, accessed: 25.10.2025

In a research project[16] conducted in Poland among technical and vocational school graduates, only 21% believe that *"if necessary, support from their family would allow them to support themselves without earning money for a year after completing their education."* This may encourage decisions related to choosing a school and profession that will ensure they become financially independent as quickly as possible. It may also influence decisions not to continue education after completing first-level vocational school.

> *Some of them just want to go to work, earn money, and have little to do with school.*
> (teacher, Poland)

According to the study 'El abandono de los estudios en la Formación Profesional en España: diagnóstico y propuestas de mejora,[17] conducted by la Caixa and Dualiza in 2024, finding a job is one of the main reasons students leave vocational training. In Spain, particularly in tourist areas, the labor market tends to be open to low-skilled workers, attracting young people with low education levels and limited motivation to continue their studies.

> *In terms of motivation, many of them – more than those in higher-level programs – enroll because they want to secure a quick route into the workforce*
> (Teacher, Spain)

Barriers Related to Educational Background

Barriers resulting from each student's personal experiences in the earlier stages of education have an impact on their further learning process. These barriers can be related to their attitude to mathematics as a school subject and the learning deficits.

Educational Gaps and Negative Learning Experiences

Country: Poland, the Netherlands, Spain

Description:

In all three countries, discouragement of mathematics often begins in the early stages of education. Students link mathematics with past experiences of failure, fear, or humiliation in the classroom.

> *Bad experiences, i.e., situations at the blackboard when a student stood there, did not know what to do, and no one showed them how, making them feel humiliated.*
> (teacher, Poland)

Such emotions – anxiety, frustration, shame, or a sense of inadequacy – can significantly reduce motivation and persistence in learning. Students who have repeatedly struggled or felt judged in math lessons often develop avoidance behaviors and negative self-concepts ("I'm just not good at math"), which hinder engagement even when they have the potential to succeed.

[16] Płachecki T., Kłobuszewska M., Humenny G., Stasiowski J., Sitek M., Płatkowski, B. (2023). Uwarunkowania ścieżek edukacyjnych i zawodowych absolwentów branżowych szkół I stopnia i techników., t 2. Losy Absolwentów - Monitorowanie, Publikacje, Analizy (LAMPA), Instytut Badań Edukacyjnych, Warszawa

[17] El abandono de losestudios en la Formación Profesional en España: diagnóstico y propuestas de mejora https://www.caixabankdualiza.es/wp-content/uploads/2024/07/ESTUDIO-ABANDONO-OK-staff.pdf (access 25.10.2025)

Polish, Spanish, and Dutch teachers consistently observe that many students arrive from previous stages of education with significant gaps in their mathematical knowledge. They often fall behind in primary school and never catch up. This makes learning new material extremely difficult, often requiring a return to content typically taught in primary school, such as basic counting with natural numbers.

> *The biggest problem is the backlog they have accumulated for various reasons. If they really are behind when they arrive, it is very difficult to catch up, because we start with the material and assume that a certain stage has already been covered and that they should know it, but that is not the case.*
>
> (teacher, Spain)

As a result, there are many different levels in the classroom.

In Spain, teachers report that many students enter vocational education with gaps in their knowledge and limited experience with effective learning strategies. They avoid asking questions or only pretend to understand out of fear of embarrassment. This reluctance is often rooted in past experiences – many have been labeled the "stupid one" before and are now highly sensitive to exposing any gaps in their knowledge.

> *These are cases where, when they come (to school), they immediately say, "But I've never been able to do this." (...). Usually, it's not that they're afraid now, but that these fears are there from somewhere before, and I think they're fears related to the fact that at some point they missed something, didn't learn a few things, and it's dragging on.*
>
> (teacher, Poland)

In Spain, according to the teachers, many students got stuck in what some teachers call a vicious cycle during their primary and secondary education:

- They never fully grasped the basics.
- They were expected to complete tasks they didn't understand.
- They didn't see progress, lost motivation, and eventually gave up.

In the standard education pathway, students face strict curriculum requirements, tight deadlines, and a one-size-fits-all approach. This rigid structure often leaves behind anyone who can't keep up – and the learning gaps only grow wider over time. Teachers in overcrowded classes don't have time to give them proper support.

Students especially struggle with tasks that involve multi-step reasoning or problem-solving. Instead of grasping the underlying logic, they tend to rely on memorization, and many find abstract thinking particularly difficult.

Examples of Positive Impact Opportunities:

Teachers see it as their job to help students change their negative beliefs about themselves, such as "I'm not good at math." However, this usually takes time and requires individual attention and support for students. Teachers deal with this in different ways: using group assignments to get all the students involved in the lesson, going back to basics to fill in gaps from elementary school, or starting with simpler challenges and praising small successes.

Gamification is sometimes used to add a competitive element to the lesson. They then gradually raise the bar and give students increasingly difficult assignments. They also invite such students to do assignments on the board more often.

Building teacher-student relationships based on trust, creating a safe atmosphere in the class. In this, it is important that everything is done to make everyone feel welcome. Making mistakes is used as an encouragement to learn. This reinforces learning with positive feedback and celebrates small successes. Even when a small mistake is made, teachers try to emphasize the positive side.

> *Mistakes are there to teach us something, not to discourage us. We make mistakes so that we remember not to do something, and sometimes we have to make the same mistake more than once, but the point is that we learn that this is not the right way to do things.*
>
> (teacher, Poland)

Teachers' proactive approach: Spanish teachers in the interviews explain that they don't rely on a simple nod or "yes" as confirmation of understanding. Instead, they ask follow-up questions to probe deeper, and if they detect uncertainty, they go back a few steps to clarify the concept.

According to the teachers, students understand better when materials are **presented in a clear, simplified way, with gradual, repetitive explanations**.

Sometimes **teachers differentiate tasks** and divide students according to their abilities:

> *It can be divided like this. It requires more work from us, because it's like preparing for two lessons. (...). And for the weaker students, we recalculate the tasks and ask them questions from the extension to see if they are on the right track. I can't just choose some tasks, not recalculate them, not check them, and not know what direction they should take. It requires more work from me, but it also brings better results because I don't lose the weaker students.*
>
> (teacher, Poland)

Across the board, teachers emphasize the importance of a **calm, patient teaching approach** – avoiding overload and ensuring that the students fully understand the basics before moving forward, even if it means falling behind in the official curriculum.

> *What I like most about teaching basic vocational training is that, for both the students and the teachers, it feels like starting over. Hearing students pass a math exam for the first time – because you began with integers and helped them gradually build their understanding, the way it should have been from the start but never was, with plenty of time and patience – is incredibly rewarding*
>
> (teacher, Spain)

In Spain, in vocational training (FP), the environment tends to be more equitable and supportive. It's less competitive and more adaptable, with realistic goals and practical, hands-on activities that help students rebuild their confidence. For some teachers, the idea of FP is a way to overcome past academic failures and recover self-esteem through learning that feels relevant and achievable.

> *Instead of doing math exercises on the board, a student in carpentry might be asked to build a boat, using geometry and math as part of the process. This requires the teacher to help the student believe that they are capable, even if they've always been told they're a "bad student".*
>
> (expert, Spain)

Biographical Barriers	Examples of positive impact opportunities
Barriers related to family background	
Generationally transmitted lack of belief in the possibility of understanding mathematics (PL)	These barriers are closely linked to the individual biographies of students, over which the teacher has no direct influence. They can only try to respond to situations in which students have a specific negative attitude towards learning or do not have enough support. Possible actions are described in more detail in the chapters on psychological barriers, as the attitude towards mathematics, although it may result from specific content conveyed at home, is psychological in nature, which justifies further analysis in this context. Examples of positive impact opportunities: • praising small successes • individual educational support • introducing a culture of learning from mistakes • focus more on the process than just the final answer • limiting theory and lecture-based teaching • creating a safe and open classroom atmosphere • developing good learning habits
Education is not treated as a priority in the family environment	
Barriers related to place of residence	
Transportation exclusion	This barrier should be addressed at the advocacy level and/or at the level of local authorities. It is difficult for teachers to address it directly, as these barriers often result from biographical circumstances that are beyond the teachers' influence and can only be addressed at the systemic level.

Biographical Barriers	Examples of positive impact opportunities
Barriers related to economic background	
Desire or need to achieve rapid financial independence	This barrier should be addressed at the advocacy level and/or at the level of local authorities. It is difficult for teachers to address it directly, as these barriers often result from social inequalities and biographical circumstances that are beyond the teachers' control and can only be addressed at the systemic level. In this case, schools and teachers can play a supporting role, including providing students with materials relevant to their desires, e.g., tools useful for their first jobs or vocational training internships, as well as introducing financial literacy (e.g. helping students understand that not all quick-money opportunities are wise).
Barriers related to educational background	
Educational gaps and negative learning experiences	building teacher-student relationships based on trust
	a proactive approach from teachers
	presenting material in a clear, simplified way, with gradual, repetitive explanations
	differentiating tasks and dividing students according to their abilities
	a calm, patient teaching approach

B. Psychological Barriers (Individual Level)

These are barriers that are connected to the individual's psychological conditions. Unlike systemic barriers, these potentially lie within the teacher's sphere of influence, and the possibilities for responding to them can mainly be seen in building relationships between the teacher and the student.

Low Self-Esteem and Low Self-Confidence

Country: Poland, Spain, the Netherlands

Description:

This barrier refers to a lack of confidence in one's own abilities, often reinforced by repeated experiences of educational failure. Students with low self-esteem tend to underestimate their competence, avoid challenging tasks, and give up easily when faced with difficulty.

