



Countries Improving in Maths

Report on countries that have turned around declining mathematics performance

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Summary

This paper examines three jurisdictions that have turned around a decline in average mathematics achievement: Austria, Ireland, and Sweden.

Common themes emerge from these countries' experiences:

- Low and/or declining TIMSS scores as well as declining PISA scores in these jurisdictions have been used as a reason to reform educational practices. It should be noted that these studies have also provided evidence in reading and science achievement and these countries' responses to the findings often address educational achievement across the curriculum.
- These countries have not relied on a single initiative as a response. Responses have involved a range of initiatives or reforms across several areas including curriculum, school structure, professional development, and national assessments.

Data from 2007 to 2015 indicate that teachers in these three countries have introduced pedagogical practices when teaching mathematics, reading, and science that education research literature suggest are most effective in improving student learning outcomes.

- These countries have continued to invest in further initiatives to build on the improvements they have made.
- These countries also have in common a high professionalism in their teaching workforces, Austrian and Irish teachers are paid and qualified significantly higher than the OECD average. Recent initiatives are addressing teacher pay in Sweden. This is likely to support attracting high-calibre candidates to train as teachers, especially across economic situations that typically affect teacher supply.
- Changes in initial teacher education (ITE) and investment in additional professional learning and development are also evident among these countries
- Early childhood education has been mandated for the year prior to school entry in each of these countries.
- Curricula for these countries appear to be more prescriptive than for New Zealand with more specific content expectation and structure including specified amounts of mathematics instruction time in the mathematics curriculum.

Limitations

While the initiatives these countries have undertaken are associated with an improvement in mathematics achievement it should be noted that causality cannot be attributed.

Another note of caution concerns that similar initiatives are likely to have been implemented in other countries but are not associated with improved outcomes. Further, this paper does not compare and examine changes and initiatives that all (or nearly all) countries will have undertaken over the last twenty-five years.² This includes countries that have improved, those with similar achievement to 20-25 years ago and those with declining achievement over this period.

¹ Vincent-Lancrin et al., 2019.

² TIMSS was first administered in 1994 and 1995.

Background

Introduction

This paper examines three jurisdictions that have turned around a decline in average mathematics achievement.

It draws on evidence from two large-scale international research programmes, that assess student achievement in mathematics while also capturing valuable contextual information about policies and practices in classrooms, schools, and education systems.

- The Trends in International Mathematics and Science Study (TIMSS), measuring mathematics achievement at levels equivalent to New Zealand's Years 5 and 9 every four years, since 1994/95.
- The Programme for International Student Assessment (PISA), measuring mathematics achievement for 15-year-olds every three years, since 2000.

This paper draws on contextual information provided by TIMSS National Research Coordinators for the *TIMSS 2019 Encyclopedia: Education policy and curriculum in mathematics and science*, a compendium to the international achievement reports.¹

This paper also draws on the OECD's *Education Policy Outlook* series for each country, as well as a variety of other sources including Ministry websites for these jurisdictions.

This paper outlines changes in conditions that may have contributed to the turnaround in each jurisdiction's mathematics performance.

Selection of comparative systems

Few countries have reversed a declining trend in either TIMSS or PISA. Most countries have consistently declined, consistently improved, or improved and then plateaued.

Three countries – Austria, Ireland, and Sweden (See Figure 1 on next page) – have turned around a decline in average mathematics achievement in at least one of the grade/age levels in these studies, while maintaining performance in other age/grade levels.

