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Investigating high achievement in mathematics and science in Ireland: An in-depth analysis of national and international assessment data

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Research context

"**higher-achieving students** (those scoring at the 90th percentile) achieved a [PISA] score that was 14 points lower than the OECD average score at that benchmark. Hence, while low-achieving students in Ireland did reasonably well, **higher achievers** underperformed relative to students elsewhere" (Shiel et al., 2007, p. 46)

"According to the Action Plan for Education 2018, the proportion of **students achieving at Level 5 or above** in [PISA] mathematics needs to be increased to 13% by 2020 and 10% in disadvantaged post-primary schools and accordingly, to 10% for science by 2025" (Government of Ireland, 2018)

"The [Project Maths Implementation] Group considered that the needs of **high achievers** are not particularly well met by the current system. The needs of the top performers should be addressed. This group of students represents a real resource to Ireland and not optimising the potential that they represent undermines our goal of a smart economy. It is beyond the remit of this Group to develop a programme to meet these students' needs but their talents should be capitalised on" (Department Of Education and Skills, 2010, p. 36)

"In order to challenge **higher-performing students** to achieve to their full potential, we need to focus on developing their cognitive skills to a greater extent by focusing on skills development as provided for in the primary and post-primary curricula." (Department of Education and Skills, 2018, p. 97)

Research problem

limited numbers

of students at the highest levels of performance in mathematics and science

underperformance

of students at the highest national percentiles in mathematics and science

lack of research

on the magnitude and consistency of these issues and the factors predicting high achievement

Research aim

An in-depth, longitudinal investigation of high achievement in mathematics and science across student cohorts, education levels, and national and international large-scale assessments and examinations in Ireland

complementary use of national and international assessment data to address research questions

similarities and differences across large-scale assessments

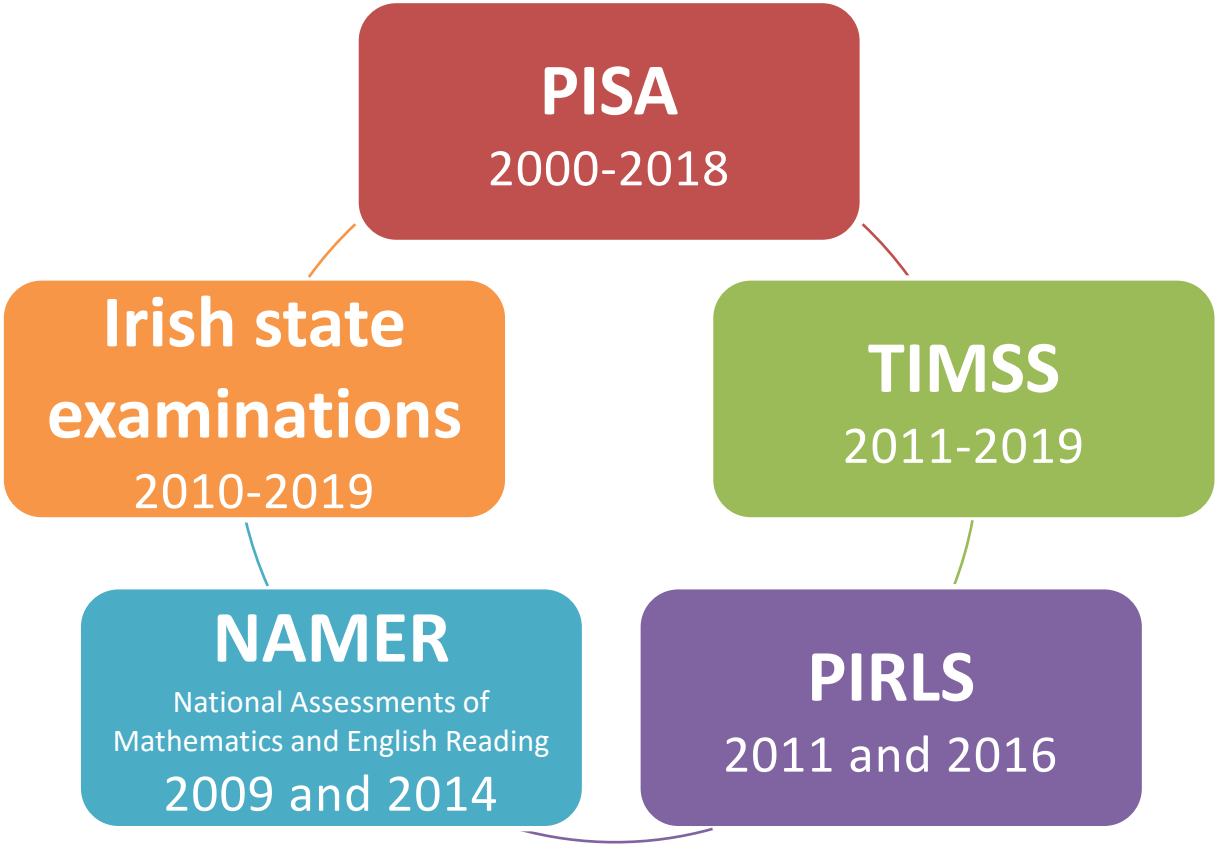
infrequently used approaches for analysis of assessment data

Research questions

1. To what extent do issues related to high achievement in mathematics and science, as noted in a range of national reports and educational policy documents, hold across education levels, student cohorts, and national and international assessments in Ireland?

2. Which student, home, class, and school characteristics predict high achievement in mathematics and science in national and international assessments at primary and post-primary levels in Ireland?

