Enhance the Attractiveness of Studies in Science and Technology

WP 6: Formal Barriers

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WP 6: Formal Barriers

Aim of the Work Package:

To examine the formal barriers
to engineering education at third-level

WP6 Key Deliverables

- Survey of education systems in partner countries
- Comparison Framework
- Report on formal barriers to engineering higher education

Status of Deliverables
1: Survey of Education Systems

Current Status: Completed

- Completed questionnaires received from five partner countries
- Survey data used to inform other WP 6 deliverables
- Full questionnaires will be included as appendices to final WP 6 report

Status of Deliverables
2: Comparison Framework

Current Status: Completed (subject to final comments/feedback)

- Data received from five partner countries
- Aim is to provide ‘at a glance’ information for comparing partner countries under key headings, relevant to all work packages
- Combination of graphs, tables and textual information used

Status of Deliverables
3: Report on Formal Barriers

Current Status: Gathering and processing data

- Data received from four partner countries

- Combination of quantitative & qualitative data

Table 1: Overview of partner universities[1]

	Aalto University	Trinity College	PoliTo	IST	KTH	Uppsala
Country	Finland	Ireland	Italy	Portugal	Sweden	Sweden
University Type	Multi-disciplinary	General	Technical	Technical	Technical	Multi-disciplinary
National Ranking	n/a	#1	#2[2]	#2[3]	#4	#3
Core Funding Sources	Government: 71%	Government: 66%	Government: 45%	Government: 41%	Government: 80%	Government: 80%
	Private donations: 29%	Student fees: 24%	Student fees: 10%	Student fees: 9%	Private sources: 13%	Public funds: 8%
		Other: 10%	Research income: 43%	Other (own income): 50%	Other: 7%	Private sources: 12%
			Other: 2%			
# of students studying to degree/accredited professional level	17,020	11,290	18,792	9,445	14,000	20,000
• % studying engineering	25% (4,289 students)	6% (700 students)	75% (14,053 students)	94% (8,832 students)	100% (14,000 students)	12% (2,300 students)
# of advanced or doctoral students	2,496	3,335	n/a	1,135	1,500	2,000
• % studying engineering	26% (657 students)	14% (460 students)		69% (779 students)	100% (1,500 students)	5% (100 students)