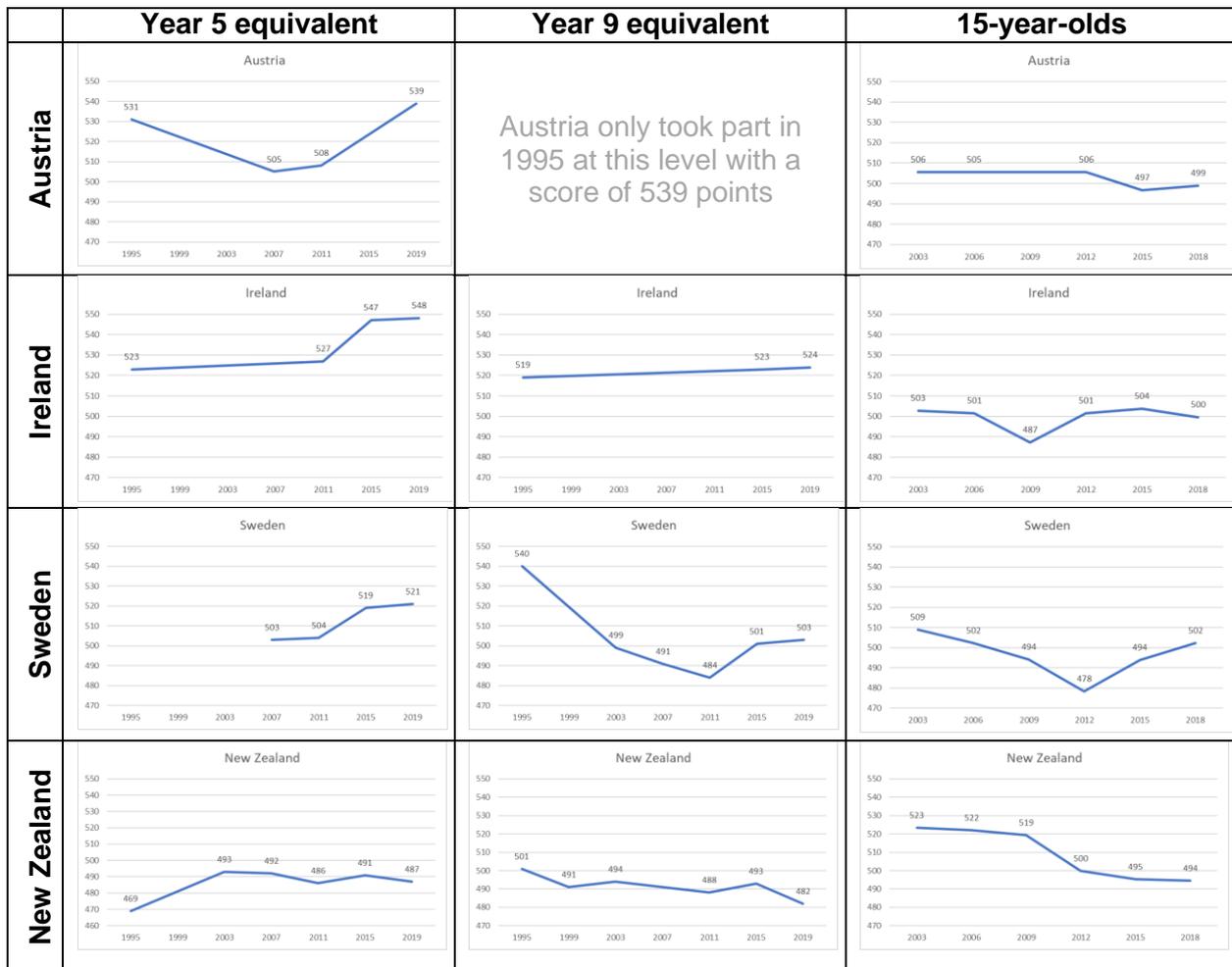
Because the impact of changes to nationwide policies and practices tends to be cumulative over each cohort's life and schooling, improvements in Year 5 tend to reflect in the same cohort four years later in Year 9.

Some points to note

- Austria has not participated in TIMSS at the grade level equivalent to Year 9 since 1995.
- Ireland's average mathematics performance declined in only one cycle of PISA; however, since 2011 Ireland has seen an improvement in mathematics scores at the level equivalent to Year 5.
- Sweden's drop in achievement was similar to New Zealand in PISA from 2003 to 2012. Since 2015, Sweden's average mathematics achievement has improved at both the primary and secondary levels.

¹ Kelly et al., 2020. For full citation see *References* at the end of this report.

Figure 1: Countries that have improved after declining performance in mathematics compared to New Zealand performance 1995–2018.



The following sections provide contextual information, where available, for each country, centred on changes or innovations across the following topics:

- General country context:
- Starting age and pre-primary education
- Initial Teacher Education (ITE)
- Curriculum
- Pedagogical practices / teaching and learning activities
- Professional Learning and Development (PLD)
- Assessment practices
- Interventions
- Evaluation
- Mathematics specialist roles

Austria

Background³

Austria has a highly centralised system with the federal ministry having overall responsibility and implementation jointly with the nine provinces. Austrian school law is a part of the constitution, and any change requires a two-thirds vote in parliament. Instruction is in German medium with a few schools teaching in minority languages.