Data and samples



Outcome variable

high achievers vs. non-high achievers

PISA	TIMSS & PIRLS	NAMER	Irish state examinations
proficiency levels 5 and 6 **vs** proficiency levels 4 and below	advanced international benchmark **vs** high international benchmark and below	proficiency level 4 **vs** proficiency level 3 and below	grade A (JC)/grades A1, A2 & B1 or 1 and 2 (LC) **vs** all other grades

Analysis

Stage 1: descriptive analysis

Ireland's mean performance, percentages of high achievers, and performance at key percentiles in mathematics, science, and reading and comparisons to international averages and similarly performing countries

Stage 2: bivariate analysis

profile-building exercise for high achievers in mathematics and science in comparison to non-high achievers and selection of predictor variables for the multivariate analysis

Stage 3: multivariate analysis

hierarchical two-level binary logistic regression models examining the contribution of selected student, home, class, and school variables in the prediction of high achievement in mathematics and science

issues = limited numbers & underperformance of high-achieving students

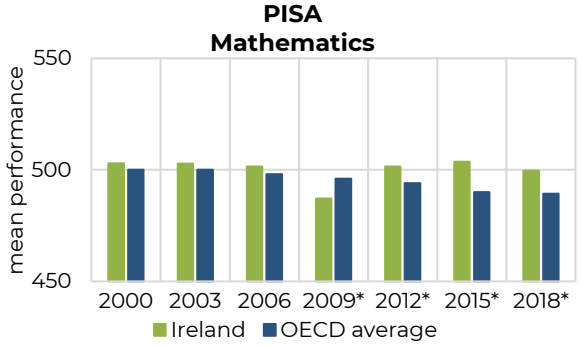
Research question 1

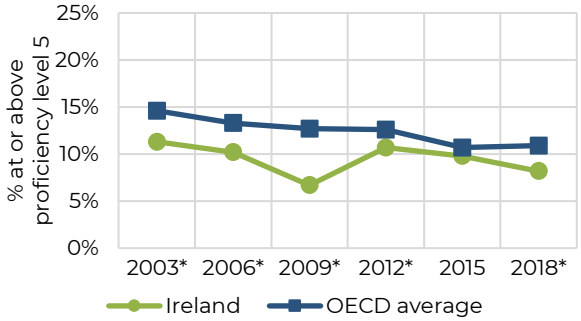
To what extent do issues related to high achievement in mathematics and science, as noted in a range of national reports and educational policy documents, hold across education levels, student cohorts, and national and international assessments in Ireland?

Mean performance and percentages of high achievers in mathematics, science, and reading in Ireland compared to international averages

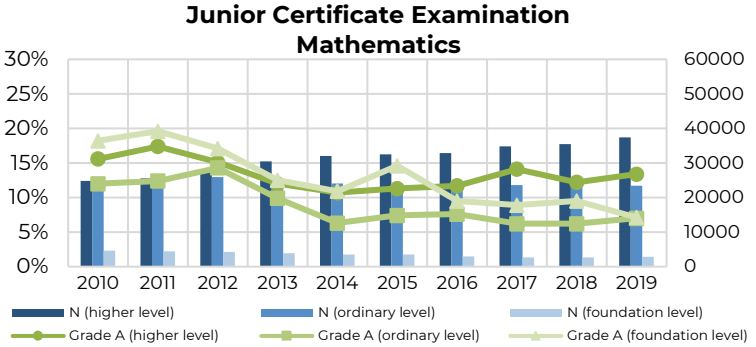
Mean performance and percentages of high achievers in Ireland

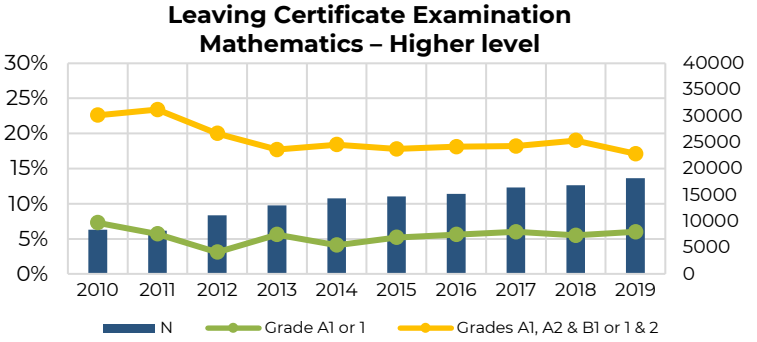
- **Higher mean performance** in mathematics, science, and reading compared to OECD, TIMSS, and PIRLS averages
- **Lower-than-expected percentages of high achievers** in mathematics and science especially at post-primary level
- **Stable or decreasing proportions of high achievers** in the Irish state examinations





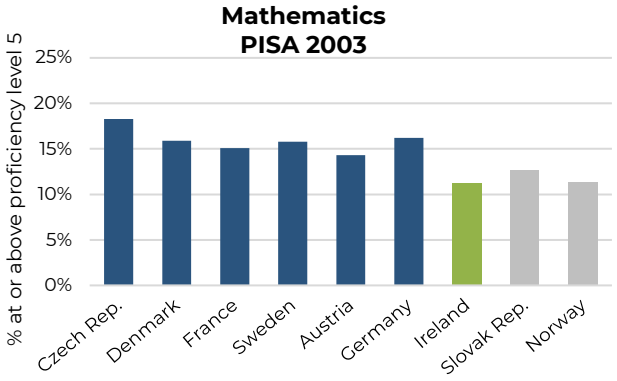
**Statistically significant difference between Ireland and the OECD average.*