Fig. 1: University funding sources

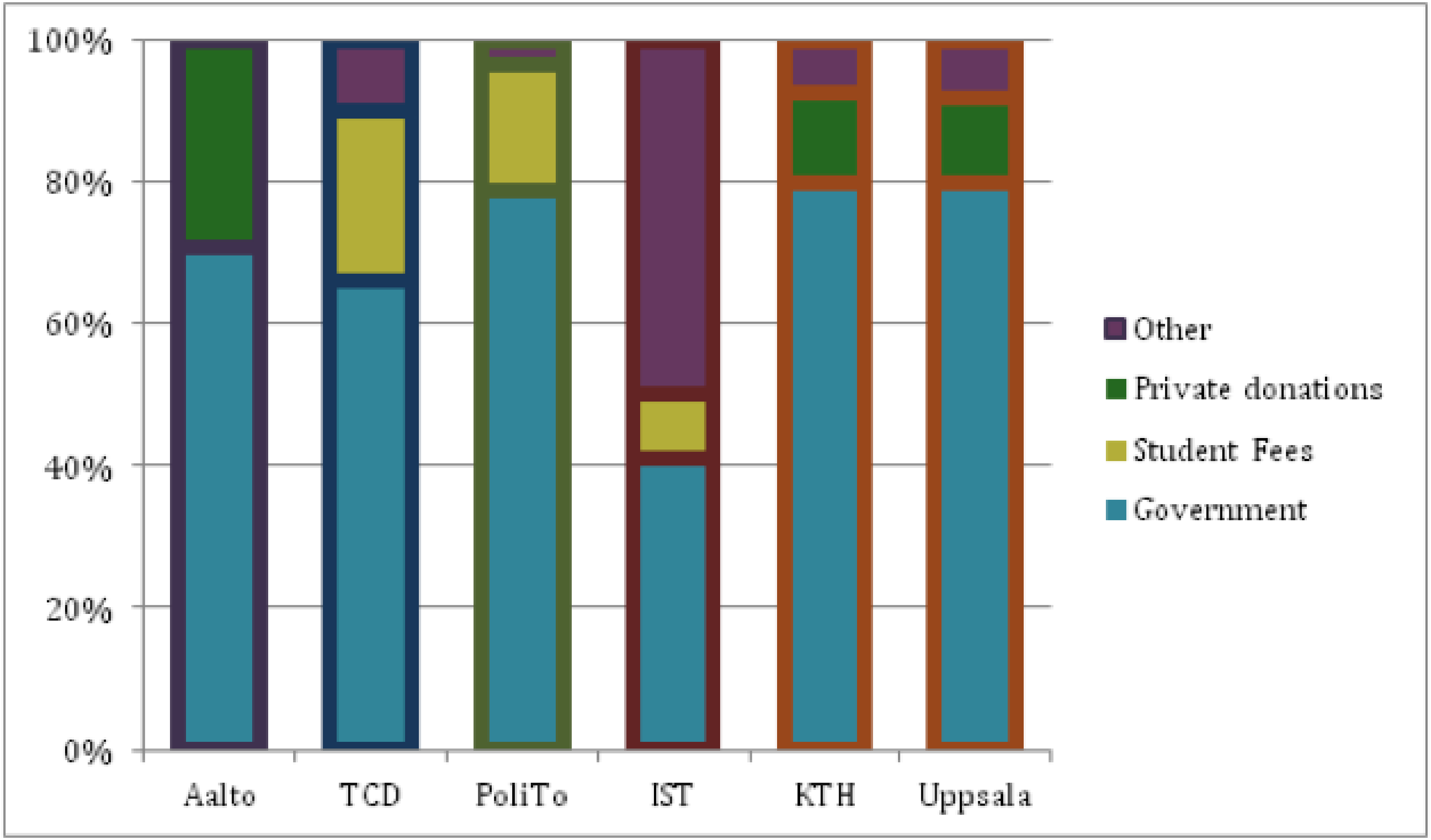


Figure 2: Organisational structure of