Austrian students had traditionally been tracked into two types of school at age 10: general secondary schools or the academic secondary schools. In 2007/08 a new type of school was introduced – the New Secondary Schools (NMS) – to reduce the stratifying effects of early tracking. These new schools now cover 60% of all students and have completely replaced the old general secondary school.

Austria's results of TIMSS 1995 triggered debates about the quality of the education system. While primary school students showed high achievement levels in both mathematics and science, students in both lower secondary and in upper secondary schools achieved below expectations.⁴ The TIMSS findings were used as evidence of the need for reforms. PISA results were also below expectation and TIMSS results from 2007 provided further impetus for reform.

Figure 2: Trends in mathematics achievement for Austria



Since then, Austria has implemented reforms, or is the process of implementing reforms. Many reforms have occurred in the period 2009-2015 including the start of national assessments, a new lower secondary school structure, changes in teacher education, and professional learning and development. TIMSS 2019 shows a significant increase in mathematics performance and initiatives prior to then are considered in the following sections.

Starting age and pre-primary education

Compulsory starting age is 6 years; before that creche (before 3) and kindergarten from 3 years is available for younger children. Mathematics (age appropriate) is covered in the national curriculum and policy for early childhood education (before 3 and 3 years and beyond).

Since 2009, all children at age 5 must attend a compulsory 'kindergarten' year.

² Main source Itzlinger-Bruneferth et al., 2020.

³ Note that despite Austria's strong performance in TIMSS 1995 at the middle primary level, it considered its lower secondary and upper secondary school performance to be below par. Austrian students scored 31 points higher on average than New Zealand Year 9 students (539 c.f., 508).

⁴ .

Initial Teacher Education (ITE)

ITE includes a supervised practicum of at least 65 days and the completion of a mentoring or induction programme during their first year(s) of teaching is required. Up until 2015/16 teachers required a three-year qualification in education to teach at lower secondary schools.

A 'New Teacher Education Scheme' implemented in 2015/16, requires university colleges of teacher education and universities to collaborate to provide a common standard for teacher education. This includes a requirement for all teachers to complete a master's courses within the first five years of entering the teaching profession).⁵ Teacher education has been re-oriented towards age groups rather than for different school types, to enhance mobility between school types and standardise the status of teachers regardless of the school type they teach in.

Curriculum

The current Austrian curriculum provides a framework laying out the general overarching aims, and states subjects within those content areas intended to meet the general aims. Thus, the curriculum is the basis for teachers to plan and implement lessons autonomously.

In lower secondary education (equivalent to Years 6–9) two versions of the mathematics curriculum exist: one version for general secondary schools (now replaced by new secondary schools) and another for academic secondary schools. The topics are the same for general/new and academic secondary schools.

In both versions, a minimum of two-thirds of the instructional time in mathematics must be devoted to 'core' topics; up to one-third may be chosen from 'extended' topics. The topics are the same for general/new and academic secondary schools.

The total amount of instructional time for each subject is specified in the Austrian curriculum. For mathematics, according to TIMSS 2019, this amounted to about 18% of total instructional time at Grade 4 (equivalent to Year 5).

In upper secondary schools, (catering for students equivalent to New Zealand Years 10 to 13) schools have a level of autonomy over the curriculum similar to their OECD peers: responsibility for 72% of curriculum decisions are taken at school level (compared to the OECD average of 73%, based on PISA 2015 data).

Pedagogical practices / teaching and learning activities

As well as the curriculum specifying content to be taught, it also sets out general didactic principles (i.e., how to deliver the curriculum). Examples from TIMSS 2019 illustrate how instructional and/or organisational practice in Austrian primary classrooms compare to New Zealand primary classrooms. Both Austria and New Zealand use whole class teaching approaches for just over half the students at the Year 5 level in half the lessons or more. However, Austrian teachers are less likely than their New Zealand counterparts to use small group teaching approaches (this is true for either same or mixed ability grouping).⁶ Memorising rules, procedures and facts was equally rare in both New Zealand and Austrian classes.

The introduction of *New Secondary Schools* (NMS) was also accompanied by the investment of an additional 164-250 million euros per year *"intended to introduce new pedagogical methods, such as team teaching, in order to better respond to the needs of the heterogeneous population catered by the NMS."*⁷

Both the academic and new secondary schools see the start of mathematics teaching by maths-specialist teachers at the age level equivalent to New Zealand's Year 6.

⁵ Since 2015, all teachers are required to hold a bachelor's degree.