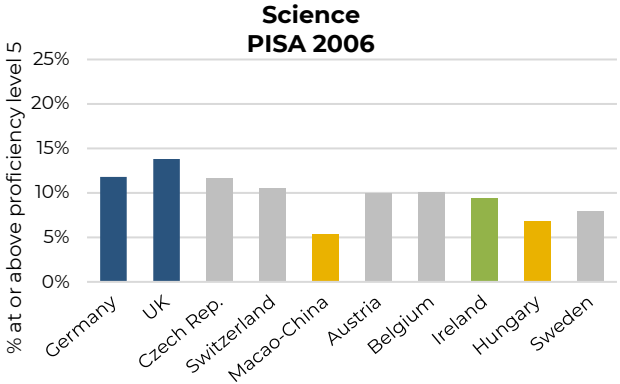


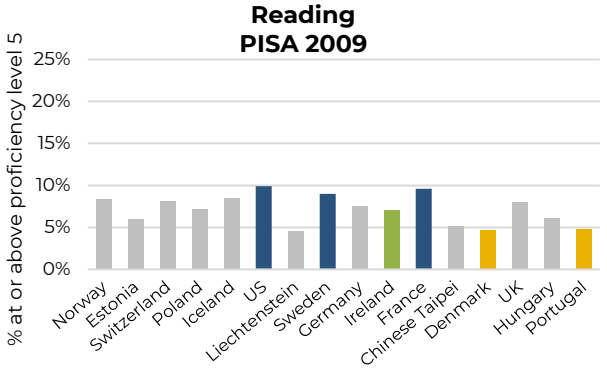


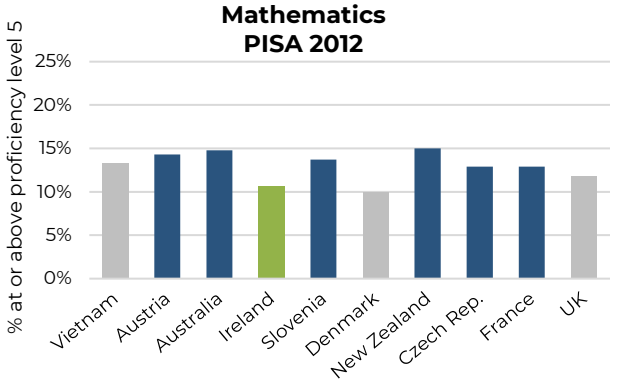
Percentages of high achievers in mathematics, science, and reading in Ireland and similarly performing countries

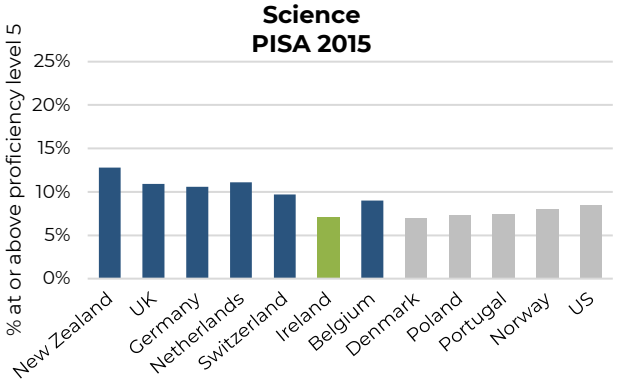
Percentages of high achievers in mathematics, science, and reading in Ireland and similarly performing countries – PISA

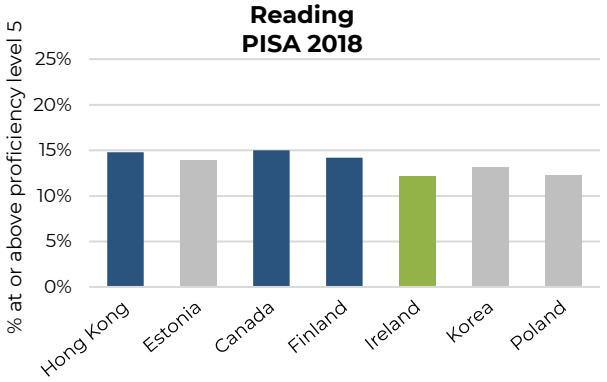






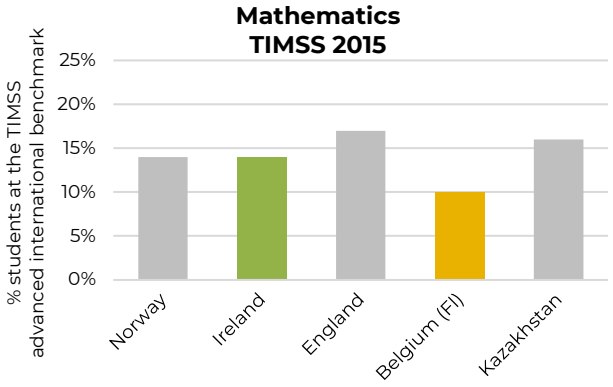


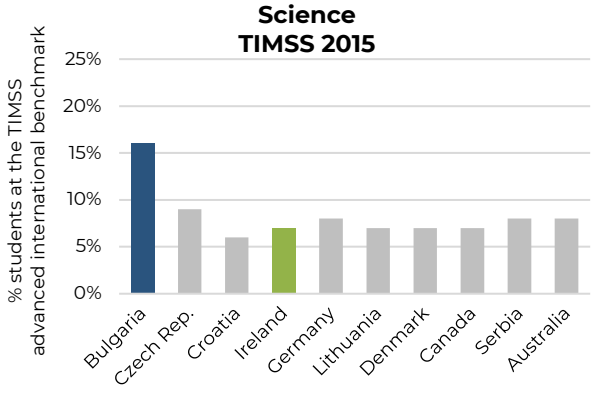


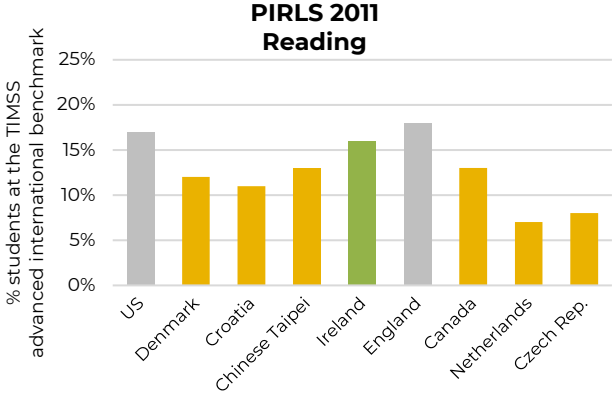


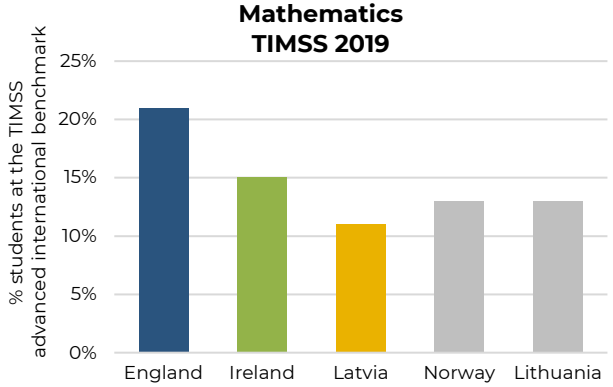
% **statistically significantly** higher than Ireland	% **not statistically significantly** different from Ireland	% **statistically significantly** lower than Ireland

