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RESEARCH BRIEFING

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EXPLORING THE CHARACTERISTICS OF EDUCATION SYSTEMS WHICH ARE SUCCESSFUL IN SCIENCE

KEY FINDINGS

- There is no single model for successful science education however in Northern Ireland science seems to have less prominence in the classroom than in a number of education systems that were more successful in science in TIMSS 2011.
- Primary pupils in Northern Ireland are at least three times less likely to be taught science as a separate subject, compared to the comparator education systems that were more successful in science in TIMSS 2011. This finding is true even for countries where science is taught as part of an integrated curriculum.
- Primary teachers in Northern Ireland are much less likely to assign science homework or administer written tests or quizzes in science and place much less emphasis on monitoring pupil progress in science than their counterparts in the comparator countries.

Northern Ireland Statistics & Research agency

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INTRODUCTION

TIMSS is a worldwide research project taking place every four years and providing data about trends in mathematics and science achievement over time. It assesses the knowledge and skills of pupils aged 9–10 and 13–14 around the world and enables researchers to collect extensive background information about pupils home and learning environments and the quantity, quality and content of teaching. This information can be used to provide educational policymakers, school leaders, teachers and researchers with powerful insights into how educational systems are functioning as well as how to improve teaching and learning in mathematics and science for pupils around the world.

Northern Ireland participated in TIMSS for the first time in 2011 – participating in the assessment of 9 and 10 year olds. Pupils in Northern Ireland performed very well in TIMSS 2011 mathematics, significantly outperforming 44 of the 50 participating countries. However their performance in science was not as strong with 17 countries doing significantly better in science. In March 2015, the Department of Education (DE) commissioned NFER to conduct secondary analysis of the Trends in International Mathematics and Science Study (TIMSS) 2011 data and encyclopaedia to explore the characteristics of seven education systems (Czech Republic, England, Finland, Hungary, the Netherlands, Sweden and the Slovak Republic) which outperformed Northern Ireland in the TIMSS 2011 science assessment.

AIMS AND OBJECTIVES OF THE RESEARCH

The objectives of this research are:

- To look at the profile of science (curriculum, teaching, pupils' views and the assessment of science), as reported in TIMSS 2011, within a set of comparator education systems that were more successful in the TIMSS science assessment.
- Compare the findings for these successful education systems with science education in Northern Ireland.
- Highlight important differences that could be used to inform policy for primary science education in Northern Ireland.

MAIN FINDINGS

Northern Ireland does not stand out as particularly different from the seven comparator countries in most of the areas science education explored, including:

- the amount of teaching time devoted to science teaching
- teacher specialisation
- pupil engagement
- teacher confidence
- content coverage.

Compared to the other countries studied, a far greater proportion of pupils in Northern Ireland are not taught science as a separate subject (as reported by their teachers). In some of the comparator countries (the Czech Republic, Finland, Hungary and the Slovak Republic) science is not only separated out as a subject but separate sciences are taught at the higher primary grades.

Teachers in Northern Ireland report setting less science homework than most other countries, with only the Netherlands have a greater percentage of pupils being taught by teachers who say they set no homework.

Teachers in Northern Ireland are also most likely to report never setting tests or quizzes and to place much less emphasis on monitoring pupil progress in science through either classroom or external achievement tests.

The key information about primary science in the seven comparator countries, Northern Ireland (NI) and the international average (Int. Average) is shown in the tables below. A certain amount of caution needs to be exercised in interpreting these tables; they show what the situation is but do not link that information to policy and practice in the various countries or imply causality.

Key to countries: CZ (The Czech Republic); EN (England); FI (Finland); HU (Hungary); NL (the Netherlands); SV (The Slovak Republic); SW (Sweden)

Science as a separate subject

	NI	CZ	EN	FI	HU	NL	SV	SW
Separate sciences at primary level	X	✓*	X	✓*	✓*	Schools choose	✓*	Schools choose