⁶ Information as to why teachers may choose particular approaches to organise their students for mathematics (e.g., multi-level classes) is not addressed in TIMSS.

⁷ Figueroa et al., 2017. .

While not directly related to mathematics, there is evidence of longer-term changes in Austrian school practices and resourcing with a clear focus on efforts to improve reading at the primary school level. Because reading skills underpin easy understanding of mathematics questions in TIMSS and PISA, this too could plausibly be related to the country's mathematics improvements. Notably, it appears research-supported practices have spread in Austrian classrooms, for instance a steady rise in learning to decode words, use of reading tests, a reduction in the use of computers in primary reading classes, and a large rise in the availability of a library in primary schools.⁸

Professional Learning and Development (PLD)

In-service professional learning is provided by university colleges of teacher education. Every teacher has the duty to attend regular professional development activities; however, topics and courses are not mandated, and teachers may choose from a variety.

Since 2013, a new national quality assurance for general education schools requires school leaders, in consultation with their teachers, to have professional development plans in place. These plans require self-evaluation as part of the plan.

Assessment and monitoring student progress in mathematics

Until 2012, there was no national assessment of achievement in Austria; therefore, international study data such as results from TIMSS were also used for system evaluation and monitoring. Starting in 2012, the assessment of national educational standards has been implemented in the grades equivalent to Year 5 through to Year 9.

These national standardised tests have been primarily used for monitoring at the school, class, and system levels and only marginally for reporting of individual students' competencies.

At older age groups new standardised and competence-oriented examinations have been implemented in academic secondary schools since the 2014/15 school year and in colleges for higher vocational education since 2015/16.

Related developments too recent to affect the turnaround

In Austria this is mainly developments from 2018 or later as TIMSS 2019 was the first major indicator of change. Note that the following School Entry package would not have impacted on TIMSS 2019 results in grade 4 in 2019.

A '*School Entry and Primary School package (2016)*' was implemented nationwide in 2016/17, to improve the transition from early childhood education to primary school by unifying the last year of kindergarten and the first two years of primary school as a single school entry phase. This change aims to allow for easier early identification of learning difficulties, as well as an exchange of teachers between kindergarten and primary schools⁹

In 2018 the Austrian Council of Ministers passed an educational package¹⁰ providing for further changes to their system. This package includes school-readiness screening, new curricula, and individual competence and performance measurement tools. This package is currently undergoing a staged implementation.

⁸ Vincent-Lancrin et al., 2019.

⁹ Figueroa et al., 2017.

¹⁰ [Educational package \(bmbwf.gv.at\)](https://www.bmbwf.gv.at)

Since 2019, additional national assessments in grades equivalent to Years 4 and 8 were announced, with implementation to be finalised in 2023. Relatedly, new tests in mathematics, German (reading), and English (receptive skills) will be assessed nationally in Years 4, 5, 8, and 9-equivalent starting in 2021. These tests will be administered by classroom or subject teachers and therefore results will be available almost immediately (except for open ended formats requiring manual scoring). The focus lies on the formative aspect of testing—that is, teachers' information about student competencies and student information about their achievement level in comparison to other students.

The Austrian curriculum is currently undergoing revisions.

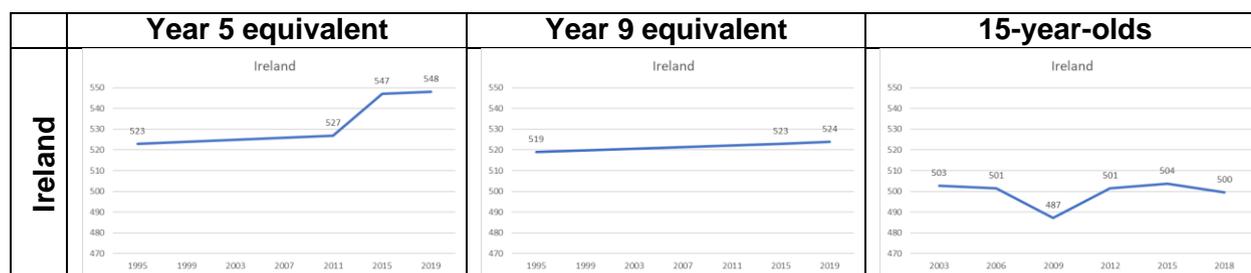
Ireland

Background¹¹

Education governance is centralised. The Department of Education and Skills is responsible for running the Irish education system, alongside a number of other organisations. The National Council for Curriculum and Assessment is a statutory body with responsibility for advising the Minister for Education and Skills on curriculum and assessment for early childhood education and for primary and post-primary schools.