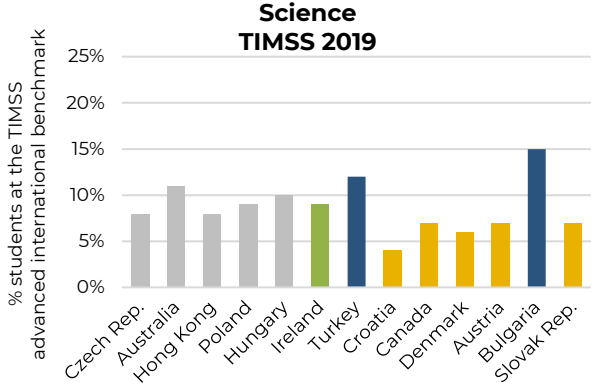
Percentages of high achievers in mathematics, science, and reading in Ireland and similarly performing countries – TIMSS & PIRLS, grade 4

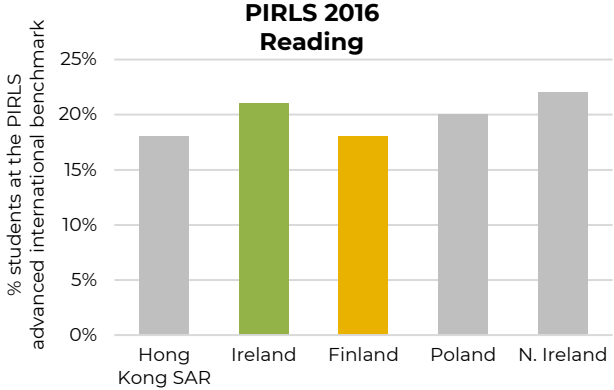












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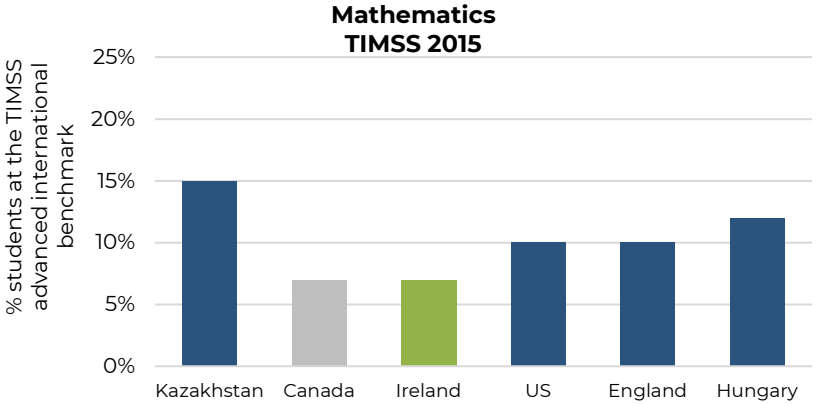
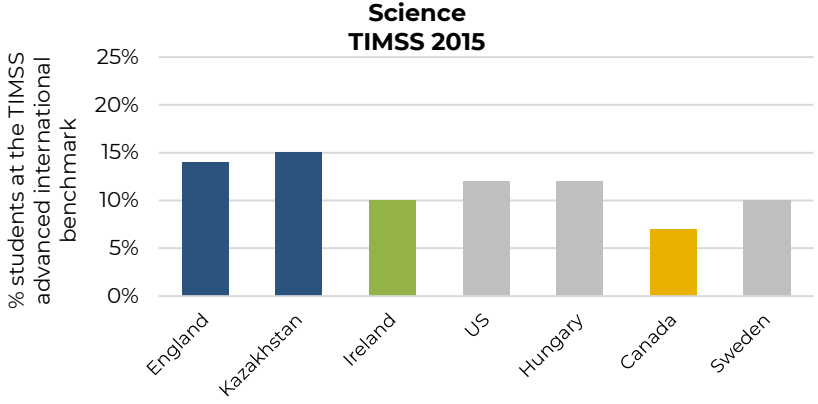
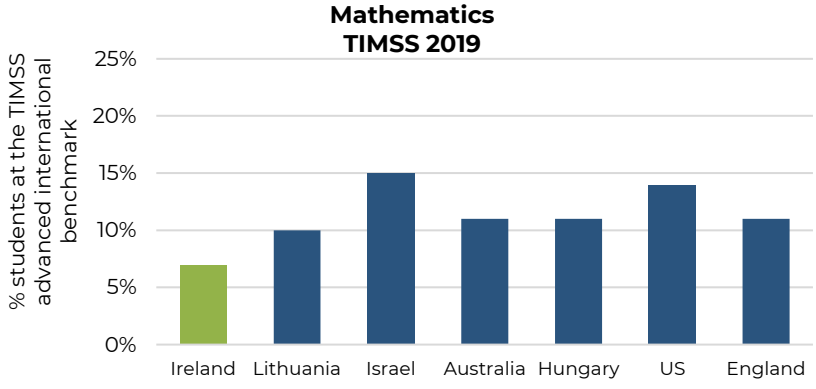
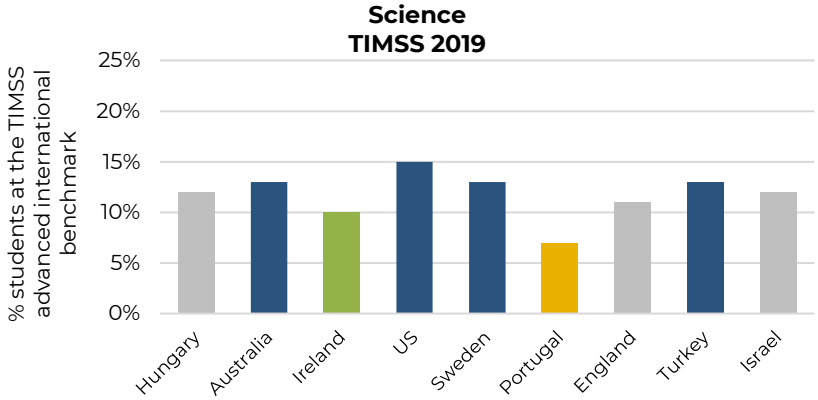
Percentages of high achievers in mathematics and science in Ireland and similarly performing countries – TIMSS & PIRLS, grade 8