* Yes, at the later primary grades

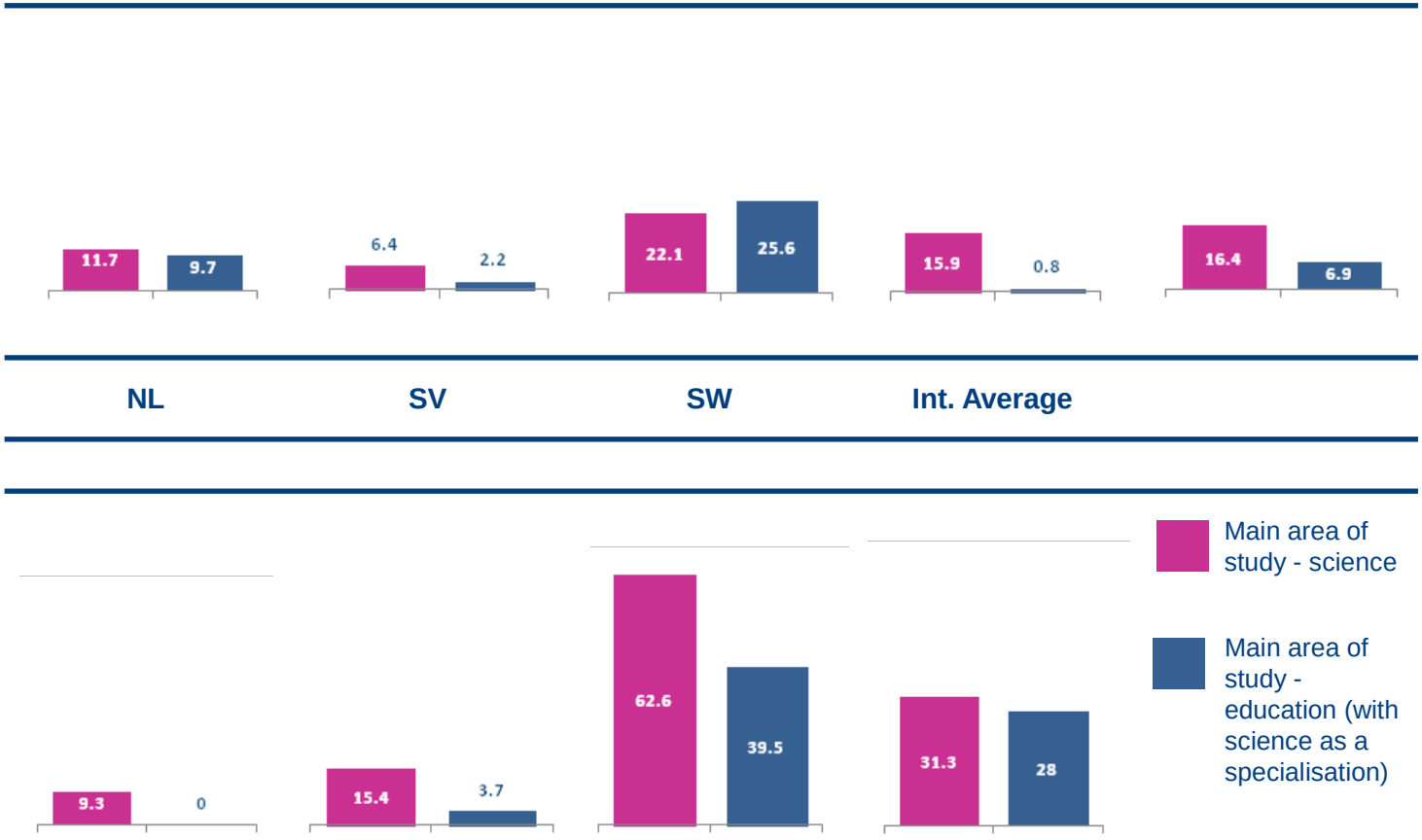
	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
% of pupils not taught science as a separate subject at primary level									
	72.3	9.2	13.3	3.7	7.4	18.7	2.7	21.9	23

	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
Teaching hours per year devoted to science teaching	72 *970	60 *782	76 *970	98 *779	72 *760	42 *1074	101 *780	75 *849	85 *897

* Total number of teaching hours per year

Specialisation in science

% specialist teachers where main area of study is science and where main area of study is education (with science as a specialisation)



	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
% of pupils where teaching in the school is not limited by a lack of teachers with specialisation in science*									
	24.6	**72.6**	**34**	**34.8**	**70.7**	**17.7**	**66.7**	**33.9**	**37.3**