education systems in partner countries

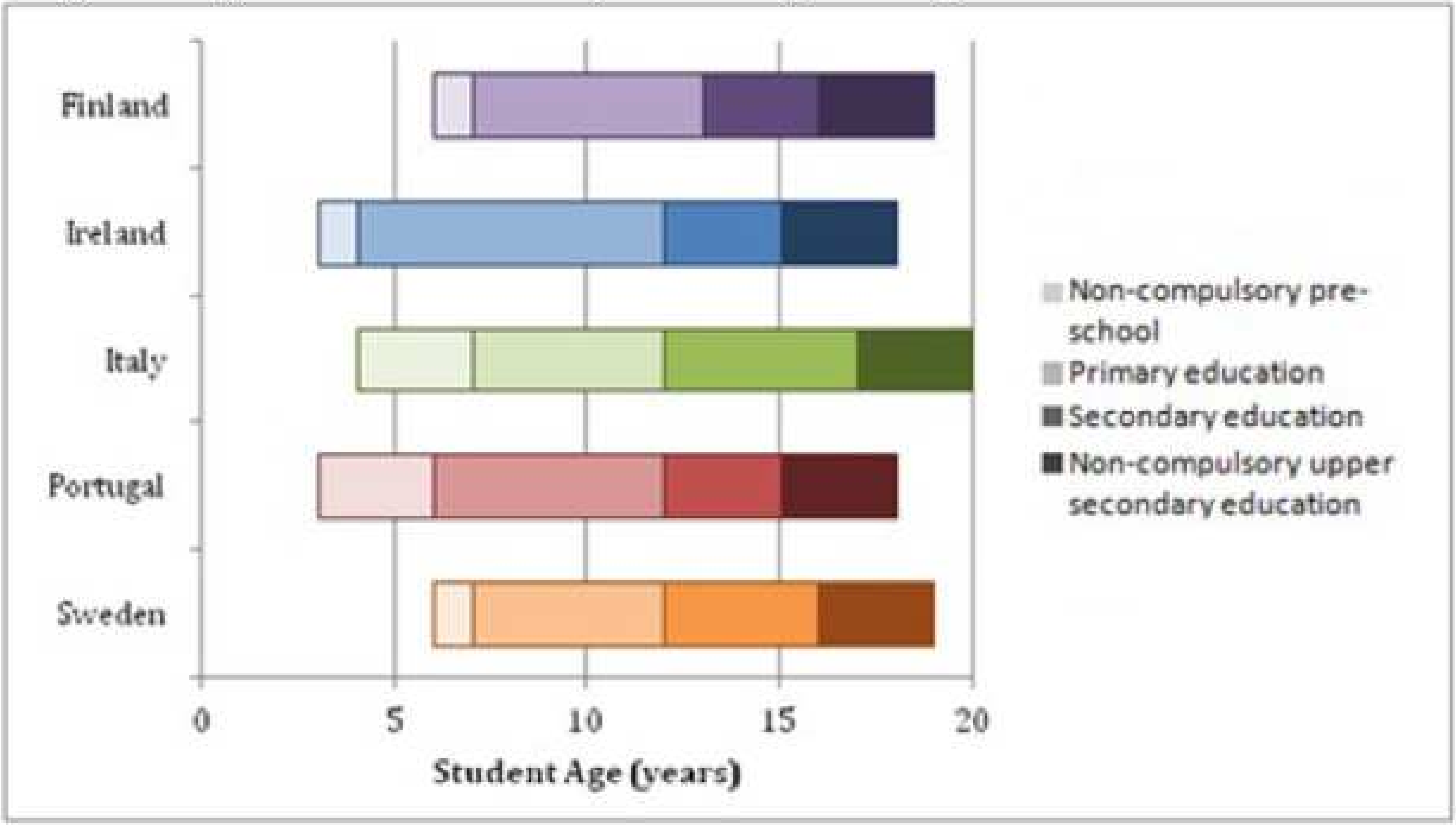
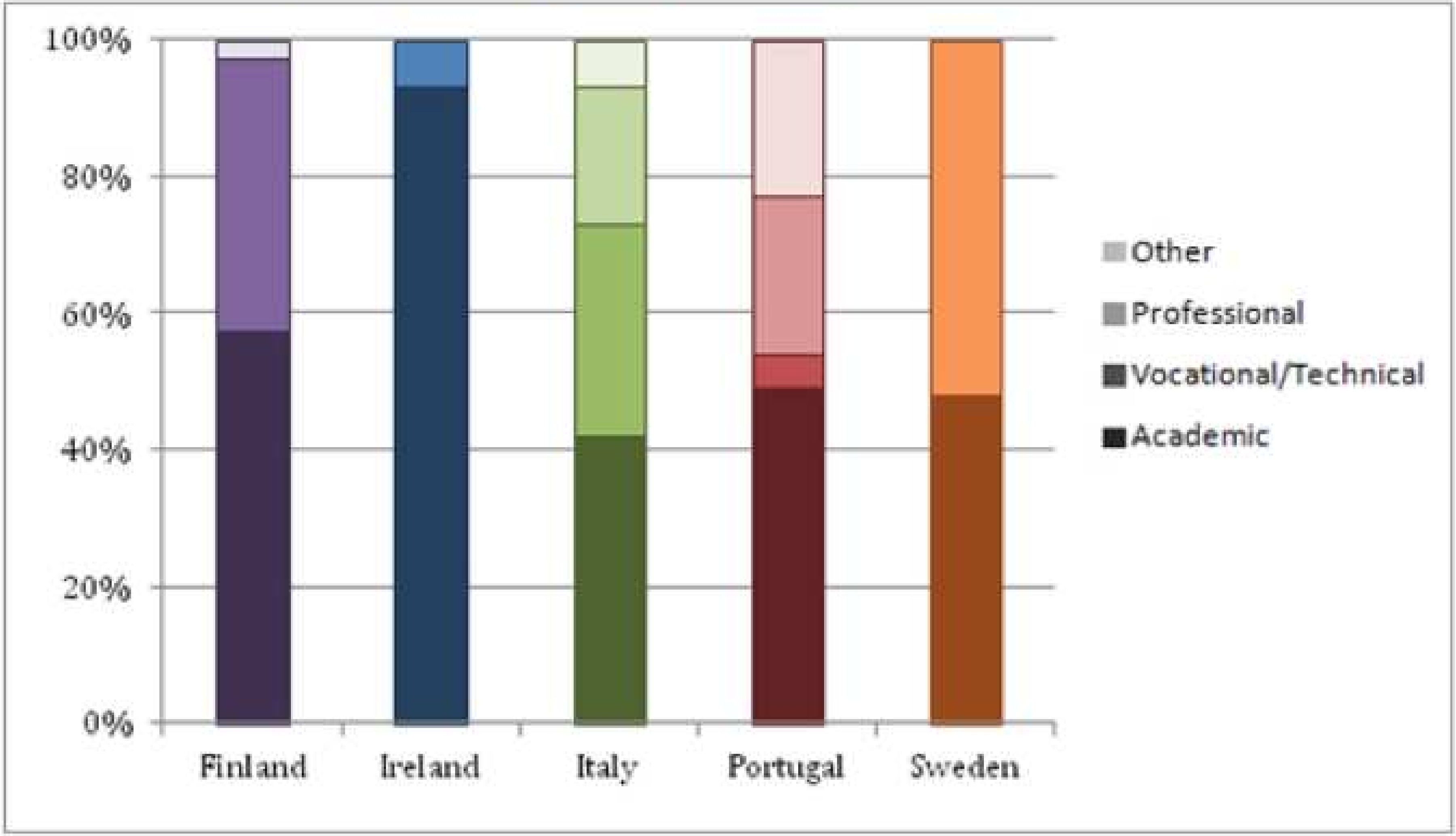