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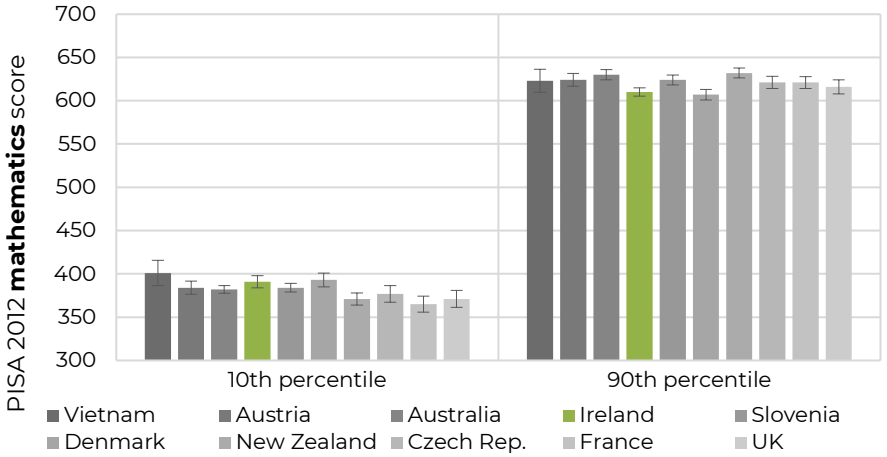
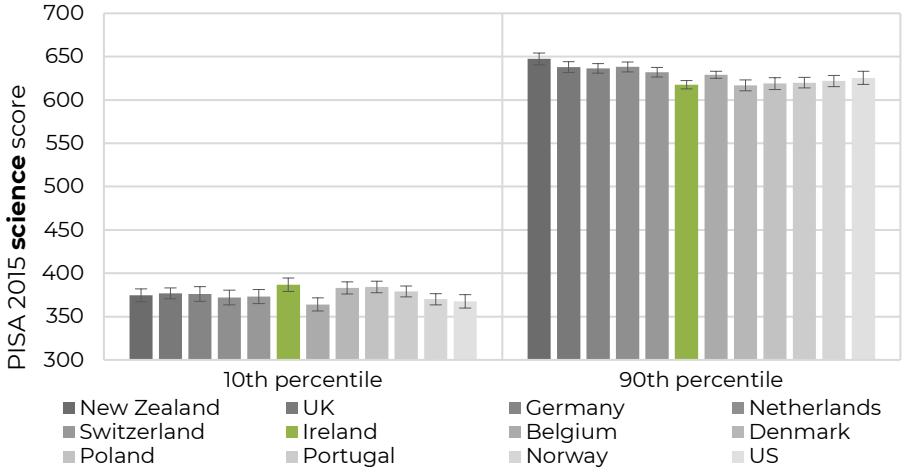
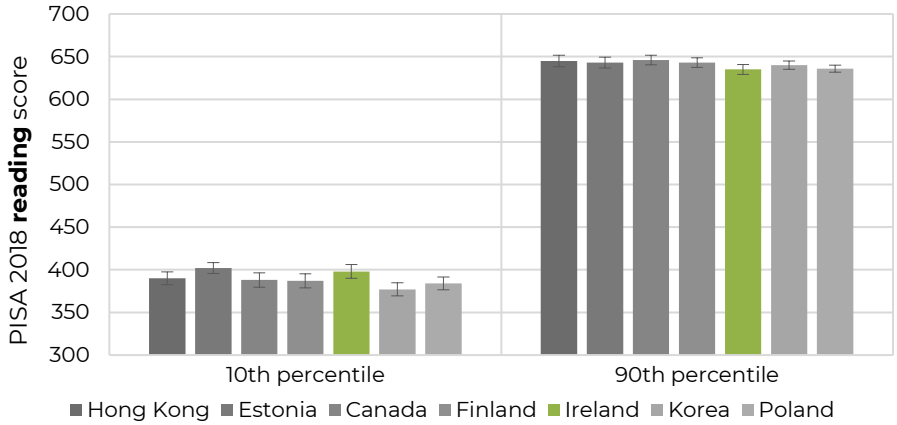
Performance at key percentiles in mathematics, science, and reading in Ireland and similarly performing countries

