

AN ACADEMIC COMPARATIVE STUDY ON THE ASSESSMENT OF PRIMARY SCHOOL STUDENTS IN SINGAPORE, FINLAND, UNITED KINGDOM, JAPAN, THE UNITED STATES, THE REPUBLIC OF MOLDOVA AND ROMANIA FROM A TRANSDISCIPLINARY PERSPECTIVE

Carmen - Paula ANDREI, Ph.D. Cnd.,

Doctoral School of Sciences of Education, Ion Creangă State
Pedagogical University of Chişinău,
„Miron Costin” Lower Secondary School Bacău, România
paulaandrei2006@yahoo.com

Abstract: *This comparative study examines the organization and implementation of national assessment at the end of primary education in several leading countries in the global educational landscape. Assessment practices serve as indicators of academic performance, yet grading scales vary significantly across national systems. The article analyses the educational approaches of the selected countries with the aim of identifying integrative perspectives on the contemporary education systems. In a world undergoing continuous transformation, a holistic and personalized approach to teaching and learning becomes imperative. Learning systems must make the transition from monodisciplinary structures to transdisciplinary frameworks. The curricula of highly developed countries is based on science, robotics, and technology. All of these are discovered by the young learners through experiential learning. While in the United States the students showed reduced interest in the exact sciences, taking into consideration the reconsideration of its educational model, this is how Finland and Singapore have developed school curricula grounded in creativity and innovation, fostering skills that enable students to navigate real-world challenges. The Finnish curriculum for early grades adopts theme- or phenomenon-based learning, encouraging students to explore the real world through multidisciplinary projects. Assessment practices involving digital portfolios, projects, journals, and discussions extend beyond evaluating the final product; they encompass a range of transversal competencies such as collaboration (teamwork), critical thinking (the ability to gather and interpret information to solve a task), and*

self-regulated learning (autonomy in completing assignments).

Keywords: *grading; assessment; grading systems; national testing; STEM; interdisciplinary and transdisciplinary approaches.*

Introduction

The COVID-19 pandemic brought about a profound transformation of the learning process. It generated a form of forced digitalization which, on one hand, created opportunities for students and teachers with higher levels of digital and educational competence to adapt successfully to online environments, and, on the other hand, resulted in significant losses for disadvantaged groups who faced difficulties in accessing and adjusting to online learning.

This study adopts a comparative approach, aiming to examine how national assessment at the end of primary school is organized and implemented in several countries that consistently achieve high performance in final evaluations. Furthermore, it analyses the educational practices of the studied states in order to identify integrative perspectives on their education systems.

Research Problem

National assessment of students at the end of primary school is not standardized. It varies from one country to another, from one educational system to another, and even from one teacher to another. This diversity raises a central question: *How is national assessment of young learners performed at the end of primary education in these high-performing countries?*

Research Questions

- a) *Which countries implement national assessment at the end of primary school?*
- b) *What type of curricular approach is used at the primary level in the selected countries?*
- c) *Do the primary school curricula of the analyzed countries assess interdisciplinary and transdisciplinary competencies grounded in STEM?*

Purpose of the Study

The purpose of this study is to analyze the curricula of countries with outstanding results in national assessments at the end of primary education, such as Singapore, Finland, United Kingdom, the United

States, and Japan. To achieve this, a rigorous examination of accredited online information sources was required.

Research Methods

The methods employed in this study included the analysis of curricular documents available on specialized platforms (official websites of ministries of education), as well as the review of scholarly articles published in peer-reviewed journals.

Findings

Results of the TIMSS 2023 Assessment

TIMSS (*Trends in International Mathematics and Science Study*) is a global large-scale assessment conducted independently from PISA or OECD evaluations, focusing on students' competencies in MATHEMATICS, READING, and SCIENCE. The most recent TIMSS cycle took place in 2023, with 59 education systems and 6 reference entities participating at the Grade 4 level (EduPedu, 2024). Its purpose was to compare performance levels, monitor global trends, and set the basis for international education policies. Regarding the methodology, the assessment was administered entirely in digital format and included interactive tasks and problem-solving activities designed to enhance student engagement. In MATHEMATICS, Romania obtained a score of 542 points, similar to the results of Turkey, England, Poland, Ireland, the Netherlands, Latvia, and Norway. This score places Romanian students within the Intermediate Benchmark (above 475 points), close to the threshold for the High Benchmark (550 points), yet still far from the Advanced Benchmark (625 points). The top performers were Singapore 615 points, Japan 591 points, United Kingdom 552 points, Finland 529 points, and the United States 517 points (EduPedu, 2024).