> *(...) some students feel very insecure. Even when they do a task well, they are never convinced that it is right. They need confirmation that it is okay. I think there is a fear among students, who have had so many failures along the way, that it will be wrong.*
>
> (teacher, Poland)

> *Students are convinced that they cannot do it. Even getting started on a task is difficult.*
>
> (teacher, the Netherlands)

Some teachers believe that low motivation often stems from low self-esteem. Many students carry the weight of repeated failures in their previous schooling, which makes it harder for them to believe they can succeed now. This mindset limits persistence and engagement, creating a self-fulfilling cycle of underachievement.

> *I think it's more about not believing in their own abilities. For example, something didn't work out at first, and that person decides that if they failed once, they will definitely fail everything else.*
>
> (teacher, Poland)

As a result of previous experience, students often experience uncertainty: even when they give the correct answers, they doubt themselves and seek confirmation. Their understanding of mathematics is fragmented, and connections between topics are not made. Fear of mathematics is common, especially among weaker students or after negative experiences, such as failures at the blackboard or lack of support.

Examples of Positive Impact Opportunities:

Interviewed teachers in all three countries emphasize the importance of **creating a safe and open classroom atmosphere** where mistakes are not punished and asking questions is encouraged. They regularly remind students to ask questions, address them individually, and involve them actively by letting them work at the board. Group work, games, and mini-whiteboards are also used to promote participation. A *learning-from-mistakes* culture is fostered – making errors is accepted and treated as an opportunity to learn. Teachers work to create a safe environment by immediately addressing any mocking, laughing, or negative comments from other students, reinforcing a respectful classroom culture, and trying to mitigate the stress resulting from other people's evaluations.

The teacher as a guide: Many teachers put the students' emotional well-being and real understanding ahead of strictly following the curriculum. They know that these students often need far more support than those in other secondary school pathways, so they don't hesitate to pause a lesson if needed – whether to talk through conflicts, address personal issues, or open up broader discussions about values and life.

In FP Básica especially, the teacher's role often resembles that of a social worker – they need to be ready to handle crises, offer emotional support, and help students navigate personal and social challenges alongside their academic work.

> *When you have a student whom the system hasn't provided answers for, but still wants to try... and you can give that answer, it's wonderful.*
>
> (teacher, Spain)

A teacher needs to be a good listener and know how to ask the right questions. Some teachers indicate that a positive growth mindset is more important in mathematics than in other subjects, but the role of the teacher is also to have a really good command of the subject matter.

Feedback loop: Teachers emphasize the importance of giving plenty of positive feedback – even for the simplest things, like sitting down to write or showing up to class. Many students aren't used to feeling appreciated or seen, so small gestures of care and praise for effort can often have a greater impact than any fancy tool or method. Teachers see their role as helping students change the negative beliefs they hold about themselves, like "I'm not good at math." However, this usually takes time and requires giving students individual attention and support.

Bringing out the positives: Noticing even small progress and building positive feedback.

> *You started thinking correctly, you just calculated it wrong.*
>
> (teacher, Poland)

Praising small successes: The greatest value for teachers is not spectacular successes, but **the small daily progress of their students** – moments when someone "understands" or "begins to believe in themselves" for the first time.

> *(...) emphasizing that they did better on the next task than on the previous one, that they have learned something more, but still need to work a little harder.*
>
> (teacher, Poland)

Group work: Several teachers said that working in pairs or small groups helps students feel less embarrassed about not knowing something. It encourages them to ask each other questions, share ideas, and feel more supported.

Perception Limitations – Low Concentration Span, Rapid Discouragement, Difficulty Assimilating Larger Amounts of Material

Country: Poland, Spain, the Netherlands

Description:

Perception limitations refer to cognitive and attentional barriers that make learning mathematics more difficult for some students. They include a low concentration span, rapid discouragement when facing complex or unfamiliar problems, and difficulty assimilating larger amounts of material at once.

> *Asking to go to the toilet three times per lesson. Seeking confirmation from the teacher at every turn. Seeking a great deal of extra attention. Or, conversely, disappearing completely. Even negative attention is welcome, as long as it is not about mathematics itself. Crying during tests. Fear of taking a test because they think the teacher will mark it (extra) strictly.*
>
> (teacher, the Netherlands)

Dutch teachers mention that during math lessons, some students show a clear pattern of avoidance and seeking reassurance. They may ask to go to the toilet, sometimes several times in one lesson, pause at every step to seek the teacher's confirmation, or demand a great deal of extra attention; others fade into the background and try not to be seen. Any interaction that isn't about mathematics feels safer, even negative attention. Tests can trigger tears or outright fear, fueled by the belief that the teacher will grade them (extra) strictly.

Such limitations often lead to fragmented understanding – students may remember procedures but fail to grasp underlying concepts. These difficulties can be intensified by fast-paced instruction, abstract teaching methods, or a lack of individual support.

One of the most frequently mentioned challenges in the interviews in all three countries is the low concentration levels of students. Some students can only concentrate on a task for a few minutes. Students need to be kept busy all the time to maintain their attention.

> *You really have to have a high energy level all the time, because when I'm tired, nothing works. I see it, I think it depends a lot on the teacher, because to keep the students' attention, you have to speak in a certain way that grabs their attention. If I sit down at my desk for three minutes for some reason, I completely lose their attention.*
>
> (teacher, Poland)

When students start working, they often seem to improvise without a plan. They do not work systematically. This makes it difficult for them to work independently.

> *These students have such a deficit of attention. They are unable to really concentrate for longer, so everything has to be fast, keeping them engaged all the time, with new information, new and new, and constant stimuli, because it's not possible to just sit down and work for 15 minutes. There's no way. They work for three minutes and then they're done.*
>
> (teacher, Poland)

Spanish students are used to constant distractions and being on their phones – it's difficult to keep them focused. That's also why some teachers decide to avoid using technology during math class altogether – they find it is easier when students don't have additional screens as they add to their general lack of attention.

Although Spain scored highly in PISA for the students' tendency to check their work for mistakes (70.4%), vocational training teachers offer a different perspective. Many report that their students often lack patience and struggle with concentration. When completing exams or assignments, it's rare for them to review their answers or double-check their work.

The above-mentioned challenges often result in students quickly becoming bored and distracted.

> *I think it was one of the most difficult moments in the beginning of my career: a student looked at me, bored, completely out of it, and asked: How long will you talk like this?*
>
> (teacher, Spain)

Teachers know that some of the more advanced topics cannot be covered due to the students' poor math skills and limited time, so they have to make choices about what to teach. In Poland and Spain, they often **teach the absolute basics**:

> *And in these vocational classes, it is important that they learn something. (...) that they know how to use a calculator, because sometimes it is a problem to calculate even simple things. In geometry, they have to be able to distinguish between area and perimeter. (...) If there is a rate per square meter, then you have to be able to calculate it so that it makes sense, not the way I think it does.*
>
> (teacher, Poland)

This approach to the material is facilitated by the fact that teachers do not feel the pressure of final exams (in FB Básica, there are no final exams, while in vocational schools in Poland, they only take place after the second stage and are usually not taken).

Examples of Positive Impact Opportunities:

Developing good learning habits: A Spanish teacher shared a strategy she uses to encourage better habits: she doesn't allow students to hand in their work before the end of the class, nor does she let them move on to other activities. As a result, students often end up rereading their answers simply out of boredom – and sometimes, that's when they start to notice and correct their mistakes.

Using mindfulness & focus techniques: A few teachers include meditation or relaxation exercises to help students manage stress and regain focus during class. One teacher even described a meditation-based exercise designed to help students improve mental calculation skills by combining calm breathing with simple math tasks.

Limiting theory and lecture-based teaching: Traditional secondary school methods – like 50-minute lectures – simply don't work in VT. Repeating them only leads to the same failures. All the teachers noted that they deliberately keep theoretical explanations to a strict minimum because most students struggle to stay focused for more than 10-15 minutes. Several teachers pointed out the need to switch up tasks, especially for students with attention difficulties, in order to keep them engaged.

> *It's true that they just stop listening after some time. It's best to show them how things are done.*
>
> (teacher, Spain)

At the same time, they stress that it's important not to go too far and emphasize the importance of having a clear, predictable lesson structure so that students know what to expect and feel secure in the classroom routine.

Adapting lesson structures to the needs of students: Short segments, lots of repetition, and a mix of theory and practice. In classes with more guidance (such as FP Básica or vocational schools), flexibility is essential because the energy, focus, and emotional state of students can vary greatly from day to day.

Connecting mathematics to real life: Teachers often use real-life scenarios – like running a restaurant or finding an apartment – to teach math, planning, and decision-making skills. One of the experts highlighted that nearly all strong FP programs rely on real-world projects because they bridge the gap between abstract knowledge and everyday needs. The system itself encourages teachers to focus on what students will actually encounter once they enter the workforce.

Using active methods: All the teachers interviewed in the Netherlands agree that the Building Thinking Classrooms method works very well in the classroom. This method involves thinking about the layout of the classroom and the pedagogy used. Some examples of how this is applied are working in groups on whiteboards. The fact that students can erase something themselves and start over contributes to their self-confidence, which makes them dare to make mistakes. However, it is also true that this takes a lot of time and is not always applicable. That is why the direct instruction model is mainly used, in which the lesson is structured in a predictable way.

> *I use Building Thinking Classrooms. It encourages independent thinking and the students love it.*
>
> (teacher, the Netherlands)

Dutch teachers mention modeling and understanding the problem (context) yourself. Creating a mathematical question yourself and then turning it into a math problem.. Providing context creates a form of creativity and self-control. Inquiry-based learning can help with discovery. Teachers also emphasize that it must be structured. The zone of proximal development is extremely important here.

Mixing different methods: Teachers highlight the importance of combining direct instruction with inquiry-based learning. While direct instruction is faster and more efficient, inquiry-based approaches foster deeper, more sustainable understanding and problem-solving skills.