Fig. 3: % of second-level students by type of school



Note: 'Other' may include Adult Education

Fig. 4: Hours spent in school per year at each stage of the schooling cycle

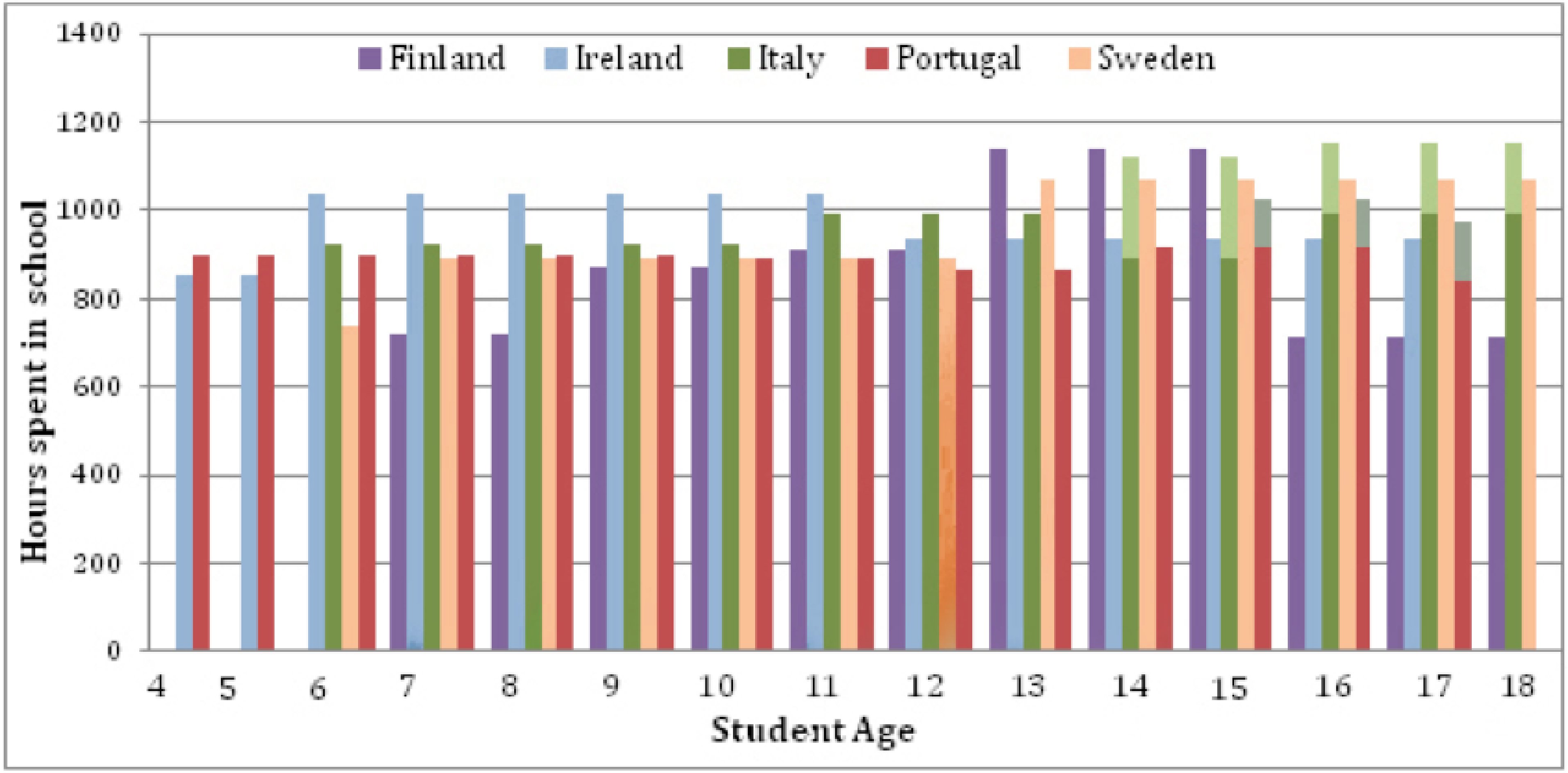


Fig. 5: Students exposure to Maths over time

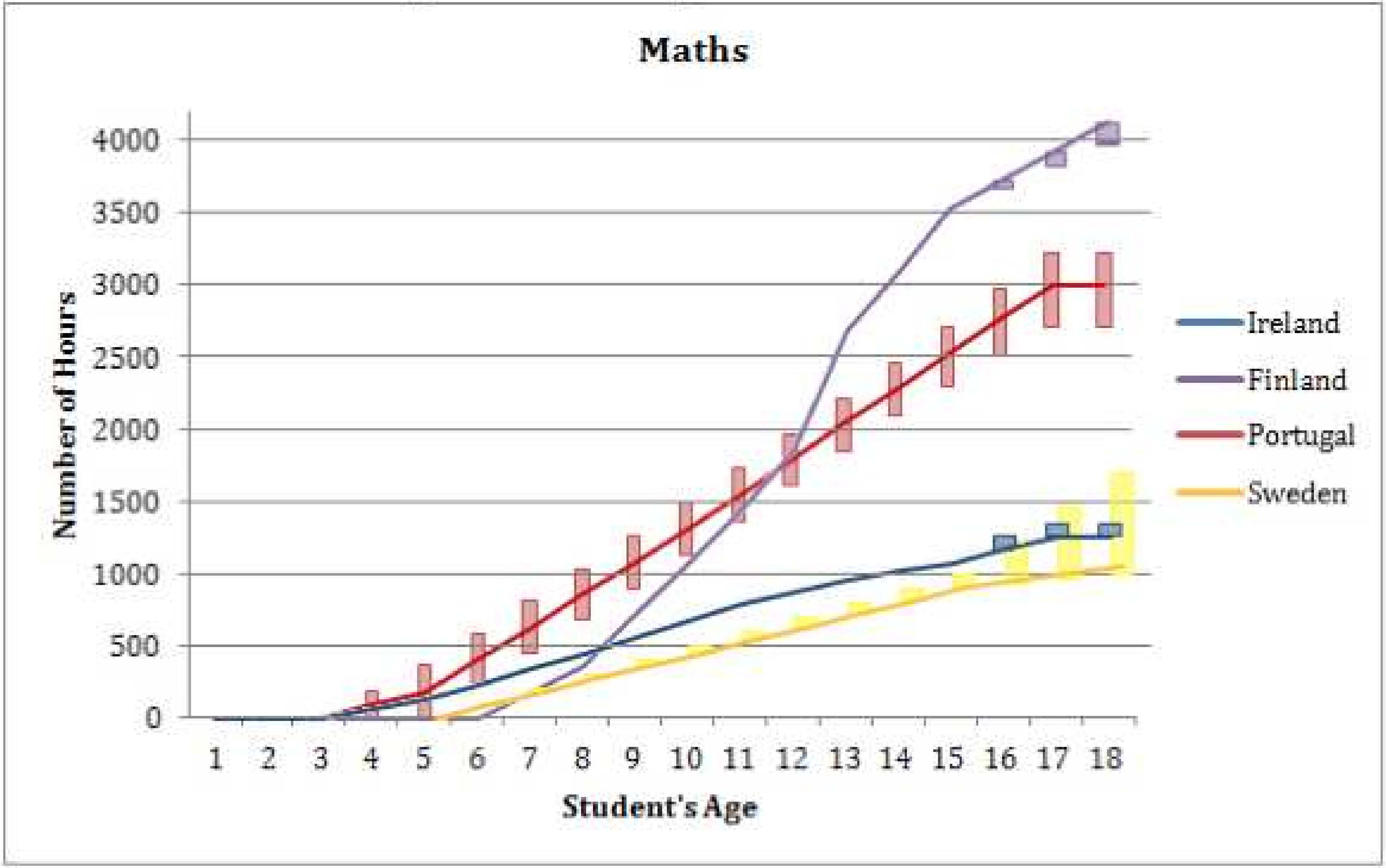