In SCIENCE, Singapore again ranked first with 607 points, followed by the United Kingdom 566 points, Japan 565 points, Finland 542 points, and the United States 532 points. Romania achieved 526 points, a score above the international average but significantly lower than its mathematics performance, similar to the results of the Czech Republic, Slovenia, and Lithuania, according to the same report (EduPedu, 2024).

The diagram below illustrates a comparative view of the *Mathematics and Science* results obtained by the countries participating in the 2023 TIMSS study and published in November 2024.

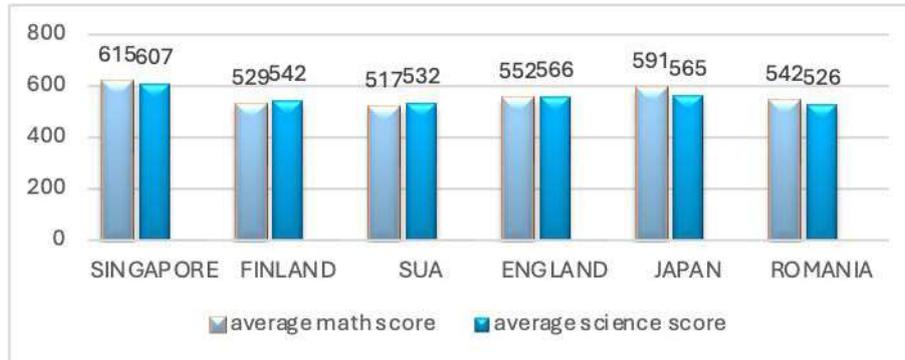


Fig. 1 The average mean and score in Mathematics and Science – TIMSS, IVth grade, 2023 (for the studied countries)

But what do the performance benchmarks used in TIMSS 2023 represent?

According to EduPedu (2024), for MATHEMATICS, Grade 4:

- LOW BENCHMARK (400) – students demonstrate a basic understanding of mathematics.
- INTERMEDIATE BENCHMARK (475) – students show mathematical knowledge in simple situations and can relate different representations.
- HIGH BENCHMARK (550) – students apply various concepts and representations in broader contexts.
- ADVANCED BENCHMARK (625) – students can select and apply information to implement appropriate operations for solving problems.

For SCIENCE, Grade 4, the performance benchmarks are:

- LOW BENCHMARK – students know some basic scientific facts.
- INTERMEDIATE BENCHMARK – students demonstrate and apply their knowledge of scientific concepts.
- HIGH BENCHMARK – students can demonstrate and apply knowledge in life sciences, physics, and other sciences which can be applied in certain scientific inquiry practices.
- ADVANCED BENCHMARK – students can demonstrate, apply, and communicate their scientific knowledge and engage in multiple scientific inquiry practices.

Results of the PIRLS 2016 and 2021 Assessments

Administered every five years, PIRLS testing evaluates the reading abilities of 10-year-old children worldwide. According to the IEA TIMSS and PIRLS 2021 report, Singapore once again ranks first with 587 points, followed by the United Kingdom in fourth place with 558

points, surpassing Finland, which ranks fifth with 549 points. Similarly, in the IEA TIMSS and PIRLS 2016 testing, the countries analyzed in this article achieved remarkable results. Singapore ranked second with 576 points, after the Russian Federation- 581 points. Finland occupied fifth place with 566 points, followed by the United Kingdom and Chinese Taipei with 559 points, and the United States with 549 points. In 2021, the United States does not appear in the ranking because it did not manage to report its data on time, along with five other countries, because of the COVID-19 pandemic.