Cognitive Problems, e.g., Dyscalculia and Low Educational Competence

Countries: Poland, the Netherlands, Spain

Description:

Cognitive problems refer to individual learning difficulties that directly affect the ability to understand and process mathematical information. They include conditions such as **dyscalculia and generally low educational competence**, often reinforced by cumulative learning at earlier stages of education. These barriers make it challenging for students in all three countries to follow standard curricula and acquire new mathematical concepts at the expected pace.

> *Another thing affecting a fairly large group of students is intellectual abilities.*
>
> (teacher, Poland)

> *In these classes, I don't have many really smart people. The smart ones are exceptions; out of thirty pairs, let's say four or five are good at math, a few are doing okay, and the rest have problems.*
>
> *(teacher, Poland)*

The Spanish teacher emphasized that the issues students face – including disabilities, learning difficulties, or psychological challenges – are varied and, due to limited support in their environment, are not always properly diagnosed or addressed.

> *On top of that, you have students with a range of educational needs: ADHD, which has been visible in many classes, and there are cases of undiagnosed dyslexia and dysgraphia. How do you discover them? You notice it when they start writing numbers backward, for example – but I had to learn what these things are myself, since I'm not a guidance counselor.*
>
> (Teacher, Spain)

The way lessons are conducted often does not allow for the development of cause-and-effect thinking skills. In the Netherlands, 95% of teaching is direct instruction. A typical math lesson is *monkey see, monkey do*. This is a good way to convey instrumental knowledge (purely mathematical) but relational understanding is not developed in this way.

Examples of Positive Impact Opportunities:

Individual educational support: As (the student) says, maybe I could understand it if I knew what it was about. "Come to my office. Tomorrow I have a free period when I'll probably be sitting there alone, and if we don't have any assignments from the principal, we'll do something." I'm trying to help. (teacher, Poland)

Most teachers interviewed in Spain say that they **focus more on the process than just the final answer**. If they see that a student's reasoning and logic are correct, they will often give partial credit for the task, even if the final result is wrong. This approach is important because many students tend to rely too much on memorization instead of really understanding how things work. By rewarding good reasoning, teachers hope to help students develop more independent and critical thinking skills.

Hands-on, project-based learning: Students grasp concepts more quickly and remember them better when they can manipulate or experience things directly.

The direct instruction model: Dutch teachers mentioned that most of the lessons (three out of four of them) follow a direct instruction model. This means that lessons are very predictable for students. This model ensures that teaching is largely teacher-led. However this predictability and teaching method also means that lessons can become boring.

Using simple language that is understandable and relevant to the students.

A practical approach, topics closely related to "real life": "Real" practical contexts increase the students' interest and are more effective educationally. Students engage in tasks that relate to real life. Contexts must be rooted in contemporary realities and contribute new knowledge. It is important to treat students as adults and not to infantilize the issues. It doesn't always have to be directly related to future jobs; sometimes it's just about linking lessons to things that students care about. For example, one teacher shared that he used the story of a Spanish nutritionist who overcame a gambling addiction and almost sold a kidney to pay off his debts. By sharing this story, he made lessons about money management real and relevant, especially since he noticed that many students mistakenly believe that gambling is an easy way to make money.

> *It's also essential to explain the usefulness of what they're learning. For example, there's a student who usually struggles with the subject, but recently told me he managed to apply those skills at the restaurant. He's only been here for 10 months and comes from Peru, but he was able to use what he learned to organize the restaurant's inventory.*
>
> (teacher, Spain)

Students' Attitude – the Approach that Math is Not for Me

Countries: Poland, the Netherlands, Spain

Description:

This approach represents a deeply rooted mindset in which students see mathematics as a subject reserved for the naturally gifted. This attitude often stems from early failures, negative feedback, or cultural stereotypes suggesting that mathematical ability is innate rather than developed through practice. As a result, students disengage, avoid effort, and interpret difficulties as proof of incapability rather than part of the learning process.

> *Most students who come to math class immediately assume that they can't do it, don't like it, and that it's the worst subject ever.*
>
> (teacher, Poland)

> *The biggest challenge is helping students overcome their own low expectations because they come with a mindset like, "I don't know, I never have, and I never will." Breaking through that barrier takes almost two months of work, telling them, "I don't want to hear that anymore, come on, try."*
>
> (teacher, Spain)

> *Some pupils have a negative mindset and say, "I can't do this" or "I'm no good at this". Sometimes it gets so bad that they put their heads on the table or start crying.*
>
> (teacher, Netherlands)

Sometimes students explain their lack of mathematical skills by pointing out their aptitude in other subjects. They believe that this exempts them from having to learn mathematics.

> *(...) if the attitude is "I'm not good at math because I'm a humanist," then nothing will come of it. I then repeat a phrase I've heard many times before: not knowing math does not make one a humanist.*
>
> (teacher, Poland)

Examples of Positive Impact Opportunities:

"Taming" mathematics through the implementation of gamification methods: Teachers use various activating techniques, such as individual work at the board with the student, leading questions, joint analysis of errors, the use of multimedia boards, working with worksheets, the use of solid models, working in pairs, brainstorming, the random selection of students to answer questions, educational games, programs such as GeoGebra and Khan Academy, and searching for real-life contexts by giving examples from everyday life. Many students who normally struggle get motivated when there's a game element and a sense of winning.

Longer project-based activities – such as the "My Company" project mentioned by Spanish teachers, where students simulate step by step how to open and run a business – tend to keep students more engaged and help them see the practical use of what they're learning.

The new curriculum (LOMLOE) in Spain now includes the importance of including the socio-affective sense in teaching mathematics:[18]

"The socio-affective sense integrates knowledge, skills, and attitudes to understand and manage emotions, set and achieve goals, and increase the ability to make responsible and informed decisions. This aims to improve student performance in mathematics, reduce negative attitudes to the subject, promote active learning, and eradicate preconceived ideas related to gender or the myth that innate talent is essential. To achieve these objectives, strategies can be developed, such as highlighting the role of women in mathematics throughout history and in the present, normalizing mistakes as part of the learning process, encouraging equitable dialogue, and promoting non-competitive activities in the classroom. The basic knowledge corresponding to this sense should be developed explicitly throughout the entire curriculum."

The Need for Abstract Thinking Arises in School Before Cognitive Competence Develops

Country: Poland, the Netherlands, Spain,

Description:

Pupils lack perseverance, often because they lost the abstraction element somewhere during their education. At that point, they were not yet ready to learn something with that level of abstraction. But if they pick up a book from years ago, they will probably be able to do so now. Pupils are often required to learn something at too young an age. Abstraction does

[18] See in: LOMLOE – Currículo básico de Matemáticas, Educación Primaria, Ministerio de Educación y Formación Profesional de España, sekcja Sentido socioafectivo, https://educagob.educacionfpydeportes.gob.es/curriculo/curriculo-lomloe/menu-curriculos-basicos/ed-primaria/areas/matematicas.html.

not come from learning tricks. In mathematics education in the Netherlands, it is said that abstraction is present in the teaching method, but this is often not sufficiently the case.

> *The main difficulties arise when students reach algebra. Many students find it hard to operate conceptually with whole numbers, to understand what a negative number really means, or to grasp the ideas behind proportions, percentages, and fractions.*
>
> (teacher, the Netherlands)

> *Because they memorize it, but don't internalize or fully understand it. As I've said, sometimes it's also a matter of age. I've noticed, for example, that our students' capacity for abstraction – needed for algebra and certain concepts – has increased with age. What 12-year-olds could grasp before, 14-year-olds sometimes still struggle with now. This is supported by studies showing that brain maturation in the area responsible for abstract thinking, which is fundamental for mathematics, is occurring later.*
>
> (teacher, Spain)

Examples of Positive Impact Opportunities:

Building the ability to draw conclusions and make generalizations from the earliest stages of education:

> *When teachers think about combinatorics, they think of eighth grade or high school, but I think it's kindergarten, grades 1-3. Such tasks build mathematical resourcefulness – for example, if I meet three people in the park, how many handshakes will there be? In high school, you learn the formula for this, but in kindergarten, you can experiment with it. The difficulty lies in understanding that there are four people involved, not three. It's about building understanding, not mechanical counting. At each stage, you can get something more out of such a task, up to the level of generalization.*
>
> (expert, Poland)

Psychological Barriers	Examples of positive impact opportunities
Low self-esteem and self-confidence	Creating a safe and open classroom atmosphere
	Feedback loop
	Praising small successes
	group work

Psychological Barriers	Examples of positive impact opportunities
Perception limitations	Connecting mathematics to real life
	Using mindfulness & focus technics
	Limiting theory and lecture-based teaching
	Developing good learning habits
	Adapting lesson structure
	Using active methods
Cognitive problems	Individual educational support
	Focus more on the process than just the final answer
	Hands-on, project-based learning
	A practical approach
	Using simple language
	Using the direct instruction model
The need for abstract thinking arises in school before cognitive competence develops	Building the ability to draw conclusions and make generalizations from the earliest stages of education

Phenomena Related to Psychological Barriers

Certain phenomena, such as fear of mathematics and motivation, are not treated as separate barriers in this report. Instead, they are understood as multidimensional constructs composed of many interrelated psychological factors, including self-esteem and self-efficacy, as well as the consequences of broader biographical, social, cultural, and environmental influences.

Math Anxiety

Fear of mathematics manifests itself in uncertainty, avoiding solving problems at the blackboard, trying not to draw the teacher's attention with one's behavior in class, or the need to repeatedly confirm the correctness of a solution.

Dutch research[19] describes how math anxiety is characterized by negative feelings, physical stress reactions, and avoidance or compensatory behavior when students are confronted with math problems.[20] There is a clear negative relationship between anxiety and performance, but the direction is unclear: low performance can reinforce anxiety, while anxiety also undermines performance. This often leads to a vicious circle.