Fig. 6: Students exposure to Physics over time

Please note the change in scale along the y-axis

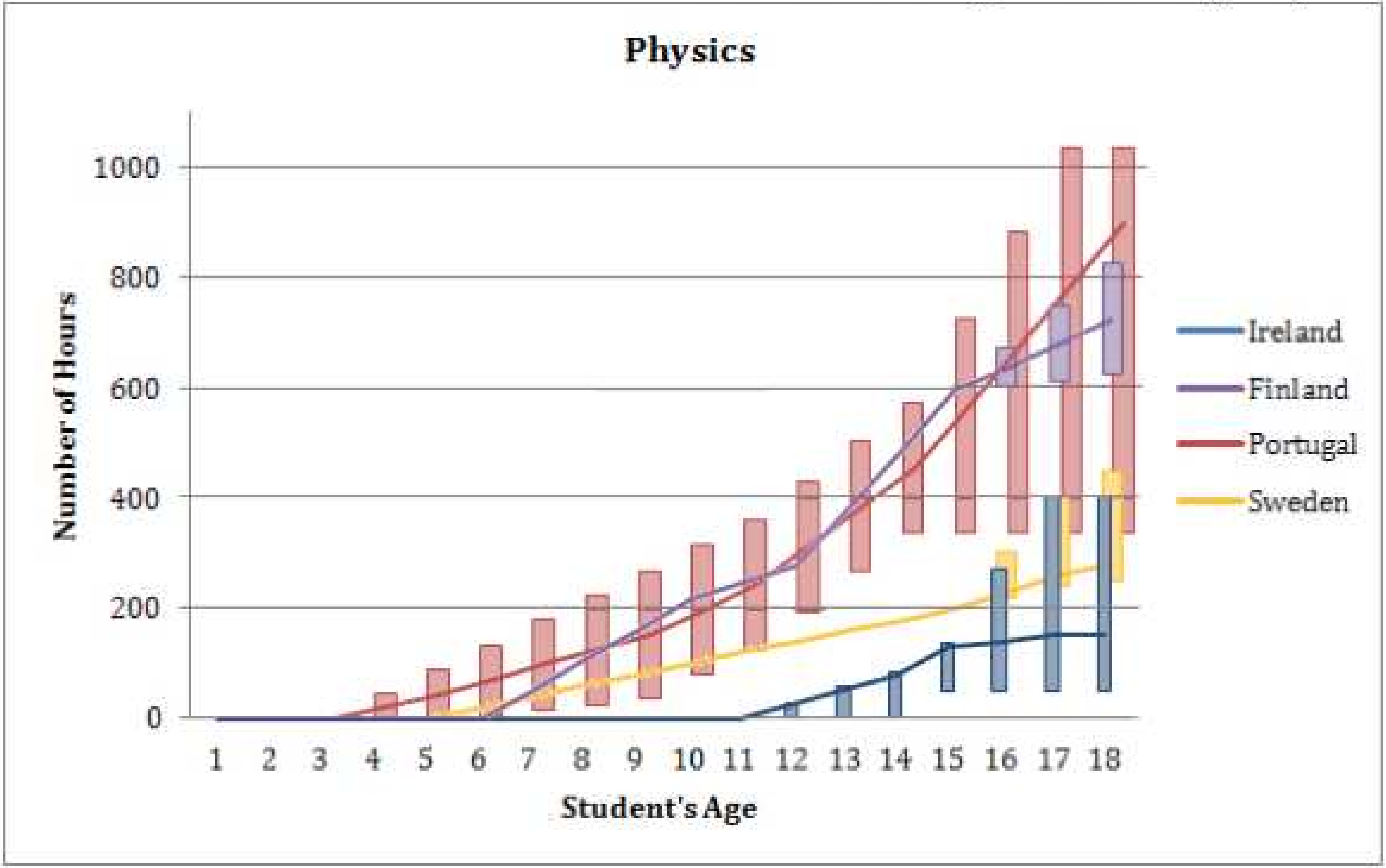