While many students in Ireland are taught in English, some students study in the medium of the indigenous Irish language. Notably, Irish is a required subject of study in all state-funded schools and a proficiency test is required of would-be teachers.

Figure 3: Trends in mathematics achievement for Ireland



While Ireland's average PISA score dipped in 2009, by 2015 average performance it appears to have returned to the levels observed in earlier years and has remained reasonably constant since then. Also of interest is the increase in scores at the primary level from 2015 onwards. The majority of Ireland's initiatives appear to have focused on the primary level including changes to ITE, induction of new teachers, guidance around student assessment and specific PLD programmes for mathematics. Many of these initiatives were implemented between 2010 and 2015.

Starting age and pre-primary education

Children are eligible for two years of free early childhood care and education between the ages of 2 years 8 months and 5 years 6 months, or until entry to primary school.

Compulsory primary education begins at age 6; primary schools however operate an eight-year programme, consisting of two pre-primary years, followed by Class 1 to 6. A child must be at least 4 years old at the start of the school year to enrol in primary school. Secondary education is divided into a three-year junior cycle and then a two- or three-year senior cycle.

Initial Teacher Education (ITE)

ITE programmes for primary and post-primary teachers are facilitated through a range of concurrent (undergraduate) and consecutive (postgraduate) programmes. Minimum entry requirements for programmes of initial teacher education are set by the Minister for Education, in consultation with the Teaching Council. Ireland's Teaching Council reviews and accredits ITE programmes and handles teacher registration.

The duration of ITE courses was extended in 2011, allowing for more time in schools: undergraduate routes increased from three to four years and postgraduate routes must now last at least two years (previously 1 year for post-primary and 18 months for primary).

¹¹ Main source: Clerkin, & Perkins, 2020.

From the 2012 school year, all newly qualified teachers have been required to complete a national induction programme that included specific components related to teaching numeracy and assessment.

A 'Bridge' model of induction and probation for newly qualified teachers was rolled out across primary and post-primary schools and is the route for induction in all schools from 2020.¹² An evaluation of the 2016 pilot found highly satisfied principals, mentors, and newly qualified teachers, with some reporting more collaborative school cultures.

While starting salaries in primary and secondary education are similar to the OECD average, after 15 years' experience, a lower secondary teacher in 2018 earned 30% more than their average counterpart in the OECD.¹³

Curriculum

All state-funded primary schools (including secular, faith-based and Irish-medium) follow the Primary School Curriculum.

Unlike the rest of the Primary School Curriculum, in which subject learning content is covered as a two-year grade band, the content in the mathematics curriculum is specified for single years.

In '4th Class', equivalent to Year 5, the curriculum is presented as strands: Number, Algebra, Shape and Space, Measures, and Data. These strands are interrelated, such that student understanding in one strand is dependent on and supportive of ideas and concepts in other strands. The strands are divided into strand units in which student learning is described using content objectives.

The stated aims of Ireland's mathematics curriculum are to help all children to:

- Develop a positive attitude toward mathematics and to appreciate its practical applications in life
- Develop problem-solving skills and the ability to use mathematics in everyday life
- Use mathematical language effectively and accurately
- Understand mathematical concepts and processes at a level commensurate to their development and ability
- Become proficient in fundamental mathematical skills and in recalling basic number facts

At lower secondary school (referred to as Year 1–Year 3), mathematics is taught at two levels (ordinary or higher).

Pedagogical practices/teaching and learning activities

In the classroom practices, teachers focus on helping students to develop mathematical knowledge and skills through the process of solving problems, rather than on helping them to find solutions. Teachers prioritise generating class discussion and facilitating mathematical reasoning as students engage in problem solving. Students learn to analyse problems and break them down into manageable steps, to reflect on their strategies and those of others, and to adjust their own approach where necessary.

Examples of differences and similarities of how Irish teachers approach teaching mathematics at the primary school level include organisational approaches where mathematics is more likely to be taught as a whole-class, teacher-led activity in Irish than in New Zealand classrooms, but they were also equally likely to create both same and mixed ability groups as well. Since at least 2011 Ireland has also had a relatively high rate of having students memorise rules, procedures, and facts, which is much less common in New Zealand. Irish students were equally likely as New Zealand students to be asked to apply their learning to solving new problems.¹⁴ Overall, Irish mathematics teaching appears to broadly line up with evidence-informed practices which research shows are linked to higher maths performance.