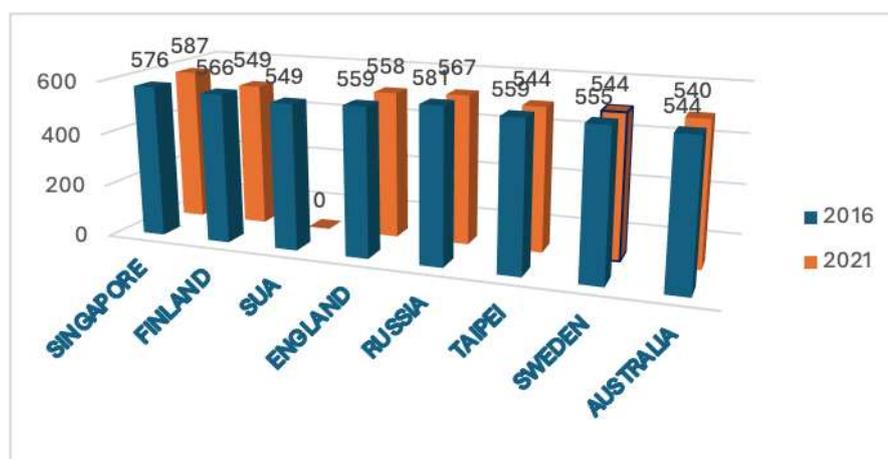


Fig. 2 Mean and average score in Reading, PIRLS testing 2016 and 2021

The PIRLS 2021 assessment was conducted in 57 countries and differs from previous editions through its transition to *an innovative, fully digital evaluation*, with texts designed to be engaging for students and the data collection, being difficult to achieve throughout the two-year period, during the COVID-19 pandemic.

Curriculum Analysis

Singapore

In contemporary times, Singapore's educational system is regarded as one of the most effective in the world. Its holistic education encourages children to acquire extensive knowledge and to cultivate a curiosity that extends beyond formal education. At the same time, Singapore maintains a preference for *traditional pedagogy*, in which teachers lead the class, an approach that contrasts with the views of many reformers who advocate for more progressive models that promote self-directed learning (Ministry of Education, National Education, MOE, 2023).

Teachers, who are well compensated yet rigorously evaluated, receive 100 hours of professional development annually to remain up to date with new instructional techniques. They prefer the numerous classes (36 students per class, compared to the OECD average of 24). The

country consistently ranks at the top of the OECD's Programme for International Student Assessment (PISA), administered every three years to eighth-grade students in Mathematics, Reading, and Science. Singaporean students are considered to be nearly three years ahead of their American peers in Mathematics. They also achieve similarly strong results on the national examination taken at the end of Grade 6. An analysis of Singapore's curriculum reveals a *predominantly monodisciplinary structure, while also showing a growing tendency toward interdisciplinarity*. The primary school curriculum is designed to provide young learners with a solid foundation. Students study subjects such as foreign languages, mathematics, science, arts, music, physical education, social studies, and character and citizenship education. In upper primary, Grades 5 and 6, depending on their national assessment results, students may study Mathematics and Science at either the standard or advanced level. Some younger students benefit from specialized early-intervention programs in English, mathematics, and mother-tongue languages. *The Learning Support Programme* (LSP) is led by trained teachers in small groups of 8–10 students, for 30 minutes daily. The Primary School Leaving Examination (PSLE) assesses students' competencies and skills, and based on their performance, they are placed into secondary school pathways that align with their learning pace and abilities. Consequently, some countries express reservations about Singapore's practice of separating high-achieving students from those with more modest results after the Grade 6 assessment, a practice not fully agreed with by all parents, who argue that the PSLE places considerable stress on children.

FINLAND possesses one of the most effective educational systems in the world, as evidenced by the fact that 93% of upper-secondary graduates pass the graduation exam, 65% of high-school students continue to university studies, and only 10% of those who aspire to become teachers ultimately enter the profession. Teachers place equal emphasis on children's emotional development and academic growth. Pupils, relaxed and confident during lessons, are encouraged to express their opinions and talents, and they feel seen and heard. Students address teachers by their first names, fostering closeness and encouraging relationships built on trust, mentorship, and personal development. The Finnish education system, fully state-funded, with no admission exams and no tuition fees, *borrow*s methods inspired by Montessori, Waldorf, and Step-by-Step philosophies, aiming to bring real life into the classroom through experiments, hands-on activities, and outdoor learning. Consequently, it is common for Finnish students

to conduct biology lessons in the forest or to meet invited guests who speak about their professions.