The causes lie both in personal predisposition (such as cognitive skills and genetic components) and in environmental factors, including parents and teachers who themselves experience anxiety or convey negative beliefs about mathematics. Social ideas, such as the belief that mathematics requires innate talent, also play a role.

[19] Janssen, B. (2023). Angst en falen houden elkaar in de greep bij rekenen en wiskunde. Volgens Bartjens, vol. 42, #4, 2023, https://www.volgens-bartjens.nl/media/6/vboo42_04_02_jansen_maart2023.pdf.

[20] Similar approach to math anxiety present Polish researchers. Szczygieł, M., Bażela, N., Knopik, T. (2025). "Lęk przed matematyką – charakterystyka, uwarunkowania, interwencje". Instytut Badań Edukacyjnych – Państwowy Instytut Badawczy (FERS.01.06-IP.05-0002/23). CC-BY 4.0. Source: https://ibe.edu.pl/images/BIBLIOTEKA/WDEDU/lek-przed-matematyka.pdf, accessed: 12.11.2025

Students react differently: some avoid the subject, while others spend an excessive amount of time practicing. Motivation and mindset appear to be crucial: intrinsic motivation and a growth mindset protect against the negative effects of anxiety, while extrinsic motivation is more often associated with increased anxiety.

Interventions focus on both reducing anxiety (e.g., through reappraisal, writing about feelings, systematic desensitization, or encouraging a growth mindset) and improving arithmetic and math skills (remediation or adaptive computer programs). Test design can also help, such as by starting with simple tasks or giving more autonomy.

Teachers play a key role in prevention and treatment. Teacher sensitivity – recognizing and responding appropriately to learning problems and emotions – has been shown to reduce the likelihood of math anxiety in students. However, scientific research on effective teacher strategies is still limited.

> *All teaching is an addition to raising them well, so that they are healthy and do not harm themselves mentally.*
>
> (teacher, Poland)

In conclusion, arithmetic and math anxiety are persistent phenomena that negatively affect performance, but with targeted interventions and sensitive guidance, students can learn to regulate anxiety and build successful experiences.

Motivation

The issue of motivation is often simplified in discourse surrounding school and treated as an obstacle to learning. However, it is a much more complex issue related to psychological aspects (such as low self-esteem), biographical aspects (e.g., education not being valued in the student's environment), and economic aspects (lack of prospects for well-paid work, regardless of academic performance).

The Spanish study[21] shows a negative correlation between resilience and anxiety: the more resilient students are, the less anxiety they experience about mathematics. In contrast, there is a positive correlation between anxiety and motivation: the stronger the anxiety, the less motivation students feel to continue learning.

The study highlights several aspects that have a direct impact on the mathematical learning experience of adolescents:

Classroom climate: The atmosphere in the classroom is crucial because it influences the students' levels of interest, enthusiasm, commitment, and motivation. Teachers should therefore create a learning environment that promotes comfort, trust, and good

[21] Trigueros, R., Aguilar-Parra, J. M., Mercader, I., Fernández-Campoy, J. M., & Carrión, J. (2020). Set the controls for the heart of the maths. The protective factor of resilience in the face of mathematical anxiety. Mathematics, 8(10), 1660. https://doi.org/10.3390/math8101660, accessed: 25.10.2025

relationships between students and with the teacher. This requires the teacher to be approachable rather than distant or intimidating, to be understanding of the students' mistakes and doubts, and to actively interact with the class.

Autonomy and ownership: Learning environments should focus on promoting autonomy rather than external control. When learning takes place through teaching methods that encourage adolescent participation, their sense of self-determination and their ability to overcome difficulties in the learning process increase.

Testing practices: Tests should be more closely aligned with the actual content covered in class. Additional challenges or unexpected tests unnecessarily increase the students' stress levels.

Education policy: In terms of policy, mathematics education should focus on applying mathematics in a variety of situations and contexts. This not only contributes to literacy, but also to the sustainable development of mathematical competencies.

The research indicates that various methodologies are already available that can be used in the classroom, such as gamification and the flipped classroom. These offer students a "playful challenge" that maintains their interest, promotes the consolidation of knowledge, and supports the assimilation of learning content.

As previously mentioned, students often lack the motivation to learn things they consider useless for their future careers. Even if professional contexts sometimes arise, they are often out of date or **artificially created**, because this is not how things are done "in real life". Low motivation is also often linked to the boredom that students feel in class:

> *(...) once, for example, I gave them the task of calculating how much paint is needed to paint a room, (and a student said to me), "Miss, I don't know who would count that; you buy a bucket, and then you buy another one at most, and that's it."*
>
> (teacher, Poland)

> *(...) I don't think they come specifically for knowledge. They come because they have to, they go because they are on work experience. They come to school because they have to go to school, not to learn something specific.*
>
> (teacher, Poland)

> *If the pupil is simply not motivated, if it is a very difficult subject – difficult in terms of framework: enlargement and scale, abstract algebra, solving equations – then you lose them. If there is a story/context, then it works, otherwise it becomes difficult and you lose them.*
>
> (teacher, the Netherlands)

Students, especially in vocational school, also indicate that they do not need mathematics. This sometimes goes so far that they stay away from classes as soon as they have achieved enough to move on to the next grade.

Fear of mathematics and low motivation are multidimensional phenomena. They are the end result of an accumulation of psychological factors (low self-esteem, low self-efficacy), social factors (negative beliefs about mathematics as a talent), and environmental factors (an atmosphere that is not conducive to learning in the classroom and school) and influence each other. Overcoming fear and increasing motivation not only requires interventions focused on mathematical skills, but above all a change of perspective. Possible actions should aim to build a positive climate in the classroom and school that promotes autonomy and eliminates stress, supporting students in the learning process. On the other hand, the substantive aspect seems important – adapting the curriculum content to the challenges young people face in their private and professional lives.

Environmental Barriers (School/Class Level)

In this report, environmental barriers are understood to be obstacles resulting from the immediate conditions in which the student functions. They are not systemic in nature, but are related to the work culture of the school and classroom, the prevailing beliefs about learning, and the attitudes to the subject. They also include organizational and material aspects, such as learning conditions and noise levels.

Unpredictable Classroom Dynamic / Classroom Management Challenges

Country: Poland, Spain

Description:

One of the biggest challenges teachers face – especially when they have just started teaching – is learning to adjust their expectations. Often, they can't deliver a lesson exactly as planned. This isn't just because they need to backtrack and fill gaps in the students' knowledge, but also because the classroom dynamic can be unpredictable.

> *(...) they show off in front of each other. Sometimes they ostentatiously refuse to work. They want to have fun; they want to eat and drink during class.*
>
> (teacher, Poland)

With some groups, they might get through an entire lesson in one day and make no progress the next because of behavioral issues or lack of cooperation. This forces teachers to stay very alert and flexible. If they see that something isn't working, they quickly adapt, changing the context, introducing a debate to address what's on the students' minds, or switching activities altogether.

Some teachers agree that their work is emotionally demanding, as students can sometimes be disruptive or even hurtful. Handling this requires preparation and support that they often don't have.

> *Imagine, it's as if you gather struggling and disruptive students from all the classrooms in one place.*
>
> (teacher, Spain)

> *You always have to have that flexibility in education, because you never know – **if behaviorally it's not the right moment**. If there was a big conflict in the previous session, maybe it's not the time for theory, but rather to work differently. Or maybe it is a moment to work in groups, or individually and separated, **trying to calm things down**. Or, on the contrary, if they're a **bit too restless, then we'll work in pairs on something else so they can talk, because silence would be unmanageable here**.*
>
> (teacher, Spain)

This barrier was not directly mentioned in the Dutch interviews. Nevertheless, classroom management is certainly a challenge for new teachers.

Class Work Culture

Much depends on the attitude of the students in the class. If the majority of the class shows boredom or disregard, it will be difficult for the few individuals who are interested in what is happening in the lesson to make themselves heard.

> *However, I think that when it comes to challenges, it's probably more independence and less interference, fewer demands, a little more giving. Because that's probably the problem with young people. They don't want to give much of themselves.*
>
> (teacher, Poland)

> *It's great in technical schools – it works really well. In other classes, you have to pull these students out, because they look down on those who do things at home.*
>
> (teacher, Poland)

Examples of Positive Impact Opportunities:

- work on teacher-student and student-student relationships by creating an atmosphere of learning from mistakes

A Spanish study[22] shows a positive correlation between anxiety and motivation: the stronger the anxiety, the less motivation students feel to continue learning.

This study highlights several aspects that have a direct impact on the mathematical learning experience of adolescents. One of them is the classroom climate: the atmosphere in the classroom is crucial because it influences the students' levels of interest, enthusiasm, commitment, and motivation. Teachers should therefore create a learning environment that promotes comfort, trust, and good relationships between students and with the teacher. This requires the teacher to be approachable rather than distant or intimidating, to be understanding of mistakes and doubts, and to actively interact with the class.

[22] Trigueros, R., Aguilar-Parra, J. M., Mercader, I., Fernández-Campoy, J. M., & Carrión, J. (2020). Set the controls for the heart of the maths. The protective factor of resilience in the face of mathematical anxiety. Mathematics, 8(10), 1660. https://doi.org/10.3390/math8101660 (access 17.11.2025)

Teachers try to build relationships based on trust, thereby creating a safe atmosphere. In this, it is important that everything is done to make everyone feel welcome. Making mistakes is used as an encouragement to learn. This reinforces learning with positive feedback and celebrates small successes. Even when a small mistake is made, teachers try to emphasize the positive side.

> *Mistakes are there to teach us something, not to discourage us. We make mistakes so that we remember not to do something, and sometimes we have to make the same mistake more than once, but the point is that we learn that this is not the right way to do things.*
>
> (teacher, Poland)

Teachers also ensure a calm atmosphere in classes, do not allow laughter at other students, and do not judge mistakes harshly – they generally try to mitigate the stress resulting from other people's evaluations.