¹² Golden, et al., 2020.

¹³ OECD (2020)

¹⁴ Vincent-Lancrin et al., 2019

Mathematics teaching by maths-specialist teachers starts at the age level equivalent to New Zealand's Year 8.

Professional Learning and Development (PLD)

Although teachers are expected to participate regularly in professional development, it is not compulsory.

At the primary level, additional targeted training has been provided to teachers since the implementation of the 1999 curriculum and in Mathematics Recovery in schools, which serves students from disadvantaged backgrounds.

The introduction of a new post-primary programme in 2010, 'Project Maths', highlighted a need to provide an additional qualification in mathematics for established mathematics teachers who did not meet new Teaching Council regulations set in 2009. The Professional Diploma for Mathematics Teaching was developed to meet this need and was fully funded for teachers who were teaching mathematics and did not meet the requirements.

More than 97% of Irish 'Class 4' students (equivalent to Year 5) are taught by a teacher who had completed at least an undergraduate (bachelor's) degree, with 18% taught by teachers who had also completed a postgraduate degree. No data are readily available on the proportion with a mathematics qualification at this level.

Assessment and monitoring student progress in mathematics

A National Literacy and Numeracy Strategy was introduced in 2011, with specific references to TIMSS as one benchmark against which to evaluate and monitor the performance of Irish students within a broader strategy to enhance literacy and numeracy. The National Strategy to Improve Literacy and Numeracy (2011-2020) set out to raise standards in early childhood education and compulsory education settings through mobilising six arms of action: teachers, school leaders, parents and communities, curriculum, assessment, and support for those with additional needs.

The influence of the assessment frameworks and methodologies used in developing TIMSS and its counterpart the Progress in International Reading Literacy Study (PIRLS) is also evident in the design and administration of the regular National Assessments of Mathematics and English Reading (NAMER) in Ireland.

The Irish Education Act requires schools *"to regularly evaluate students and periodically report the results of the evaluation to the students and their parents."* Schools are required under the National Strategy to Improve Literacy and Numeracy (2011) to provide meaningful information to parents about student progress.

To assist them in this regard, the National Council for Curriculum and Assessment produced a range of report card templates and published assessment guidelines for primary schools in 2007, reflecting a wide range of assessment approaches at the primary level, such as teacher questioning and observation, conferencing, and student self-assessment. The National Strategy requires standardised test results in English, mathematics, and for Irish-medium schools, Irish to be reported to parents and to the Department of Education and Skills annually.

The Department of Education and Skills (DES) requires these results at two-year intervals throughout a child's primary schooling. In practice, yearly administration of standardised mathematics tests is almost universal for all students in primary schools. Individual schools choose their own assessment instruments, with the proviso that standardised tests have been normalised for an Irish population and are consistent with the Primary School Curriculum.

The National Strategy does not require individual schools to publish data, nor does it allow data to be used for the compilation of school comparison league tables.

Related developments too recent to affect the turnaround

These are developments mainly from 2015 or later as Ireland's TIMSS 2015 primary mathematics achievements showed significant improvement.

From 2015, the Junior Cycle Profile of Achievement (JCPA), (first awarded in 2017, introduced a more holistic approach to student assessment as part of wider reforms to the Junior Cycle curriculum. The JCPA incorporates classroom-based assessment and state examination results, as well as wider reporting on formal and informal learning, including wellbeing (as of 2020).¹⁵

An interim review in 2017 of the National Strategy to improve Literacy and Numeracy found considerable progress, especially in literacy. As a result, strategic priorities were revised, reinforcing the numeracy focus.

The 2017 STEM Education Policy Statement, was developed following stakeholder consultation, research, and the publication of STEM Education in the Irish School System. The three implementation phases cover enhancing ongoing activity (2017-19), including professional development, quality assurance and curricular reform; embedding activity through capacity building and coherence (2020-2022); and realising the vision (2023-2026).

As part of the 2018 Teacher Supply Action Plan, the DES introduced a teacher-sharing scheme for high-demand subjects (mathematics, science, and languages). For 2019/20, two schools had the right to jointly recruit a teacher, employing them on more hours than if recruited to a single school and thus optimising the workforce.