Finland has abandoned the strict division of knowledge into age-segmented school subjects and has transitioned toward an education model grounded in inter- and **trans disciplinarity**. Traditional subjects, as understood in standard educational systems, are gradually being replaced by *phenomenon*- or *theme*-based instruction. Instead of focusing on conventional subjects such as English, mathematics, or history, schools emphasize argumentation, character formation, and personality development. **Trans disciplinarity** aims to provide students with transferable competencies and requires classroom activities to support integral education by removing boundaries between disciplines.

The school pathway is structured into three levels: *compulsory education*, *secondary education*, and *higher education*. Before the age of seven, children attend preschool, followed by compulsory elementary education until age sixteen. At sixteen, students may choose either an academic or vocational track (three years), with 43% opting for vocational schools. At 19, students may enter university, followed by master's and doctoral studies. Another notable feature of Finnish education is the provision of free, nutritionally balanced meals for all students, reflecting the belief that maintaining and improving students' health and well-being is essential for learning.

Regarding **assessment in Finland**, it emphasizes support for students' educational development. Pupils receive no grades during their first six years of schooling and are not ranked. The Finnish curriculum requires continuous assessment throughout the school years and a final evaluation that leads to a certificate of completion. In Grades 1–3, the assessment is verbal or numerical: 5 – adequate, 6 – moderate, 7 – satisfactory, 8 – good, 9 – very good, 10 – excellent (Eurydice – Student Assessment in Finland).

Finnish primary education is well-known for its effectiveness in meeting children's individual needs. It emphasizes an integrated approach based on experiential learning and extensive play. Students enjoy 15 minutes of play after every 45-minute lesson, which supports development and concentration. There are no standardized tests until the end of upper-secondary school. Continuous assessment is conducted by the teacher responsible for Grades 1–6, who supports each student individually without ranking them. Primary teachers provide qualitative evaluations based on verbal feedback and progress reports. In Grades VI-IX, students receive grades, and during Grade IX teachers prepare several reports aligned with the criteria of the final evaluation. There is only *one mandatory standardized test, taken at*

age sixteen. At the end of each school year, students receive a report. A frequently mentioned vulnerability of the Finnish system is that it does not strongly encourage the Olympians, focusing instead on the average level, however, the system is intentionally designed to meet the needs of all children.

The Finnish curriculum for Grades I-VI adopts **phenomenon/theme-based learning**. Students do not study subjects separately but explore **the real world through multidisciplinary projects**. Subjects such as Finnish/Swedish language and literature (official languages), mathematics, foreign languages, practical and artistic skills, natural sciences, and ethics/religion are integrated. For example, in a five-day project titled *The Forest*, students may measure trees (mathematics), draw landscapes (arts), identify tree species (science), or memorize a poem (language and literature).

Assessment focuses on the learning process and each student's individual progress rather than ranking.

Key **principles** in project assessment include:

- *Continuous formative assessment*, the students benefit from ongoing feedback until they finish the project, with role of guidance and coordination.
- *Self-assessment and peer assessment*, encouraging reflection on one's own work.
- *Absence of grades*, with descriptive evaluation delivered verbally or through individual reports detailing acquired competencies.

What is assessed in a project?

Assessment in early grades goes beyond the final product and includes *transversal competencies* such as *collaboration* (teamwork), *critical thinking* (how information is gathered and interpreted), and *self-management* (autonomy in completing tasks).

Assessment tools include digital portfolios, learning journals, and individual discussions.

According to the *Finnish National Agency for Education (2025)*, each school is required to implement at least one multidisciplinary module or project per year, and its assessment must integrate objectives from multiple subjects, creating a holistic picture of the student's development.

THE UNITED STATES OF AMERICA

In the United States, children begin school at the age of 5 and complete high school at 18. The American education system is structured differently depending on each state (Integral Edu, 2021):

- The 6+3+3 model: elementary school (K–5), middle school (6–8), high school (9–12);
- The 8+4 model: elementary school (K–8), high school (9–12);
- The 6+6 model: elementary school (K–6), combined junior and senior high school (7–12).