They also work to create a safe environment by immediately addressing any mocking or negative comments from other students, reinforcing a respectful classroom culture.

Environmental Barriers (School/Class Level)	**Examples of positive impact opportunities**
Unpredictable classroom dynamics / classroom management challenges	Possible actions are described in more detail in the chapters on psychological barriers, as classroom culture and dynamics stem from attitudes, emotions, and beliefs, and are therefore psychological in nature, which justifies further analysis in this context. Examples of positive impact opportunities: • developing teacher flexibility and adaptive teaching skills • limiting theory and lecture-based teaching • creating a safe and open classroom atmosphere • focus more on the process than just the final answer • hands-on, project-based learning
Class work culture	

Institutional and Systemic Barriers

In this report, institutional and systemic barriers to learning and teaching mathematics are defined as obstacles that do not stem from the individual characteristics of students or teachers, but from the way the education system and schools are organized. They are structural in nature and relate to the rules, curricula, work organization, and institutional resources.

These barriers affect the functioning of students in technical and vocational schools and their attitude toward mathematics, and changing them is not going to be possible through individual actions. Teachers try in various ways to cope with the limitations imposed by systemic barriers. They have to find a balance between what they are required to do (implementing the core curriculum), the limited time, and what makes the most sense for individual students.

Positive impact opportunities can come from various sources, not only from systemic and institutional measures, which are often slow to implement and sometimes even impossible. In such situations, teachers draw on their own resources – time, commitment, and creativity – to overcome these barriers. This is the case, for example, when teachers prepare their own materials because the textbooks are not good enough. Sometimes their actions consist of choosing the best of a set of bad options. This is the case, for example, with the curriculum of vocational schools, which is not tailored to the needs of students. Teachers adapt the curriculum, teaching what is necessary and abandoning more abstract topics in favor of those related to the lives and experiences of their students.

No good solutions have been found for some of the barriers, either in desk research or in discussions with teachers. We leave them as an open topic for further exploration.

Topics Too Difficult for Vocational Schools, Not Suited to the Competences and Abilities of Students, and an Insufficient Number of Hours

Country: Poland, Spain, Netherlands

Description:

In Poland, the curriculum at vocational schools is designed to prepare students for the high school leaving exam:

> *These things are useful if they continue their education, but they are not useful for vocational exams or work. Education is geared toward continuing education.*
>
> (teacher, Poland)

According to a 2024 report by the Polish Supreme Audit Office,[23] only about 6% of first-level vocational school students continue their education at a second-level vocational school. According to data from the Central Examination Board, **17.4%** of second-level vocational school graduates passed the mathematics exam in 2024. In August, **26.7%** of examinees from these schools were entitled to retake the exam. Nearly **60%** of graduates of second-level vocational schools failed the exam altogether (they were not entitled to retake it or did not take it).

Teachers are well aware that the lack of deep reflection on the core curriculum means that students learn about issues that they will not need in their further education or professional work. Often, these are issues that are beyond their cognitive abilities to understand.

> *Trigonometric functions, on the other hand, are not necessarily required. I shouldn't say this because I have to teach them, but I simply don't do it because I consider it unnecessary.*
>
> (teacher, Poland)

> *They (...) will learn all these quadratic functions, sines, and cosines, things they will never use later in life.*
>
> (teacher, Poland)

[23] Najwyższa Izba Kontroli, Szkolnictwo Zawodowe. Wyniki kontroli https://www.nik.gov.pl/plik/id,29659,vp,32517.pdf, accessed: 25.10.2025

The inadequacy of the core curriculum is also accompanied by an insufficient number of mathematics lessons:

- In vocational schools in Poland, there are two lessons in the first grade and one or two in the second and third grade. In technical schools, the distribution of math lessons may be uneven between the different years of study.
- In *FP Basica* in Spain, there are only two hours of math per week, which makes it almost impossible for teachers to cover the entire curriculum.

One teacher described it as a:

> *survival way of teaching: you do as much as you can, but you'll never cover everything.*
>
> (teacher, Spain)

In Poland, another significant obstacle is **breaks in teaching due to practical training**:

- *technical schools* have a month of practical training per year and vocational exams
- *vocational schools* – vocational courses (the biggest challenge for teachers is multi-vocational classes, where each profession has a course at a different time).

Students are excused from classes, which creates gaps in their knowledge that are difficult to make up for with the small number of math lessons.

> *The worst are internships – I know they have to learn a profession, but because I have students from different professions in my class, I always have some absences... sometimes 3 students are missing, then another 5, then another 20. I'm always missing someone, and it's hard to conduct lessons this way. And they can't catch up later.*
>
> (teacher, Poland).

Examples of Positive Impact Opportunities

The possible courses of action here are beyond the influence of teachers. Positive impact opportunities in this area lie mostly in advocacy activities and changes introduced by policymakers at both the local and national levels. However, the challenge is so great that teachers have to adopt some strategies to deal with it.

Teachers Strategies

In Poland, teachers have to find a balance between what they are required to do (implementing the core curriculum), the limited time, and what makes the most sense for individual students. The teachers are well aware that the lack of deep reflection on the core curriculum means that students learn about issues that they will not need in their further education or professional work. Often, these are issues that are beyond their cognitive abilities to understand.

In Spain, since teachers know they won't be able to cover the entire curriculum and there are usually no high-stakes exams or strong parental pressure, **they can prioritize what they think will benefit the students most**.

Thanks to this flexibility, teachers often use math classes not only to teach mathematical content but also to fill broader gaps in the students' education. Sometimes, this is directly related to math, such as showing how it can support critical thinking, help interpret history, or make informed decisions.

However, it often goes beyond that. Since many students struggle with writing or expressing themselves verbally, teachers may ask them to copy texts to improve focus or assign short presentations to build public speaking skills. They try to prioritize what will be useful for students in everyday adult life and the workplace.

> *Sometimes I think, damn, these poor kids are going to a company or starting a job in the future and they don't know anything. They don't even know where the sun rises or sets, how many planets there are... Sometimes, almost ironically and with some exaggeration, there are students who can't even locate their own country or the city they live in on a map. So, there's a real difficulty.*
>
> (teacher, Spain)

The Lack of Good Textbooks or Students Without Books

Country: Poland, Spain, Netherlands

Description:

Teachers in all three countries indicate that good textbooks for this target group are often lacking, and they therefore often develop a lot of teaching materials themselves.

Problems with school resources were underlined in the Diagnostic Study on the Situation of Mathematical Competence in Spain done by the Comisión de Educación Comité Español de Matemáticas (CEMat) in 2024.[24]

This report highlights the inadequate quality of many educational resources for students and teachers in Spain. While there are numerous resources, they often lack mathematical accuracy and didactic structure. This issue is compounded by the insufficient training of teachers in didactics and mathematics. Students often resort to online resources that focus on procedural knowledge rather than conceptual understanding, leading to "self-medication". Textbooks, which are widely used, often fail to promote deeper mathematical competence and are not always aligned with the current curriculum.

In FP Básica in Spain, there are **no textbooks specifically designed for this student profile**. Teachers often rely on ESO or Bachillerato books and adapt the content to their students' needs. When it comes to vocational subjects that include mathematics, the available **textbooks tend to use outdated examples**.

> *I'll also tell you that within the Spanish education system – which I know well from being a director – this stage is the most neglected by the administration. On the one hand, we don't have basic pedagogical resources like other educational levels do.*

[24] Estudio diagnóstico sobre la situación en competencia matemática en España (2024), CEMat, https://gestion.sema.t2v.com/Documentos/Fotos/0/3/9/2/noticia_fichero_392-ficheros-1718891132-73971900-85684.pdf.

> *I've had to fight with publishers to get updated textbooks; it seems they just don't produce them for this stage. Some even say, "No, we don't have materials for basic vocational training." But please, it's a part of the education system! There are no materials or resources available.*
>
> (teacher, Spain)

> *They need more tools for everyday life, and the theory in the textbooks and what exists today has become very outdated.*
>
> (teacher, Spain)

In Poland, students often do not even have or want to carry textbooks:

> *(...) in vocational schools, it can be difficult with these textbooks because not all students want to carry them. (...) Besides, you have to buy the textbooks and they cost quite a lot, although you can buy used ones. And you have to remember about them.*
>
> (teacher, Poland)

In the Netherlands, there are teaching methods for mathematics in secondary education. For vocational education, these are scarce or non-existent. Teachers are therefore left to their own devices and have to develop a lot of the material themselves. Even if the materials exist, they often do not match the context or the students' everyday lives.

Examples of Positive Impact Opportunities

In Spain, teachers frequently **update textbook materials by creating more relevant and engaging scenarios** – some even use AI tools to generate new exercises. Teachers prepare their own materials, building a kind of **'collage' from textbooks, online resources, and materials shared by colleagues**. The more experienced a teacher is, the less time they usually need for new preparation, but they still make an effort to keep the materials fresh and up to date.

The Low Status of Mathematics in Vocational Schools

Country: Poland

Description:

In Poland, general subjects (including mathematics) in technical and vocational schools (*szkoły techniczne i szkoły branżowe*) are considered less important than vocational ones. According to the interviews conducted, this is the opinion of both the school management and the teachers, as well as the students themselves.

> *(...) we have to focus on vocational subjects. Almost half of the lesson plan consists of vocational subjects. And there are a lot of them. When I started in the first grade, even with the current class, there were only two hours of math per week. That's how the schedule was made.*
>
> (teacher, Poland)

As a result of the subject's low status, as well as shortages of premises and personnel, mathematics is sometimes placed at the end of the school day, when the students are tired and find it more difficult to process information.