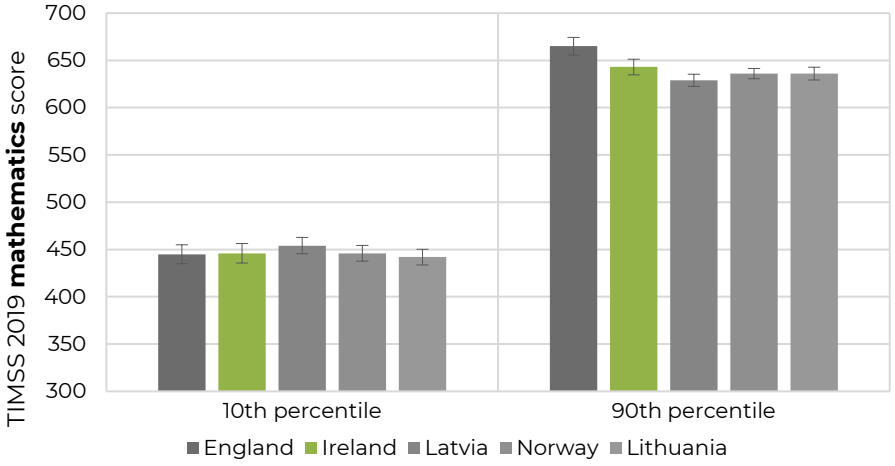
Scores at the 10th and 90th percentiles in mathematics, science, and reading in Ireland and similarly performing countries – PISA

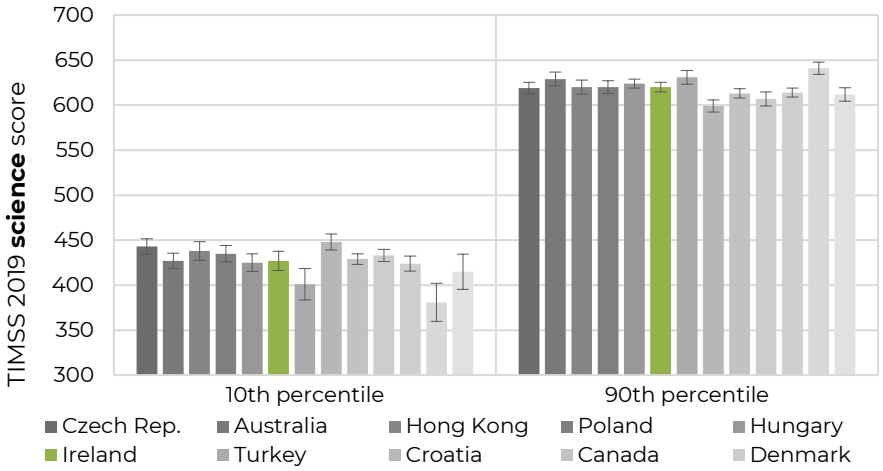


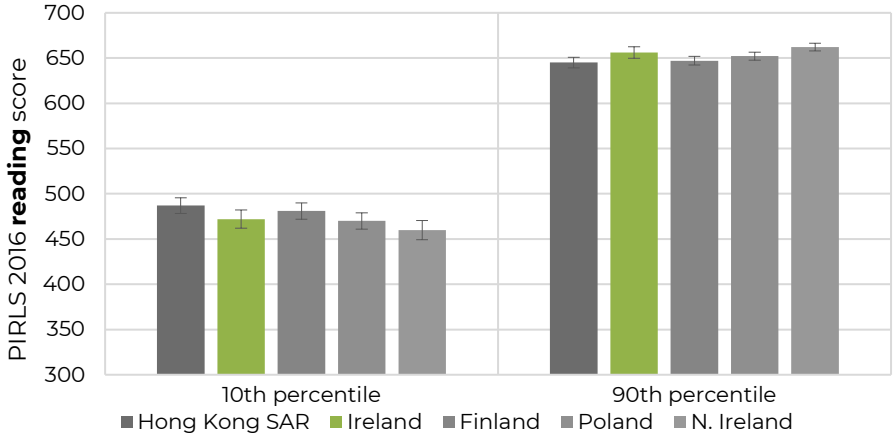




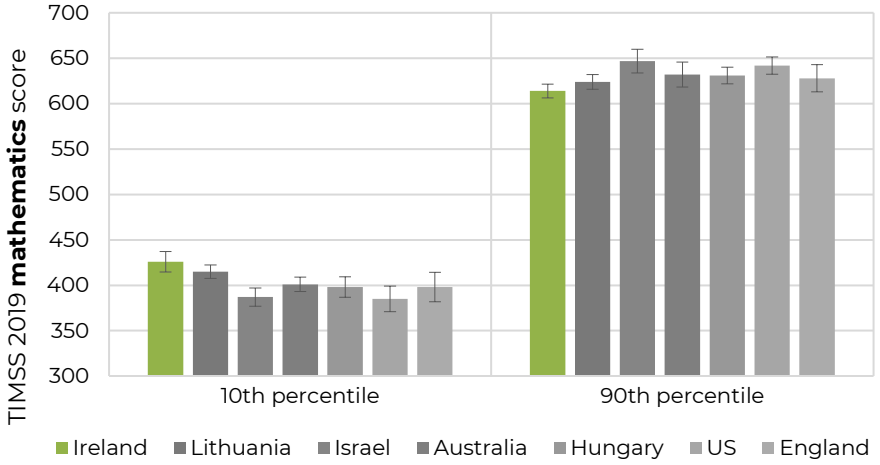
Scores at the 10th and 90th percentiles in mathematics, science, and reading in Ireland and similarly performing countries – TIMSS & PIRLS, grade 4

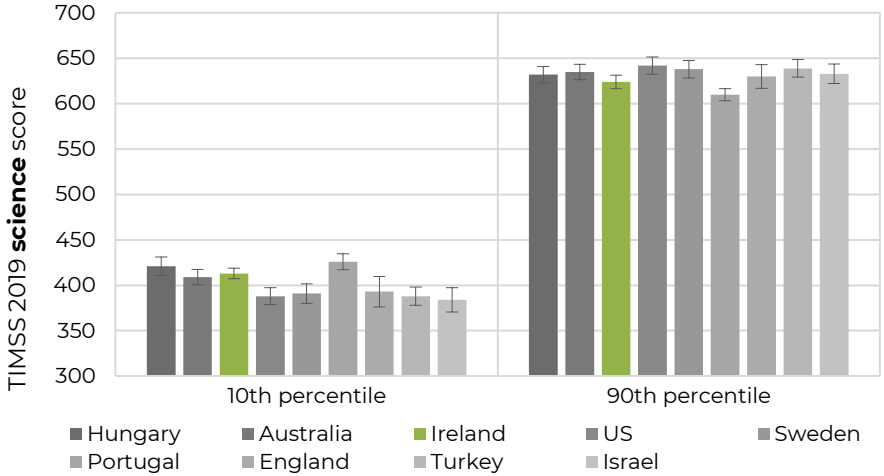






Scores at the 10th and 90th percentiles in mathematics, science, and reading in Ireland and similarly performing countries – TIMSS, grade 8