In elementary school, students study mathematics, science, physical education, social studies, and the arts. In the U.S., transversal competencies specific to the primary curriculum vary from state to state. The curriculum typically includes mathematics, science, reading, literature, visual arts, physical education, and music. Teaching standards are established by each state for all curriculum areas. The guiding principle of American education is the *No Child Left Behind* philosophy, with a strong emphasis on mathematics and reading. The interest in *integrated and transdisciplinary learning* has increased, and many teachers employ innovative strategies that develop critical thinking, inquiry-based learning, and experimentation. This approach develops interdisciplinary skills such as teamwork and communication. Student placement is determined by residential address rather than entrance examinations.

Grading in the U.S. resembles that of China, and admission to college requires two standardized tests: *the American College Testing (ACT)* and *the Scholastic Aptitude Test (SAT)*, both assessing mathematics, science, and text analysis. The grading system consists of five letter grades: A for exceptional performance, B for above-average performance, C for average, D for below average, and E or F for poor or very poor performance (Andrei C. P., 2022).

THE UNITED KINGDOM

The first year of primary education in the UK is called the *Reception Year*, corresponding to the final year of kindergarten in Romania. Children learn to write, read, and acquire basic mathematical skills. Classes include a maximum of 30 pupils, and teachers change annually, allowing children to interact with different adults. Education is compulsory and may be provided in state schools, private schools, or through homeschooling. Schooling is free between the ages of 5 and 16. Children attend nursery for only one year, then enter the preparatory class at age 4–5, where extracurricular activities predominate, followed by formal education.

Education in UK is structured into *Key Stages*, and *SATs* are standardized tests taken by primary school pupils in May. These tests assess knowledge in English and mathematics. Testing varies across the UK. In *Wales*, teachers administer *personalized assessments in reading and numeracy*. In *Scotland*, pupils take *assessments in*

reading, writing, and numeracy in primary years P1, P4, and P7. The *Early Years Foundation Stage (EYFS)* provides a summary of a child's developmental progress to support their transition into Year 1. This assessment takes the form of a questionnaire covering 17 developmental domains, including physical, emotional, and social development. The phonetic testing (KS1), taken by 6-year-olds individually with a teacher, is considered the most effective tool for assessing phonetic skills.

Year VI (ages 10–11) includes standardized assessments (SATs) in mathematics, reading, and writing, aligned with the national curriculum. *Previously, tests were graded by levels, but parents now receive raw scores alongside national averages* (Exam Papers Plus, 2025).

Year VI (10-11 years old category) is also called *The 11 Plus* and it supposes the students to take 11 exams in order to be admitted in the secondary schools. Although testing varies by region, it generally covers *Mathematics* (also known as numerical reasoning), *Verbal reasoning*, and *Non-verbal reasoning* (not required in all schools). The UK offers a wide range of educational options (state schools, private schools, academies, and international schools). Compared with the Romanian system, the English system includes *boarding schools*, where students may reside during the term. A major difference between the two systems is the extremely high cost of private education in the UK.

Regarding the grading system, it uses either letters (A+, A, B+, B, C+, etc.) or percentages up to 100%. The average is expressed through the *Grade Point Average (GPA)* system, with a maximum score of 4 (Exam Papers Plus, 2025).

JAPAN

The Japanese pre-university education system comprises 12 years of study, 9 of which are compulsory: 6 years of elementary school, 3 years of lower secondary school, and 3 years of upper secondary school. The school year begins in April and ends in March of the following year. Holidays are shorter, with the summer break lasting from 20 July to 25 August. Classes are large (30–40 pupils), the minimum school age is 6, and uniforms are mandatory. Subjects include Japanese language, mathematics, English, science, physical education, music, calligraphy (for learning Japanese characters), and home economics. Students spend 7 hours per day at school, from 8:30 to 15:30. Lunch is served in the classroom, free of charge and nutritionally balanced. Schools do not employ *cleaning* staff; cleanliness is maintained partly because both students and teachers wear special indoor shoes. Examinations in Japan are extremely

rigorous. At age 12, students take entrance exams for lower secondary schools, and at age 15 for upper secondary schools. These exams are so demanding that the preparation period is known as *shiken jigoku* (“exam hell”). Students often prepare for up to two years in advance, studying at home, at school, and in *juku*, schools specialized with training students for the exams. For university admission, only 56% of candidates succeed on their first attempt.