* Reported by the school principal

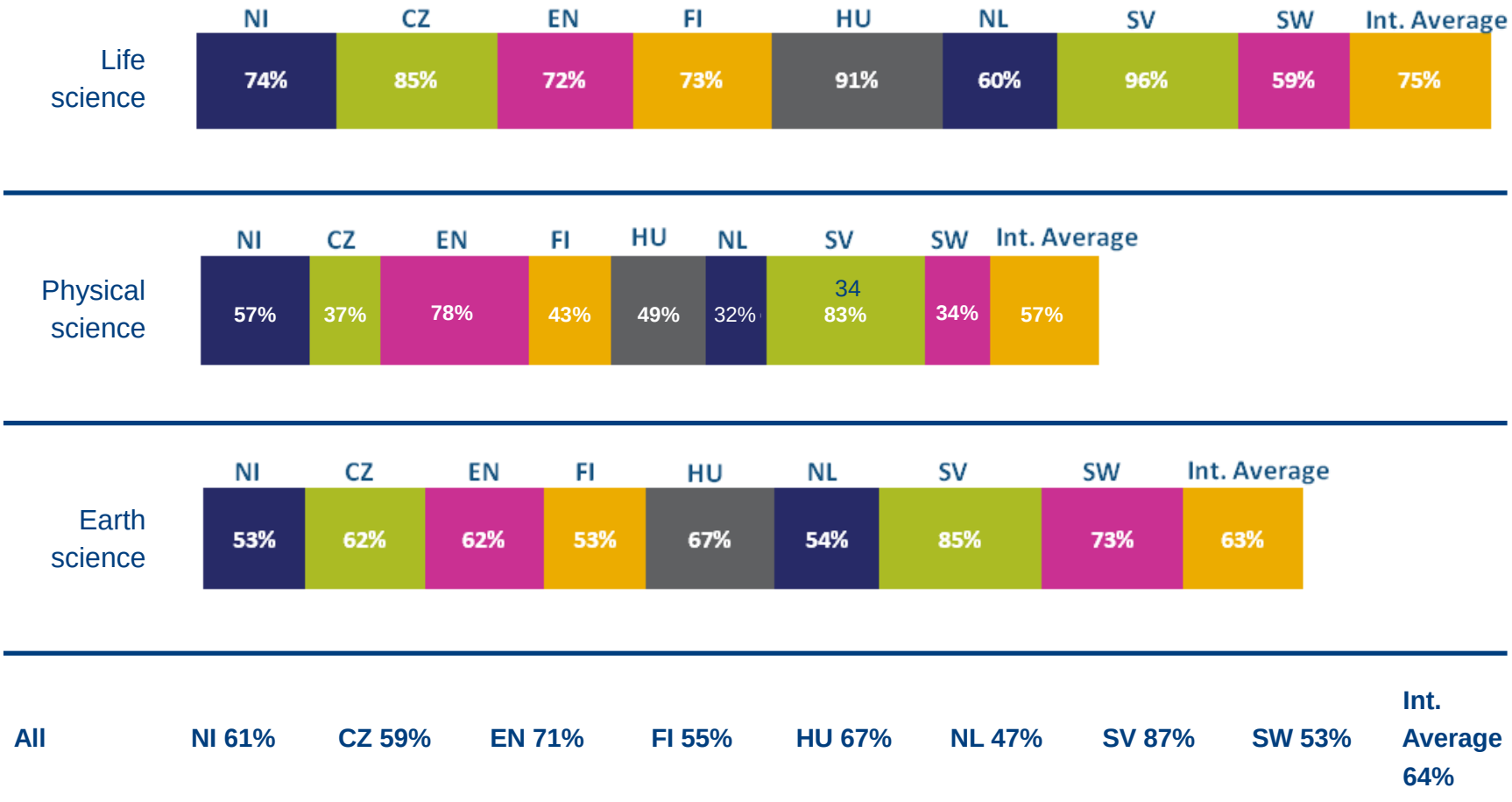
Classroom practice (only areas that show Northern Ireland as an outlier are shown)

	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
% of pupils whose teachers never assign science homework*	62.1	5.5	39	0.7	2.8	68.9	15.4	45.8	18.3

	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
% of pupils whose teachers never administer written tests or quizzes in science*	39.4	0	19.2	1.8	0	25.4	0.6	30.9	6.2

* at Primary level

TIMSS Grade 4 science topics: % of pupils mostly taught the topic before or in the assessment year



All	NI 61%	CZ 59%	EN 71%	FI 55%	HU 67%	NL 47%	SV 87%	SW 53%	Int. Average 64%

* Grade 4 pupils are ages 9 to 10

Monitoring pupil progress in primary science

% of pupils whose teachers use the following methods to monitor pupil progress in primary science