Summary of findings – Research question 1

different performance patterns across mathematics, science, and reading

lower percentages of high achievers in mathematics and science in Ireland compared to similarly performing countries

lower scores among students at the highest percentiles of mathematics and science in Ireland compared to similarly performing countries

more apparent differences in mathematics than science, and at post-primary than primary level

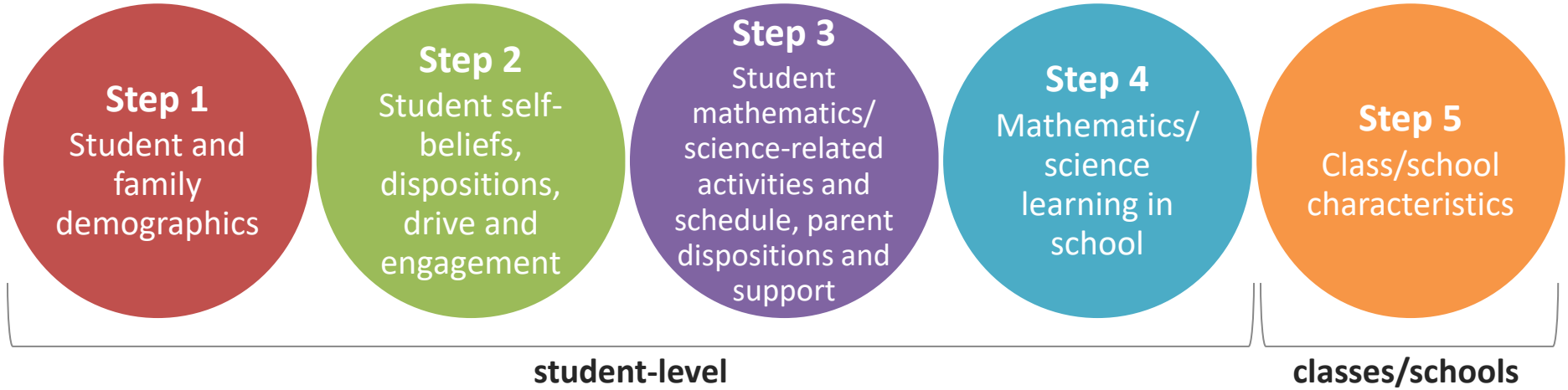
consistent findings across student cohorts and assessments

majority of **national targets** for high achievement **have not been met**

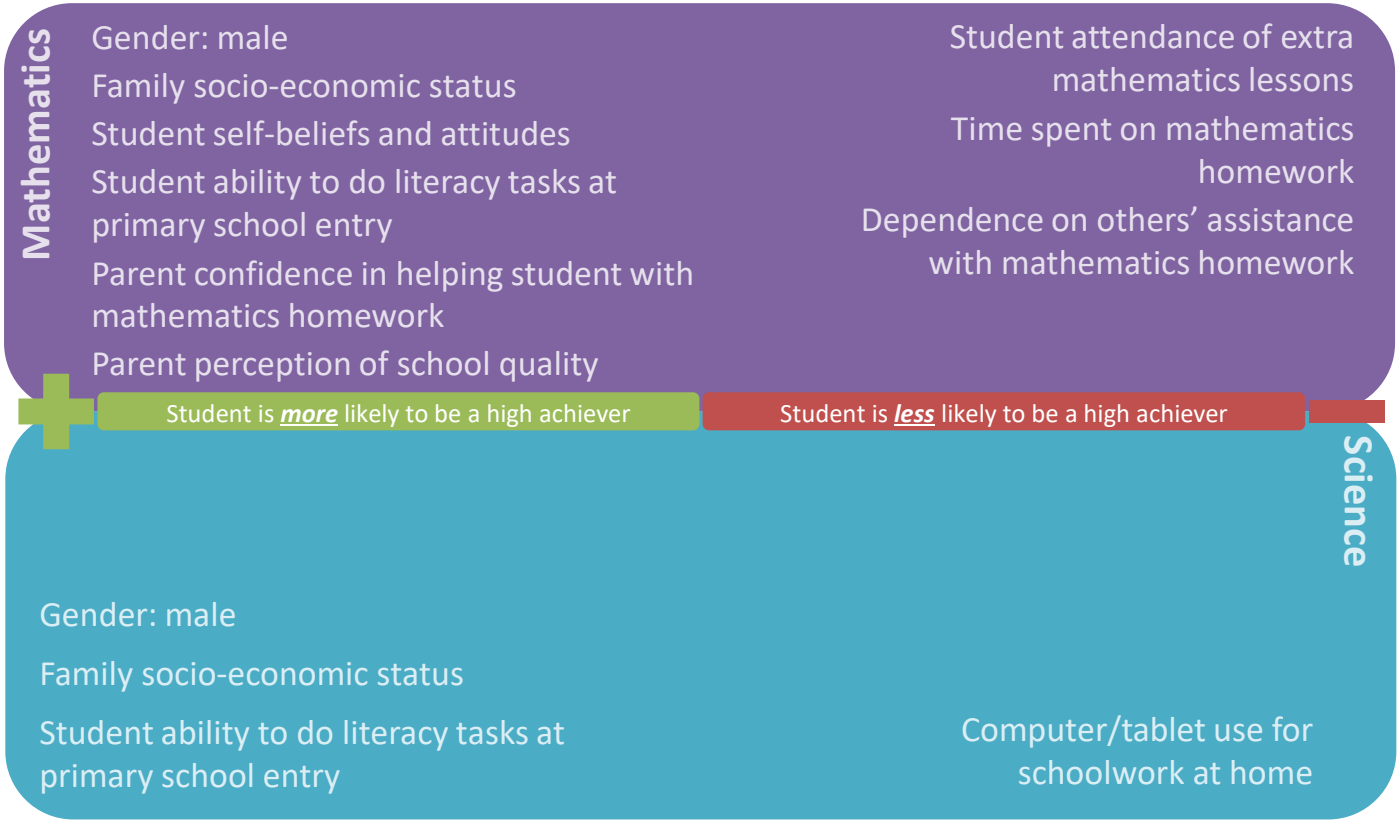
Research question 2

Which student, home, class, and school characteristics predict high achievement in mathematics and science in national and international assessments at primary and post-primary levels in Ireland?