According to Nihon (2018), the Japanese education system is structured as follows:

- Yōchien (幼稚園, kindergarten): ages 3–6
- Shōgakkō (小学, elementary school): ages 6–12
- Chūgakkō (中学, lower secondary school): ages 12–15
- Kōkō (高校, upper secondary school): ages 15–18
- Daigaku (大学, university) or Senmongakkō (専門学校, vocational school), typically 2–4 years long

In comparison, the U.S. system includes:

- Preschool (ages 3–5)
- Kindergarten (ages 5–6)
- Elementary school
- Middle/junior high school
- High school
- College/University/Vocational school

A major difference between Japanese and American primary schools is the subject of *moral and ethical education in Japan*, taught alongside core subjects such as mathematics, science, music, and physical education. This discipline emphasizes character development and manners. Students learn values such as kindness, compassion, justice, courage, generosity, and empathy. No standardized tests are administered before age 10. 85% of students report being satisfied with school, and no student repeats a grade within grade I-VII. The Japanese public education system is considered a source of national pride and consistently ranks among the top performers in PISA assessments. Thus, Japan administers the *National Assessment of Academic Ability (NAAA)* in grades VI and IX. These assessments cover mathematics, Japanese language, and science, and since 2019, English as well. The test includes items assessing both subject knowledge and the ability to apply knowledge in everyday situations. In 2019, these sections were combined to reflect the revised curriculum. The same subjects are tested simultaneously. The government publishes annual regional average scores, and local education boards may choose to release school-level results. These scores are generally used to identify areas for improvement in teaching and learning.

How are students assessed in Japan?

Teachers monitor each student's progress and provide personalized feedback. Emphasis is placed on practical learning, creativity, and problem-solving. Instead of grades, young students are encouraged through praise, intrinsic motivation, and self-assessment. Despite the absence of grades in early years, the Japanese education system remains one of the most effective in the world. Education focuses not only on competition and achievement but also on cultivating responsible individuals motivated by genuine interest rather than obligation.

Japan promotes an educational philosophy grounded in discipline and respect.

REPUBLIC OF MOLDOVA

In the Republic of Moldova, national assessment at the end of grades I–IV is administered in Romanian Language and Literature (for non-native speakers – oral examination), Mathematics, the Language of Instruction, and Mother Tongue and Literature (Ukrainian, Bulgarian, Gagauz). Pupils do not receive numerical grades, only qualitative descriptors, and, according to the *Methodology for Organizing and Conducting National Testing in Primary Education* (2019), the conversion of scores into qualifiers is as follows: Recovery – 0–24 points; Sufficient – 25–57 points; Good – 58–89 points; Very Good – 90–100 points.

The qualifier obtained functions as a current qualitative assessment awarded following a final evaluation. In the Republic of Moldova, criterion-referenced assessment based on performance qualifiers is applied. This type of assessment represents a system of teaching, learning, and continuous, differentiated evaluation that does not rely on numerical classification. According to the valid methodology, performance qualifiers are qualitative criteria that describe how pupils' competencies are manifested, facilitating the evaluation of achievement levels.

According to the National Agency for Curriculum and Evaluation of the Ministry of Education and Research of the Republic of Moldova, a new element introduced in the 2025 national testing session was the possibility for pupils to take the mathematics test in digital format, because in 2024 a pilot test where 25 primary school pupils from two high schools in Chişinău took part in. They solved 14 mathematics items in 60 minutes on a specialized digital platform. *Transdisciplinary activities* in the Republic of Moldova aim to develop life competencies through an integrated curriculum approach focused on real-world problems in everyday contexts. These activities, performed both inside and outside the classroom, promote positive interaction, motivation,

and active participation in one's own learning, by harnessing the elements of experiential learning, the adventure learning (expedition-based), inquiry-based learning, research activities, museum learning, field trips, task-based learning, and problem-based learning. However, STEM activities are not included in the Moldovan curriculum. Even so, the cognitive development characteristics of primary-level pupils allow the interdisciplinary approaches to practical STEM activities, enabling problem-solving from multiple new perspectives.