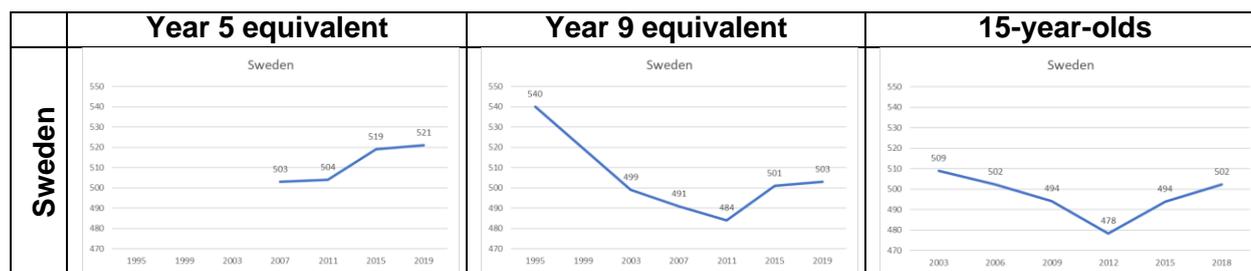
¹⁵ Golden et al., 2020.

Sweden

Background¹⁶

The Swedish education system is highly decentralised. Its parliament and the government define a national curriculum, while central authorities, municipalities, and various institutions ensure that education activities are implemented in line with the legislative framework.

Figure 3 Trends in mathematics achievement for Sweden



Improvement in TIMSS and PISA average mathematics scores have been seen since 2015 at all levels measured by these studies. These changes have occurred following curricula changes in 2011 and initiatives such as the Continuing Professional Development Programme for Teachers (from 2007). From 2012, PLD focusing on mathematics has reached over 80% of Swedish mathematics teachers. These initiatives have occurred over the period that changes in pedagogical practices were observed between 2007 and 2015.

Starting age and pre-primary education

More than 95 percent of 6-year-olds attended preschool class even before it was made mandatory (since the 2018–2019 school year a one-year preschool class is mandated for prior to turning 6 years old).

Compulsory education comprises nine years of schooling for children ages 7 to 16, although children may start school at age 6 if parents prefer.

Initial Teacher Education (ITE)

Teachers receive their education through a university teacher programme. Since 2011, teachers must apply for a certificate from the Swedish National Agency for Education to obtain permanent employment and to grade students.

Starting teacher salaries are close to the OECD average. However, teachers at the top of the scale are paid less than the OECD average.

Curriculum

The national curriculum for compulsory school was implemented in 2011 and revised in 2017 and 2018. It contains general goals, guidelines, syllabi, and knowledge requirements.

¹⁶ Main source: Axelsson 2020. Also refer to Peterka et al., 2017.

Pedagogical practices/teaching and learning activities

Examples of activities and organisational practices from TIMSS 2019 illustrating how Swedish teachers compare to their New Zealand counterparts in their approach to teaching mathematics include them rarely using same ability grouping practices and much less likely than New Zealand teachers with whole class and mixed ability grouping equally likely. Since at least 2007 Sweden has seen a large increase in its maths teachers helping students to memorise rules, procedures and facts, a practice much more common there than in New Zealand. Swedish teachers were equally as likely as New Zealand teachers to encourage their students to apply their learning to solving new problems.

The share of students at middle primary whose teachers ask them to memorise rules, procedures and facts in mathematics increased significantly from 2007 (6% of students) to 2015 (37% of students).¹⁶ This increase was higher than the OECD's average increase?¹⁷

More generally, Sweden has undergone a relatively high level of changes in classroom practices since 2007, and most of these changes appear to have been towards what research suggests are more effective practices, especially so in mathematics and reading. In mathematics, alongside the changes in memorising, there has been a spread of practices related to fostering students' higher order skills and independent knowledge acquisition. In reading, there has been a relatively large increase in the frequency of teaching reading as a whole-class activity. Sweden has reduced some forms of access to (and use of) computers in classrooms whose effectiveness doesn't appear well supported by evidence, while increasing others.¹⁸

Professional Learning and Development (PLD)

In 2007, the Continuing Professional Development Programme for Teachers was introduced to raise student achievement levels by improving teacher competence. Teachers were given the opportunity to deepen their competence in subjects in which they already had a degree, and to broaden their competence in subjects in which they lacked education.