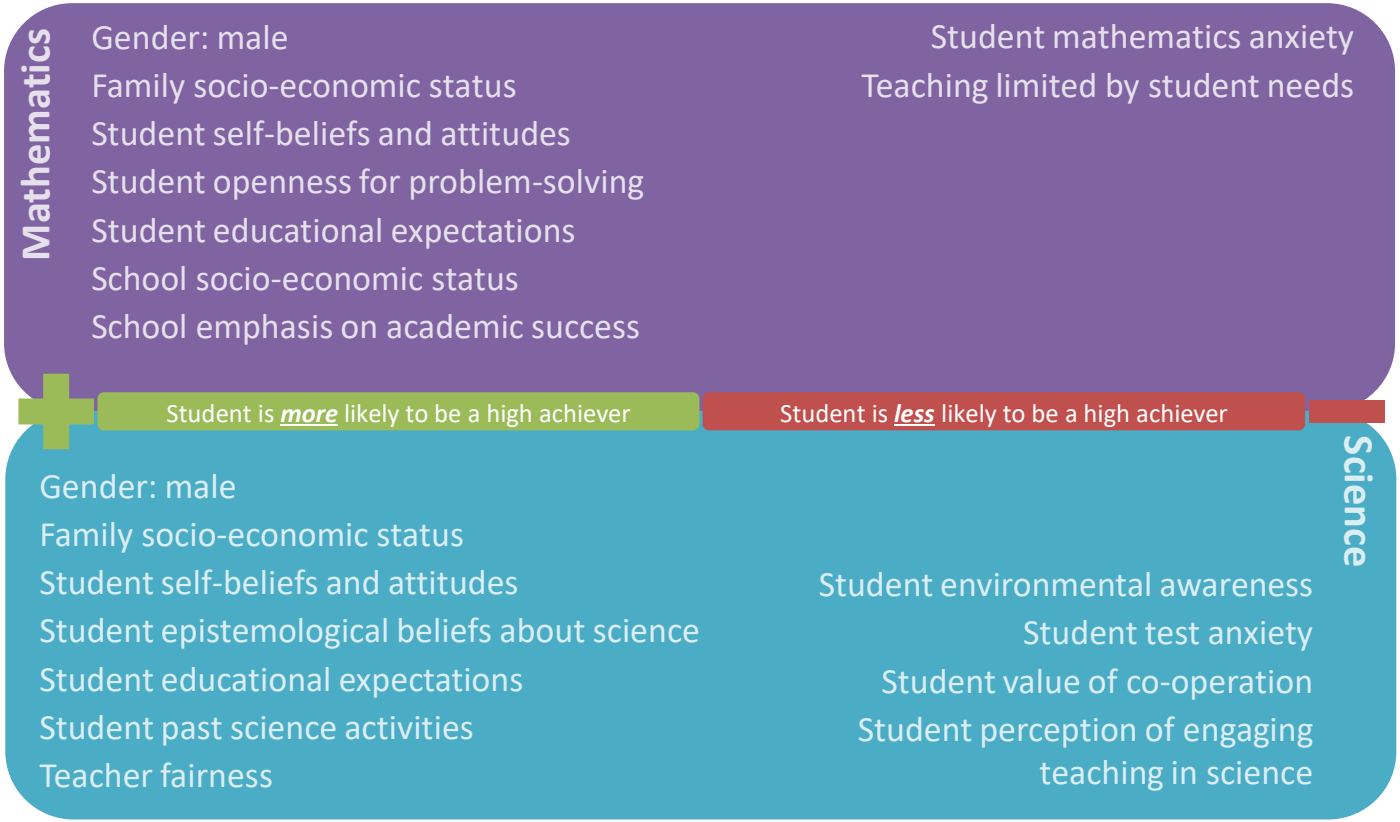
Hierarchical two-level binary logistic regression models



Model results for primary level – TIMSS & NAMER



Model results for post-primary level – PISA & TIMSS



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Summary of findings – Research question 2

- **Average explained variance**
  - Student level: 41.4% (*SD* = 11.7)
  - Class/school level: 42.3% (*SD* = 26.7)
- **Student and family characteristics** were found to be more robust predictors of high achievement in mathematics and science compared to class and school characteristics
- Most **consistent predictors** of high achievement
  - family socio-economic status
  - student self-beliefs and attitudes
  - student early knowledge and skills
  - student engagement with mathematics and science at home
- **Sex differences** – more pronounced than for overall achievement

Contribution and implications

- **First detailed analysis of high achievement** in mathematics, science, and reading across student cohorts, education levels, and assessments in Ireland
- **In-depth evidence** regarding the magnitude and consistency of issues pertaining to high achievement and the profiles of high achievers
- **Crucial role of family** – home-school collaboration
- Importance of examining different **levels of performance**
- Part of the core documentation for the ***New Literacy, Numeracy and Digital Literacy Strategy*** (Kennedy et al., 2023)

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My PhD journey & the Kathleen Tattersall Award

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Examiners: *Dr Eugenio Gonzalez* (ETS) & *Dr Maurice O'Reilly* (DCU)

Thank you!

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