ROMANIA

In Romania, according to the National Education Law (Law 1/2011), the purpose of assessment is *to guide and optimize learning*. All assessments are performed based on national evaluation standards, and results are expressed through qualifiers at the primary level. Assessment is competence-based, provides feedback to pupils, and forms the foundation of individual learning plans (Eurydice, 2025). At the end of the preparatory grade, a comprehensive evaluation report is drafted, covering physical, socio-emotional, cognitive, linguistic, communicative, and learning-attitude development.

The *Fundamental Acquisition Cycle* corresponds to the first three years of schooling and focuses on developing basic competencies: reading, writing, mathematical calculation, values, and attitudes. This stage also lays the groundwork for further studies and productive integration into the educational system. The *Development Cycle* (grades III–VI) marks the formation of capacities necessary for continued learning and targets cognitive and sociocultural competencies, as well as the enhancement of imagination and creativity. By the end of primary education, pupils are expected to have developed the competencies outlined in the curriculum.

At the primary school level, *the Romanian curriculum adopts a predominantly integrated approach* in the preparatory, first, and second grades, which has become particularly significant. Mathematics (MEM) is studied in correlation with Environmental Exploration – Natural Sciences, requiring a multi-perspective approach to topics. Other subjects include Music and Movement, Visual Arts, and Practical Skills. In grades III and IV, as well as in lower and upper secondary education, the curriculum shifts toward a monodisciplinary approach.

Article 68 of the National Education Law no. 1/2011 identifies eight key competencies shaping *the student formation profile*: communication in Romanian and the mother tongue, communication in foreign languages, mathematical, scientific, and technological competencies, digital competencies, social-civic competencies,

entrepreneurial competencies, learning-to-learn competencies, and cultural expression competencies.

According to Article 9(1) of the Methodology for Organizing and Conducting National Testing in Primary Education, *tests for the National Assessment (EN) are developed by the National Center for Assessment and Examination (CNEE), taking into account the following requirements:*

- a) clarity, precision, and strict alignment with the current school curricula for each subject;
- b) a medium level of difficulty.

The tests designed for the National Assessment resemble those used internationally. *The teacher's booklet*, prepared by CNEE, includes the marking scheme and other essential information about the testing process. The first test for EN II assesses written message production; the second evaluates reading comprehension; the third assesses mathematical competencies.

Regarding the revision of assessment methods and exam formats, L. Ciolan (2008) mentions *that the results obtained by Romanian pupils do not support the myth that the national education system is high-performing, nor that current assessment practices are adequate*. International test items focus on application, competencies, skills, correlations, transfer, and critical thinking. The national assessment practices remain limited, relying heavily on mechanical memorization. In this context, the introduction of **alternative, competence-based assessment methods** are urgently needed to support an integrated curriculum.

Does the curriculum of the analyzed countries include STEM/STEAM/STREAM activities?

One of the main reasons STEM education is included in education, including at the primary level, in developed countries (the United Kingdom, Finland, the United States, Japan, China, etc.) (Freeman et al., 2019) is that it offers a constructivist approach to integrating natural sciences, mathematics, engineering, and technology.

To meet society needs, education systems are continuously evolving. Educational development aims to foster innovation in the field of technology. STEM integrates science, technology, engineering, and mathematics. Adding A (Arts) results in STEAM, and integrating STEAM with R (reading – literacy) produces STREAM, which enhances children's communication skills. Since the world cannot be understood monodisciplinary, most real-life problems require the connection of multiple disciplines. Finland is highly committed to STEM, treating it as an instructional standard. Singapore, although maintaining a monodisciplinary curriculum with interdisciplinary

tendencies, offers STEM programs through agencies coordinated by the Ministry of Education, which support schools in implementation. In the United States, interest in STEM has increased due to lower PISA results among 15-year-olds and declining interest in technical fields, leading to a growing need for engineering and other specialists. Former President Obama integrated STEM into the school curriculum, yet challenges persist due to insufficient teacher training and organizational management. Japan, China, Taiwan, and South Korea have national policies and plans in science and technology. For example, Japan has the Science and Technology Law and five-year basic plans emphasizing research and innovation, essential in an advanced society.