	NI	CZ	EN	FI	HU	NL	SV	SW	Int. Average
Evaluation of pupils' ongoing work									
	96.1	100	100	99.6	100	92.1	100	96.2	98.5
Classroom tests									
	54.7	99.6	77.1	98.5	97.9	78.9	98.8	76.0	93.0
National or regional achievement tests									
	27.2	37.7	52.3	21.7	78.5	41.7	71.5	61.2	67.7

CONCLUSIONS AND IMPLICATIONS FROM THE RESEARCH

The aim of this research is to provide the DE with information that will inform policy and practice in improving the science attainment of primary pupils in Northern Ireland. Based on the secondary analysis of the TIMSS 2011 data and Encyclopaedia, we have outlined below some implications that DE may wish to give consideration to.

The comparator countries tend to teach science as a separate subject in primary education. This is an area that policy makers in Northern Ireland might wish to explore in order to improve primary science attainment.

Attainment in science could be potentially improved by raising the profile of science by separating it out more within the subject area 'the world around us', possibly looking at how the Dutch approach science within the 'personal and world orientation' subject area as a model.

Alternatively, attainment in science could be potentially improved by raising the amount of formal monitoring of science learning using classroom or external assessment.

Policy makers would need to review the extent of curriculum changes, and the impact on teachers and any teacher specialisation required, before deciding whether separating out science more within the curriculum would be feasible. It might also be that without accompanying monitoring or accountability changes the way science is taught will not change and the situation will not measurably improve.

This analysis shows that in a number of the comparator countries there is a greater emphasis on the use of national tests to monitor pupil progress. However, given the potential resource implications it would be harder to justify this as a policy recommendation without conducting further evidence gathering and exploring in more detail how other countries use national monitoring tests in science and whether there are links between the use of such tests and improved attainment in science.

It might be worth looking in more detail at how classroom tests are used in the comparator countries to see if any of the models provide a potential solution for Northern Ireland.

METHODOLOGY

The research focussed on countries which outperformed Northern Ireland in TIMSS 2011 in science at Grade 4[1], that is the countries that had scale scores for science that were significantly higher than Northern Ireland's mean scale score. Seventeen countries outperformed Northern Ireland and, of these countries, 12 outperformed Northern Ireland only in science.

[1] **This is Year 6 in Northern Ireland (pupils aged nine and ten)**

TIMSS participants out performing Northern Ireland only in science	
12 countries with their TIMSS scores	
Finland	**(570)**
Russian Federation	(552)
United States	(544)
Czech Republic	**(536)**
Hungary	**(534)**
Sweden	**(533)**
Slovak Republic	**(532)**
Austria	(532)
Netherlands	**(531)**
England	**(529)**
Denmark	(528)
Germany	(528)

The seven countries in bold are the countries selected for in-depth comparison. The research constructed a profile of each country, which includes curriculum and system-level information taken from the TIMSS Encyclopaedia, as well as information about teaching practices, assessment practices and pupil views extracted from the TIMSS international data sets. As the TIMSS data was collected in 2011, a review was undertaken to ensure that any changes since 2011 that impact on the science curriculum and teaching are referenced in the relevant country profile.

Each country profile includes the following information from the TIMSS Encyclopaedia:

- a description of the science curriculum at primary level
- a description of the use of teaching materials, including technology, equipment and laboratories for primary science
- information about teacher education for primary science teachers and requirements for continued professional development
- information about national assessment of science at primary level
- information about whether any special programmes exist to support science education in the country.

To further elaborate what happens in the classroom, the country profiles also examine responses to the following questions from the TIMSS teacher questionnaire:

- whether science is taught as an integrated subject
- teacher confidence in teaching specific areas of science and how well prepared they feel to teach science
- how much time is spent on practical aspects of science
- what resources are used to teach science
- what topics are covered and what content is taught in science lessons
- how often pupils are given science homework
- monitoring pupil progress in science.

Information from responses to the following question from the school questionnaire:

- how is the school's capacity to provide instruction affected by a shortage or inadequacy of a number of different resources.

The profiles also include information from responses to the following questions from the pupil questionnaire:

- views about learning science
- views about their science lessons.

THE PROJECT

The project was undertaken for the Department of Education by the National Foundation for Educational Research (NFER).

FULL REPORT

The full research report entitled “Exploring the characteristics of education systems which are successful in science” is available on the Department of Education website.

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