> *It also happens that I am responsible for the timetable for the entire school, so it is easier for me to make sure that math is scheduled before the sixth lesson and not later, because they can't think after that. But it's also true, especially two years ago, that we worked in shifts, so math was sometimes actually at 3 or 4 p.m., because they came to school at noon. That makes it harder to work.*
>
> (teacher, Poland)

Examples of Positive Impact Opportunities

There is some hope for increasing the role of mathematics, including in technical schools, given that it has been a **compulsory subject in the high school graduation exam**. This leads to an increase in external motivation, as some students may consider mathematics not only useful in their studies, but also crucial in the recruitment process, particularly for technical fields of study.

> *(...) these exams at the end motivate them a little, but they are not motivated by the fact that it is cool to know something. I have the impression that there are few individuals who want to learn just for the sake of knowing. Rather, it is the external exam that motivates them to work.*
>
> (teacher, Poland)

Uncoordinated Core Curricula and Subject Plans

Country: Poland

Description:

This barrier only occurs in Poland.

In Poland, vocational and general subjects are usually taught independently and without much coordination. If there is cooperation, it is due to the willingness of the teachers of both subjects, but it is not required or included in the framework.

Lack of cooperation is particularly evident in vocational schools, where vocational subjects are usually taught in external courses and, above all, during work in companies. There are therefore no organizational possibilities for increasing cooperation between teachers of vocational and general subjects

Examples of Positive Impact Opportunities:

- Strengthening collaboration between general and vocational subject teachers

Although cooperation is not formally required, building stronger links between general and vocational subject teachers could enhance the relevance of mathematics, support interdisciplinary learning, and make teaching more coherent and practical.

> *Perhaps we could sit down together sometime in September and decide on the topics and how to link them to make it easier, but I'm just saying, we usually solve this by asking each other.*
>
> (teacher, Poland)

Teachers Training and Professionalization

Country: Poland, Spain, Netherlands

Description:

In secondary education in Spain, there is a clear shortage of subject-specific training and mentoring, particularly in the early years of a teacher's career. Only 48% of Spanish mathematics teachers in secondary education have a university degree in mathematics. This proportion is significantly lower than in countries with better performance, such as Finland (60%), Estonia (65%), and Ireland (70%).[25] This shortage of specialized personnel contributes to the structural weakness of the system. The problem is exacerbated by the declining influx of mathematics graduates choosing a career in education. The increasing demand for mathematicians in business and industry – particularly for applications in technology, artificial intelligence, and data science – is making careers outside education increasingly attractive and leading to a shift of talent to the private sector.

> *In the Netherlands, many teachers do not have sufficient knowledge to teach inquiry. Many teachers also have a fear of mathematics. Subject knowledge is extremely important. If you only know how to do rows of sums, how will you ever be able to solve this yourself?*
>
> (teacher, the Netherlands)

In Poland, according to data from the 2016 report of the Supreme Audit Office,[26] 97% of the teachers had a master's degree with pedagogical training or a doctoral degree. Since 2019, according to the law, teachers (including mathematics teachers) must have a master's degree in the relevant field or have completed postgraduate studies in teaching the subject.

On the other hand, teacher training and continuing education appear to be inadequate. The emphasis is often on theory, while practical teaching skills are insufficiently addressed. Many teachers resort to traditional, rigid teaching methods, leaving little room for interaction and innovation.

The most common approach in mathematics education in Spain, Poland, and the Netherlands consists of traditional methods: explanation by the teacher, working with textbooks, and doing exercises on the board. Many lessons are dominated by the presentation of the material and practice exercises, often in the form of direct instruction.

[25] Los matemáticos advierten del insuficiente nivel de parte del profesorado que imparte la asignatura, El Pais, https://elpais.com/educacion/2024-09-05/los-matematicos-advierten-del-insuficiente-nivel-de-parte-del-profesorado-que-imparte-la-asignatura.html, based on PISA 2022 results, date of access: 15.10.2025

[26] Najwyższa Izba Kontroli, Raport o stanie matematyki. informacja o wynikach kontroli, https://www.nik.gov.pl/plik/id,20330,vp,22953.pdf, date od acces: 25.10.2025

In the interviews conducted as part of the study, the differences between teachers are apparent – more experienced teachers tend to stick to traditional methods, while younger or recently trained teachers are more likely to use innovative, student-centered strategies, such as gamification, escape rooms, or digital tools.

Teacher Burnout and Discouragement

Country: Poland, the Netherlands

Description:

The results of a study on teacher well-being conducted in early 2023 showed that burnout is a common experience among Polish teachers: 67.5% of respondents feel exhausted, 57.3% feel that their work is meaningless, and 52.5% feel stressed.[27]

> *I am discouraged and burned out, mainly because of the demands of parents, the students' reluctance to learn, and the headmistress I have had to deal with for the last fifteen years, for whom the most important thing was what the parents said, without verifying any of it.*
>
> (teacher, Poland)

In Poland, the average age of the teachers is steadily increasing and, according to data from the Ministry of Education from 2024, is currently 47. According to this data, 66,908 teachers of retirement age were working in schools and educational institutions in 2024, with the oldest being 85.[28]

Although Spanish interviewees mentioned challenges such as workload and classroom management, they generally seemed satisfied with their current situation. Still, it's important to remember the limitations of the study and that burnout and other mental health issues affect many teachers. For instance, a survey by CCOO in Spain found that 49.5% of teachers often or always experience significant emotional exhaustion.[29]

In the Dutch interviews, these challenges are mentioned, but not related to burnout problems. However, burnout symptoms are common among employees in education, especially among teachers. Research by TNO[30] shows that a quarter of primary school (PO) teachers report burnout symptoms, and 34% of secondary school (VO) teachers, compared to 20% across the rest of the Netherlands. The proportion reporting burnout symptoms is also relatively high among other school staff.

[27] M. Paliga, Raport z badania dobrostanu zawodowego nauczycieli, M. Paliga, Librus, Warszawa 2023, https://files.librus.pl/art/23/03/4/Raport_dobrostan_zawodowy_nauczycieli_Librus_marzec2023.pdf, date of access: 15.10.2025

[28] Seniorzy uratowali szkoły. Co dziesiąty nauczyciel jest w wieku emerytalnym - GazetaPrawna.pl, date of access: 25.10.2025

[29] La mitad de los profesores sufre un desgaste emocional significativo por su trabajo | Educación | EL PAÍS, date of access: 25.10.2025

[30] S. van den Heuvel, E. de Vroome Werkdruk in het Onderwijs – 2, https://monitorarbeid.tno.nl/wp-content/uploads/sites/16/2025/04/Werkdruk-in-het-Onderwijs-II.pdf, accessed 25.10.2025

Institutional And Systemic Barriers	Examples of positive impact opportunities
Topics too difficult for vocational schools, not suited to the competences and abilities of the students, and an insufficient number of hours	This barrier should be addressed at the level of advocacy and policymakers, as it is part of the organization of the education system. It is difficult for teachers to address it directly. Teachers cope with this situation by selecting only certain topics that they believe are necessary for students.
Lack of good textbooks or students without books	Update textbook materials by creating more relevant, engaging scenarios.
Low status of mathematics in vocational schools	This barrier seems to be beyond the influence of teachers, as it is part of the organization of the education system. Positive impact opportunities in this area lie mostly in advocacy activities and changes introduced by policymakers on both the local and national levels. The data collected in the research does not allow us to create recommendations for positive impact opportunities for this barrier.
Uncoordinated core curricula and subject plans	Strengthening the collaboration between general and vocational subject teachers.

Summary

Summary

The analysis of barriers indicates clearly that what happens in the previous stages of education is of the greatest importance for the further educational trajectory of technical and vocational school students. This, of course, applies to educational gaps and a lack of mathematical skills, which date back to the earliest years of primary school.[31] However, it turns out that earlier experiences also shape attitudes to mathematics, self-esteem, and self-confidence. The way in which mathematics lessons were conducted influences the students' behavior and attitudes to this subject in subsequent years of education. Complex phenomena such as math anxiety or low motivation often have their roots in the early school years.

The question has to be asked: what can be done at the secondary level when it is clearly not possible to influence what education was like in previous years? The teachers provide the answers. In our interviews, they point to numerous good practices that can be used when looking for positive impact opportunities – areas within the teachers' sphere of influence where they can take action.

It is important to show students situations in which they can succeed, even if it is only a small success, in order to give them a sense of achievement, try to engage them, and not lose the opportunity to continue working with them. Failure to do so can lead to learned helplessness, dropping out of the education system (a very big problem in Spain), and, as a consequence, serious difficulties in later life.

The second important aspect is moving away from theory and toward practical solutions in teaching. These do not always have to be related to the specific profession. Our research shows that it is important for students to be treated like adults. One solution may be to combine topics in class that may be useful to them in everyday life or help explain the complexity of the world, while at the same time conveying mathematical content.

There are few educational interventions or programs aimed at supporting teachers in their work with students in technical and vocational schools that address both educational and psychological issues.

With this in mind, we created the Maths Is Everywhere project. The results of the research will allow the creation of innovative educational materials that combine mathematical content with psychological, pedagogical, and classroom management elements. We believe that this approach can make learning mathematics more than a necessary chore, but rather a preparation for life in the modern world.

[31] Najwyższa Izba Kontroli, Raport o stanie matematyki. informacja o wynikach kontroli, https://www.nik.gov.pl/plik/id,20330,vp,22953.pdf, date od acces: 25.10.2025

Recommended Approach for Math Teaching and Learning

Recommended Approach for Math Teaching and Learning

1. Contextualization of Mathematics

Mathematical materials should be rooted in contexts that feel authentic and relevant to the students. Financial, social, historical, or vocational themes make mathematical concepts tangible and relatable. Educational materials should connect to the students' world – their interests, daily experiences, and cultural backgrounds. Students would like to be treated as adults. Showing how mathematics is used in different areas of life and everyday examples help students recognize the usefulness of the subject. Striking or unusual examples can also provide engaging entry points, as long as they remain meaningful and relatable.