Upon completion of the programme, teachers could apply for new subject accreditation. The National Agency for Education organised programme courses in cooperation with universities, and municipalities could apply for government grants to help cover the cost of reducing teaching hours for teachers who attended these courses. A new career reform programme for teachers was introduced in 2013, offering a substantial increase in salary for appointed teachers, paid by the government.

The uptake of this programme is reflected in TIMSS data where the proportion of students whose teachers participated in professional development in mathematics content increased substantially from 2007 to 2015, at both Year 5 and Year 9 equivalent levels. This increase was the largest observed at Year 9 and the second largest at Year 5 levels. Large increases at both levels were also observed for maths teacher participation in programmes on pedagogy and at the Year 5 level for PD on assessment.

Sweden does not require teachers to participate in continuous professional development, but 95% of Swedish teachers reported having participated in professional development activities in the previous 12 months (similar to the TALIS average of 94%).¹⁹

Sweden does not have a formal teacher appraisal system. While teachers may be evaluated collectively as part of school self-evaluation and school inspection, individual teacher appraisal is not regulated by law.

¹⁷ According to Vincent-Lancrin and colleagues, 2019. Over the same period, Ireland and Austria had very little change on how often this skill was taught.

¹⁸ Vincent-Lancrin et al., 2019.

¹⁹ OECD, 2019

Assessment and monitoring student progress in mathematics

Sweden pays close attention to the findings of international assessments such as TIMSS and PISA, which have sparked discussions of ways to improve performance in mathematics. In 2015, the OECD published *Improving Schools in Sweden: An OECD perspective* to support Sweden in response to their declining results in PISA. Its recommendations included:

- a. Establish the conditions that promote quality with equity across Swedish schools.
- b. Build capacity for teaching and learning through a long-term human resource strategy.
- c. Strengthen the steering of policy and accountability with a focus on improvement.

Sweden also monitors and assesses students in compulsory schooling through a system of national tests, diagnostic materials, and written reports with individual development plans and grades. The tests have been developed and constructed at several of the country's universities on behalf of the National Agency for Education.

These tests provide support for teachers in monitoring student progress according to the curriculum and syllabus and support teachers in assigning grades. The National Agency for Education also provides diagnostic materials, tests, and individual test items that are intended to highlight individual student strengths and weaknesses, to help teachers monitor student progress and make impartial judgments.

National mathematics tests are provided for students at three-year intervals through their schooling: equivalents to New Zealand's Years 4, 7 and 10.

Each school decides how to assess progress further in different subjects. At least once a semester, students and their parents receive progress reports and meet with teachers to discuss student progress and how learning can be stimulated and supported (development dialogues).

Progress reports are regulated by law. Parent-teacher meetings on student progress serve as a substitute for annual progress reports and grading until School Year 6 and continue throughout compulsory school.

Special initiatives in mathematics and science education

In 2012, an extensive in-service training initiative was launched, aiming to reach all teachers of mathematics in primary, secondary, and adult education in Sweden with a one-year programme. The initiative also targets preschool teachers and teachers in preschool classes. This initiative also included a five-day course for school leaders.

Within the initiative, teachers were given time to work collaboratively on modules presented in a web-based portal. The modules focus on different aspects of mathematics education and comprise different activities (e.g., reading texts, watching classroom films developed for the programme, discussing material with colleagues, and trying out ideas in the classroom). Groups of teachers work through the modules together, supported by tutors who are skilled mathematics teachers trained to support the programme.

Preliminary evaluations show that the initiative has been successful. By the end of the project in 2016 it had reached around 80% of Swedish mathematics teachers. The Web-based portal is still being maintained, and teachers still continue to use the material.

Related developments too recent to affect the turnaround

These are developments from 2015 or later as improvements were apparent in both TIMSS 2015 and PISA 2015.

A new *Teacher Salary Boost* initiative earmarked an additional SEK 3 billion (USD 339 million) per year in the budget for teacher salaries starting in 2016.

To both address the teacher shortage and foster quicker integration for migrants, Sweden implemented a Fast Track for Teachers programme in 2016. Newly arrived teachers could have their qualifications validated quickly and enter a fast-track teacher training programme.

In 2016, the Inquiry on National Tests proposed a new national system for assessing knowledge, consisting of three components: national tests, national assessment support materials and national knowledge evaluation.

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We **shape an education** system that delivers
equitable and excellent outcomes

He mea **tarai** e matou te **matauranga**
kia **rangatira** ai, kia **mana taurite** ai ona **huanga**