Fig. 7: Students exposure to Chemistry over time

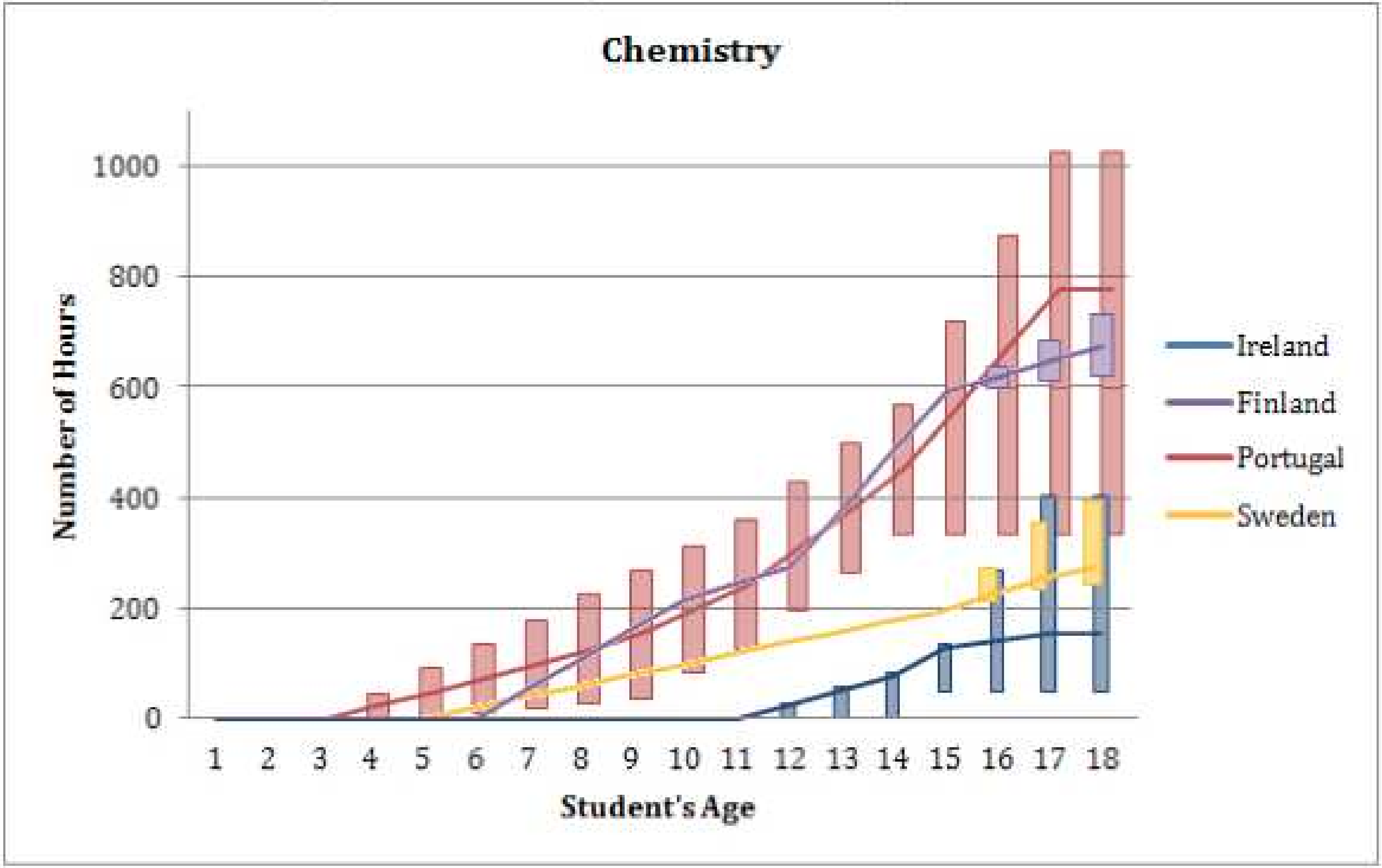
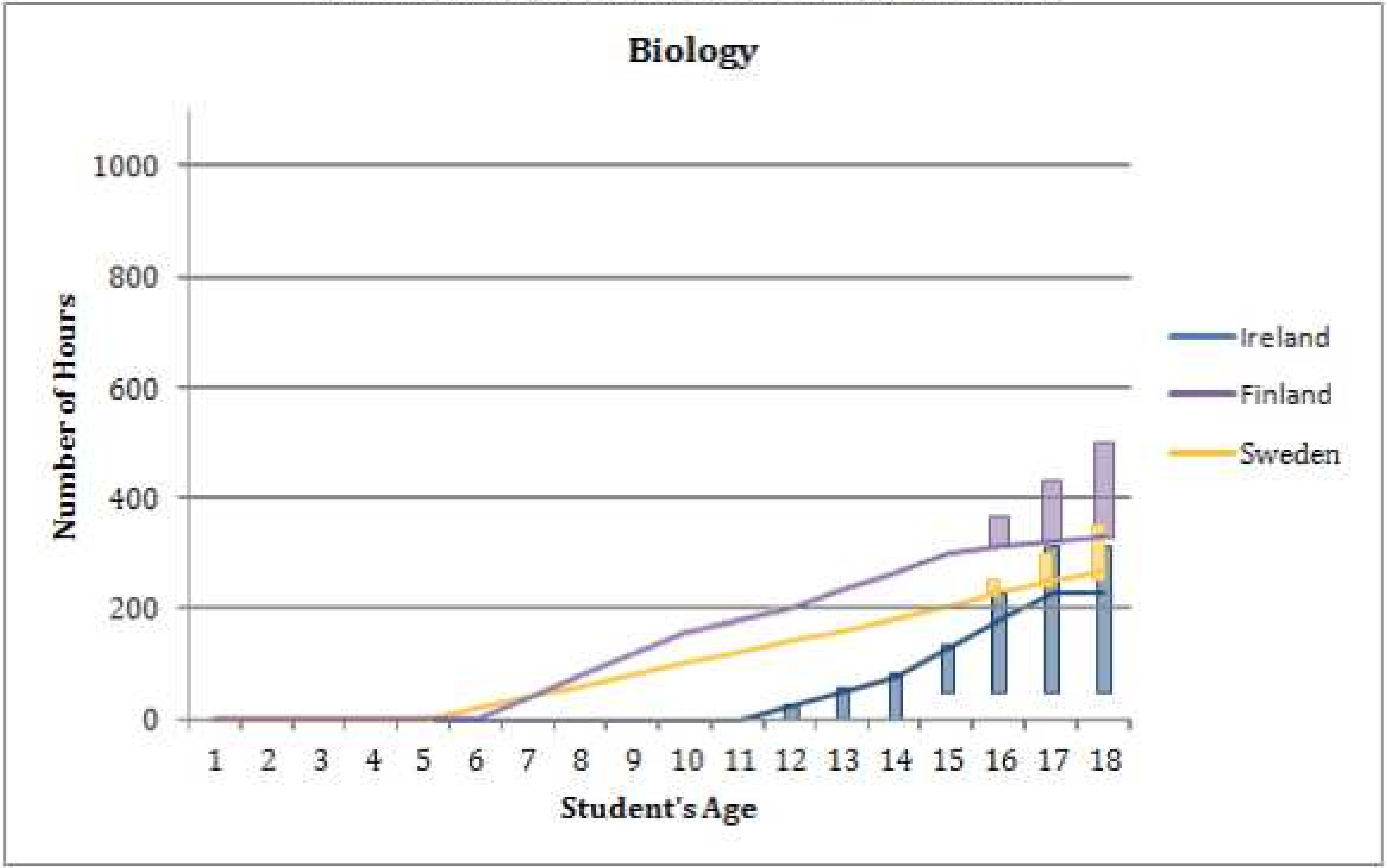