2. Making Purpose, Relevance, and Application Visible

It should be clear to students *why* the topic is important, *how* it applies to real life, and *how* it connects with other subjects or future situations. This clarity helps students see mathematics not as an isolated discipline but as a transferable set of tools. The design should therefore include explicit links to practical applications, interdisciplinary uses, and broader life relevance.

3. Building from the Basics and Supporting Progress for all Students

Materials should guide students step by step, beginning with basic concepts and gradually increasing in complexity to ensure that all students can participate and experience success. This means starting with the basics, breaking down concepts into small, manageable steps, and creating room for mistakes as part of learning. Differentiation has to be embedded in the design, allowing students to work at their own level without creating visible gaps in ability. Building confidence requires opportunities to make mistakes safely, emphasizing understanding over perfection. Small achievements and visible progress foster motivation and counteract math anxiety.

4. Combining Variety With Predictable Structure

Effective educational materials balance variety and structure. Students benefit from diverse tasks – short information blocks, group work, mini-projects, or playful challenges – provided within a predictable and safe framework. A consistent rhythm and clear structure support systematic learning, while short, dynamic activities maintain attention and engagement.

5. Fostering a Safe and Collaborative Learning Environment

A sense of security and belonging is essential for learning. Materials should promote cooperation, peer support, and collective problem-solving. Encouraging collaboration – and rewarding it – strengthens self-confidence and motivation, trust, and a positive emotional connection to mathematics. A playful or gamified approach, such as competitions or escape rooms, can increase engagement, but must be paired with emotional safety – an atmosphere where making mistakes is seen as part of growth.

6. Aligning With the Curriculum but Prioritizing Relevance

Educational materials should fit within the official curriculum to ensure usability for teachers. However, alignment should not mean the rigid coverage of every topic. Instead, focus on what truly supports understanding and real-world application. Connections to real-life challenges can make mathematics more relevant and integrated into the students' broader education. Highlighting interdisciplinary connections and opportunities for critical thinking strengthens both cognitive and practical outcomes.

7. Integrating Socioemotional Dimensions

The socioemotional and cultural dimensions should also be included. Mathematical materials can contribute to the students' socioemotional growth and positive mindset by normalizing mistakes and enabling experiences of success, encouraging persistence, reflection, and cooperation. In this way, mathematics not only becomes a subject to be mastered, but also a means for students to develop self-confidence and motivation.

8. Encouraging Reasoning, Reflection, and Autonomy

Materials should actively engage students in reasoning, explaining their thought processes, and comparing problem-solving strategies. Offering choices – in tasks, methods, or contexts – enhances student autonomy and the ownership of learning. Incorporating reflective moments allows students to see their progress and learning strategies, which strengthens motivation and metacognitive skills.

9. Supporting Teachers With Ready-to-use, Adaptable Materials

For teachers to integrate new materials effectively, they must be easy to use, flexible, and clearly structured. Ready-made lesson formats, examples, and easily adaptable materials reduce preparation time and encourage experimentation. Brief information units help maintain attention and facilitate systematic teaching. Providing concrete, inspiring ideas – such as games, projects, or interdisciplinary activities – may inspire teachers to look for other topics where mathematics intersects with real-life applications.

10. Building Positive Experiences

The designed educational materials should enable students to experience success frequently, even in small steps. Positive feedback, playful learning, and the recognition of effort – not just results – help create a positive learning identity. Mathematics then becomes not merely a subject to master but a space for building confidence, curiosity, and joy in problem-solving.

With this in mind, we created the Maths Is Everywhere project. The results of the research will allow the creation of innovative educational materials that combine mathematical content with psychological, pedagogical, and classroom management elements. We believe that this approach can make learning mathematics more than a necessary chore, but rather a preparation for life in the modern world.

Recommendations for the development of educational materials for maths teaching

Recommendations for the development of educational materials for maths teachin

A number of recommendations for the development of educational materials within the Maths Is Everywhere project resulted from the conducted research. These recommendations are presented below and will guide our subsequent work on the materials.

Back to Basics and Differentiation

Develop materials that make it possible to fall back on basic skills, with clear differentiation so that students can start at their own level and experience progress.

Short Blocks and Structured Flow

Provide a toolbox with short, clear assignments and working methods that match the students' limited attention spans and support a systematic structure.

Context and Career-oriented Examples

Integrate realistic and recognizable contexts, preferably from vocational subjects or the students' everyday lives, to demonstrate the relevance of mathematics.

Safety and Collaboration

Include working methods that encourage collaboration, allow and reward mistakes, and contribute to a safe learning environment in which students can build self-confidence.

Practical and Motivating Themes

Offer themes that connect with the students' lives, such as financial literacy, social issues, and practical projects, so that the applicability is immediately clear.

Innovative Teaching Methods Alongside Direct Instruction

Provide a toolbox with examples of innovative strategies (such as gamification, escape rooms, etc.) that can be easily used alongside traditional instruction.

Support for Teachers

Provide ready-to-use materials, inspiring examples, and formats that teachers can use and adapt, reducing the burden of developing their own materials and encouraging exchange.

Focus on Small Successes and Positive Feedback

Develop assignments and formats that highlight small, achievable steps so that successes can be celebrated and students have positive experiences with mathematics.

Appendix 1

Appendix 1

The interview script

Welcome and Introduction

- **Welcome & Thanks**: *Thank you all for taking the time to join this discussion*. We appreciate your participation and want you to feel comfortable sharing your thoughts.
- **Introduce Moderator & Purpose**: *I am [Name], and I'm part of the project team*. Our project is looking at ways to support vocational and technical school students in successfully using math in practical and everyday contexts. We want them to believe that they can successfully learn math and that there are reasons to do so. I want to understand your experiences and challenges as teachers of math-related subjects, so I can better understand your needs. I learn from you and develop innovative approaches and tools that make math more relevant to everyday life. We believe that showing the practical side of math can make learning more fun and interesting for students. We're here to get **your insights** on these topics, not just what research already says, so we can dive deeper into the reality of teaching math in secondary schools and vocational and technical schools.
- **Session Length & Confidentiality**: This conversation will last about **60 to 120 minutes**. It's completely confidential – nothing you say will be individually reported, and there are no "right" or "wrong" answers. We want you to speak freely about your true experiences and opinions.
- **Recording (If applicable)**: We'd like to record the session just so we don't miss any details. *Is everyone okay with that?* (If yes, proceed with recording.)
- **Participant Introductions**: Before we jump in, let's get to know each other a bit. *Could you each briefly introduce yourself – for example, tell us what you teach, where, and how long you've been teaching?* (Allow each participant to introduce themselves.)

Great, thank you. Now let's get started with our first topic.

Topic 1: Daily Teaching Practice

Introduction:

First, we'd like to talk about your everyday classroom experience. This section explores what a typical day looks like for you as a math teacher and what kinds of activities and strategies fill your daily lessons. We want to understand the **micro-level details** of your teaching practice – what works well in your day-to-day teaching and what challenges might come up regularly.

Questions:

- **Typical Day:** *Can you describe a typical day in your classroom?* For instance, what's the usual flow of a math lesson or a school day for you? What is the topic of this lesson? What materials are you using? Why these ones? What do you like about your job? What's difficult? How do you normally prepare? What's useful?
- **Successful Lesson Example:** *Can you share an example of a lesson that went really well and why you think it was so successful?* What was special about it or the way students responded?
- **Unsuccessful Lesson Example:** *Now, tell us about a time when a lesson didn't go as planned or didn't work out well*. What do you think went wrong, or what were the factors that made it challenging? What was the topic of this lesson?
- **Favorite Topics to Teach:** *Are there certain math topics or parts of the curriculum that you especially **enjoy** teaching?* Why do you enjoy those topics or find them rewarding to teach?
- **Least Favorite Topics:** *On the flip side, are there any topics that you find difficult or **less enjoyable** to teach?* What is it about those topics that makes them challenging for you or your students?

(After discussing daily practice, transition to student motivation.)

Topic 2: Teaching Methods and Innovation

Introduction:

Now let's discuss the teaching methods and tools you use, and where there might be room for new ideas. We want to know what techniques you rely on in the classroom and why, as well as how you learn about new teaching methods. This is also a chance to talk about how you bring innovation into your teaching and how you connect math to real-world contexts. Essentially, how do you teach, and how do you keep your teaching practice fresh and effective?

Questions:

- **Current Methods/Tools**: *What tools or methods do you use regularly in your math classes, and why do you choose those?* (For example, do you often use group work, hands-on activities, digital tools, traditional lectures, etc.?)
- **Common Approaches**: F*rom what you see, what are the most common teaching methods among math teachers (perhaps in your school or generally)?* Do many teachers stick mostly to textbooks and problem sets, or do some use storytelling, real-life examples, projects, games, and so on? Feel free to share any examples you know of.
- **Encouraging Questions**: *How do you know if your students understand the topic? How do you encourage students to ask questions when they don't understand something?* Is there anything you do to make sure students feel comfortable speaking up or saying "I don't get it"?