The UK's *STEM Learning platform* provides teaching materials for teachers and not only. Additional valuable resources are available on the IEP Platform, offering materials organized by domain, age, topic, and project/experiment duration.

In Romania, unfortunately, interest in STEM remains limited, with only a few teacher training courses or summer schools for students.

The table below illustrates how the countries analyzed in this study integrate STEM elements into the primary school curriculum, with approaches ranging from fully interdisciplinary integration to optional programs or national strategies under development. Here is how STEM is present in the curriculum of each analyzed country:

Country	Approach	Implementation
Singapore <i>(Global leader in integration)</i>	STEM is the foundation of the educational system.	Begins as early as kindergarten, with a strong focus on research and innovation for future-oriented industries.
Finland <i>(Emphasis on STEM and inter-/trans disciplinarity)</i>	Strong focus on STEAM (including the Arts). Flexible curricular structure. Lessons adapted to students' interests.	Project-based learning and transversal competencies are central, promoting problem-solving through collaboration across disciplines.
United Kingdom <i>(integration through practical projects)</i>	The national curriculum includes clear specifications for STEM, combining science, technology,	Science often serves as the catalyst for STEM activities, demonstrating to pupils the applicability of

	and mathematics to create practical Design-and-Make projects.	theoretical concepts in everyday life.
Japan (<i>Zest for Life and trans curricular education</i>)	The curriculum emphasizes the concept of <i>Zest for Life</i> , integrating science education with engineering activities and digital technology.	Strong emphasis is placed on logical thinking and on processes of identifying patterns in nature and technology.
USA (<i>NGSS-based standards</i>)	Although the curriculum varies by state, the majority rely on <i>the Next Generation Science Standards (NGSS)</i> , which directly integrate engineering practices into science instruction.	STEM is a federal priority, aiming to develop critical thinking from the early years of education.
Romania (<i>developing elements</i>)	STEM is not a proper subject, but it is present through thematic modules and digital skills development programmes.	There are ongoing efforts to integrate STEAM approaches in primary education (e.g., Grades I and IV), often delivered through optional robotics courses or interdisciplinary approaches within Mathematics and Environmental Exploration, Arts.
Republic of Moldova (<i>curricular modernization</i>)	The national curriculum for primary education has been updated to include competencies specific to science and technology.	Although it remains structured around separate subjects, there is a growing tendency to integrate STEAM projects to stimulate pupils' curiosity and analytical thinking.

Table no. 1 – Integration of STEM in the primary education curriculum of the analyzed countries

Conclusions

In Romania, the curriculum prescribes an integrated approach in the preparatory grade and Grades I and II. In Grades III and IV, instruction shifts toward single subject structures, preparing pupils for lower secondary education, where a monodisciplinary model is promoted, similar to those in Singapore, Japan, and the United States. In Finland, since 2014, the curriculum has emphasized an integrative approach. The transversal competencies specified in the curricula of the analyzed countries indicate that such competencies cannot be developed within a system centered on isolated school subjects, but, mostly, a transition from monodisciplinary to interdisciplinarity and, especially, to transdisciplinarity is required.

In Singapore, the United States, and Japan, strong emphasis is placed on character formation in early education. In Finland, the focus is on developing transdisciplinary competencies related to well-being and sustainable development (Bărnăuțiu Sârca & Ciascai, 2021).

The concept of *STEM education* promotes interest in integrated STEM approaches and is well established in the countries examined in this study, with the exception of Romania and the Republic of Moldova, where no explicit curricular policy exists, although emerging initiatives can be observed.

What are the effects of a high performing educational system in the countries analyzed?

- Improved learning outcomes – international assessments consistently indicate strong educational performance and, consequently, better preparation for future professional pathways.
- Innovative curricula – emphasis on critical thinking, problem solving, and creativity.
- Global recognition – qualifications that are widely acknowledged internationally.
- Inclusion – integration of children with special educational needs as well as those from diverse cultural backgrounds.
- Support for international students – facilitated by cultural integration programmes and visa opportunities.

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