- **Self-Checking Work**: *How do you know if your students check their own work? What strategies do you use to encourage students to check their own work and catch their mistakes?* For instance, do you have routines or tips that help students review their answers before they finish an exercise?
- **Connecting Concepts**: *In what ways do you help students connect new mathematical concepts to things they've learned before?* Do you deliberately link new topics to prior knowledge or real-life analogies so it sticks better?
- **Active Learning**: *How do you encourage students to take an active role in their learning during your lessons?* (For example, getting them involved in discussions, having them solve problems on the board, peer teaching, etc.)
- **Student Explanations**: *Do you ask students to explain their thought process or how they arrived at a solution during class?* How often do you do this, and what do you find is the benefit when you do?
- **Reflecting on Strategies**: *What techniques do you use to challenge students to reflect on how they solve problems and perhaps consider alternative methods?* (For instance, do you ever present a problem and then discuss multiple ways to solve it or have students critique different approaches?)
- **New Approaches**: *Have you tried any new teaching approaches or tools recently?* If so, how did it go? Are there any approaches you haven't tried yet but are interested in or see an opportunity to use in your classroom soon?
- **Learning New Methods**: *How do you learn about or discover new teaching methods and ideas?* (Do you attend workshops, talk with colleagues, read online resources, etc.?) What sources do you find most useful for improving your teaching?
- **Practical Applications**: *How do you incorporate real-world contexts or practical examples into your math teaching?* Can you share an example of a math topic that you taught in a way that connected to everyday life or a future job scenario for students? What topics from the curriculum do you perceive as the most interesting for students and applicable in everyday life? What topics from the curriculum would be worth connecting with everyday life? Give some examples, ideas? Do you think that it is possible to indicate topics (choose practical aspects of maths) common for vocational schools, which would be useful for students of mechanical, IT, or culinary schools [info for moderator it can be e.g. inflation or taxes system] What kind of topics could be particularly useful for students of mechanical, IT, or culinary schools [info for moderator: it can be e.g. certain aspects of geometry, statistics, and for culinary students e.g. calculating proportions, converting units of measurement]
- **Engaging Topics**: *In your opinion, which math topics are especially easy or important to connect with real life or vocational situations?* Are there any topics that your students find more engaging because you can relate them to real-world examples? (Feel free to give specific ideas or experiences where linking math to real life got students excited.) What topics/aspects could be interesting for teachers to explore, to enhance his/her expertise in introducing practical applications of mathematics in selected areas of life? / Or DO you see any kind of support for teachers that could be interesting, helpful in their teachers' everyday job to help them in introducing practical usage of maths? Are there any areas

of your knowledge that you would like to strengthen in order to more effectively introduce students to the practical application of mathematics in life and later work?

(After discussing methods, move to the role of the teacher.)

Topic 3: Challenges and “Pain Points”

Introduction:

Now, let's talk about the challenges – or "pain points" – you experience when teaching math. In this part, we want to dig into the difficulties students have with math and the tough moments for you as a teacher. This can include anything from points in a lesson where students get lost or disengaged to broader obstacles that make teaching math harder. We're looking for those **micro-level classroom challenges** that you face regularly.

Questions:

- **Overall Obstacles**: *What would you say are the biggest challenges, obstacles, or difficulties your students face when learning math?* (These could be specific concepts, skill gaps, attitudes, etc.) What topics from the core curriculum do they have the most difficulty with? What do you think might be the cause of these difficulties? Can you give an example of the issues that students usually have the most difficulty with?
- **Losing Students**: *Are there specific moments in a lesson when you notice you're "losing" students' attention or understanding?* For example, can you tell when they get confused or bored? What typically is happening at those moments?
- **Anxiety and Insecurity**: *Some students feel anxious or insecure about math*. How can you tell if a student is anxious about math, and what do you do to help them feel more confident or comfortable during your lessons?
- **Commonality of Challenges**: *Do you think most math teachers face similar challenges to the ones you’ve described?* In your opinion, **why** do these problems occur (e.g. is it the subject matter, student background, etc.)? And have you found anything that helps to prevent or minimize these issues in your classes?

Optional questions if needed:

- **Disruptions and Struggles**: *What about students who cause disruptions or those who fall behind because they struggle with the material?* How do you deal with a student who is disrupting the class, or help one who isn’t keeping up with the lesson?
- **Truancy/Skipping (if applicable)**: *Have you had cases where students frequently skip your class or end up failing math?* What do you think is behind that, and is there anything you can do (or have done) to address it?
- **Specific Struggling Student**: *Can you give an example of a particular student who really struggled with math and how you handled that situation?* What did you try with them, and how did it turn out?

(Next, transition into teaching methods and innovation.)

Topic 4: What teachers think about their students and performance

Introduction:

Lastly, let's discuss your direct experiences with students and their performance in math. We want to hear some personal stories and reflections on how students are doing in your classes. This includes memorable student stories, how students view you, and patterns you see in student performance. The goal is to capture the human side of teaching – the relationships and outcomes that stick with you.

Questions:

- **Memorable Student Story**: *Can you share a story about a student that has really stayed with you throughout your teaching career?* It could be a success story or a challenging situation – something that was particularly memorable. What happened, and why did this experience leave such an impression on you?
- **Student Perceptions of Teacher**: *How do you think your students perceive you as a teacher?* What kind of feedback (formal or informal) have you gotten from them about your teaching style or personality? And do you feel the way your students see you affects how you teach or interact with them?
- **Teacher's View of Students**: *People sometimes have misconceptions about vocational students*. What do you **really** think about your students? What do you appreciate or enjoy most about them? And honestly, what are some things that frustrate or challenge you about your students? *(Feel free to clarify any stereotypes vs. reality here.)*
- **Overall Performance**: *How do your students generally perform in mathematics?* For example, do most of your students pass and grasp the material, or do many struggle? What do you think influences their overall performance?
- **Strengths and Struggles**: A*re there particular math topics or areas where your students tend to do really well?* And on the other hand, which topics do they usually struggle with the most?
- **Differences Among Students**: *Do you notice significant differences among your students in how they learn or perform in math?* For instance, differences based on their background (like prior preparation), learning style, or level of motivation? How do you address these differences in your teaching?

(After this section, proceed to conclude the session.)

Topic 5: Student Motivation

Introduction:

Next, let's focus on student motivation. Here we want to explore what motivates (or demotivates) students in math, and how you as a teacher try to encourage them. We're interested in your strategies for sparking interest in math and keeping students motivated, as well as any **challenges you face when students lack interest**.

Questions:

- **Student Attitudes**: *How would you describe your students' overall attitude toward math?* Do they generally come in curious and open-minded, or do some see math as a chore or "not for them"? Why do you think they feel that way? Based on your observation, please explain what could be the reason that some students think that maths is not for them or just are not interested in developing maths skills? Based on your observation, tell us what could be the reason for their low motivation?
- **What Drives Students**: *In your experience, what drives students to learn mathematics?* In other words, what do you think gets them interested or excited about learning math (if anything)? Are there any math topics that students perceive as interesting for them—can you share some examples with us? Do students ask you questions, e.g., "For what purpose do I need this topic?" Do students look for any connection between math and real life?
- **Motivation Strategies**: *What methods do you use to motivate your students in math?* Which approaches have worked well for you? (Can you give examples?) And have you tried any approaches that didn't work so well? For instance, what do you do if a student is really disengaged or says something like "I'm just not good at math"? What do you think about that as a teacher?
- **Addressing "Not Good at Math" Mindset**: *Many students think they are "just not good at math." What do you think about it? How do you respond to that mindset?* Do you have ways to encourage a student to believe they can improve (promoting a growth mindset in math)? What do you usually say to these students?
- **Biggest Motivation Challenges**: *What are the biggest challenges you encounter in trying to keep your students motivated?* (For example, do you face issues like students giving up easily, external distractions, lack of confidence, etc.?)
- **Learning from Others**: *Do you ever exchange ideas with colleagues about motivating students?* Maybe you've picked up some techniques from other teachers or from workshops/training sessions? If so, what kind of strategies have you learned from them?
- **Making Math Relevant**: *Do you try to show students how math is relevant to their everyday life or future jobs as a way to motivate them?* If yes, could you give an example of how you've done that, with which topic from the curriculum and did it help engage the students? Do you have any ideas on how teachers could further motivate students to take interest in math?

(After covering motivation, move on to challenges and pain points.)

Topic 6: The Role of the Teacher (Personal Perspectives)

Introduction:

*Next, let's talk about **you** and your role as a teacher.* This section is about how you see your position as a math teacher, what motivates you in your job, and what you value in teaching. We want to understand your personal perspective: what being a math teacher means to you and what you consider success in your teaching.

Questions:

- **Role in the System**: *How do you see your role as a math teacher within the education system?* (For example, what responsibilities or impact do you feel you have beyond just teaching math content?)
- **Personal Motivation**: *What motivates you in your work as a teacher?* Can you share an example of a moment when you felt your work was especially meaningful or rewarding – a time that reminded you why you do this job?
- **Being a Good Teacher**: *In your view, what does it mean to be a "good" math teacher?* What qualities or actions do you think define a good math teacher?
- **Student Takeaways**: *What are the three most important things you hope your students will take away from their mathematics education with you?* (These could be specific skills, attitudes, knowledge, or anything you find most important.)
- **Achievements vs. Small Successes**: *How important to you are your students' big achievements in math – like high scores or exam results – compared to the smaller day-to-day successes, like a student having an "aha" moment or a class that goes really well?* Which of these give you a sense of satisfaction as a teacher, and why?
- **(Optional) Math vs. Other Subjects**: *Do you feel that teaching math is different from teaching other subjects?* If so, in what ways? (This could include how students perceive math, the challenges in teaching it, or how you approach it differently than a teacher might in another subject.)

(After this section, proceed to conclude the session.)

Conclusion

- **Summarize Key Points**: *Before we wrap up, I'd like to quickly summarize some of the key points I heard.* (Moderator provides a brief summary: "It sounds like … [e.g., the group discussed X challenges, uses Y strategies, values Z outcomes, etc.]"). *Does that summary sound about right? Did I miss anything important?*
- **Additional Comments**: *Is there anything we haven't discussed that you think is important to mention?* Any other thoughts or advice you'd like to share that we didn't cover with our questions?
- **Thank You and Next Steps**: *Thank you so much for sharing your experiences and insights.* Your input is extremely valuable for our project. We'll be using what we learned today to inform the next steps of our work (like designing new materials or support for teachers). We may reach out with follow-up questions if needed, and of course, we'll keep you posted on the project's progress. Thank you again, and have a great day!

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