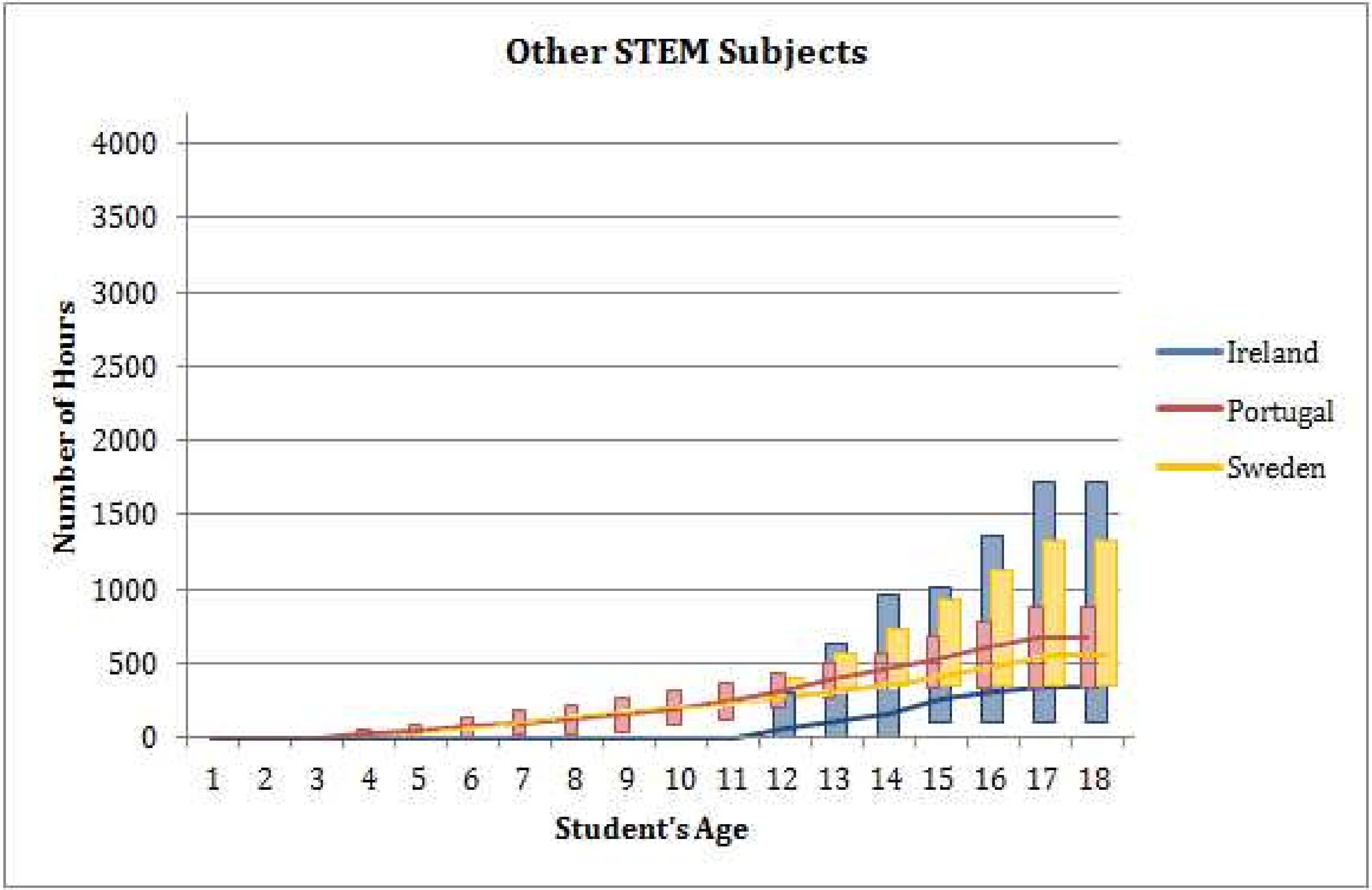


Fig. 8: Students exposure to Biology over time





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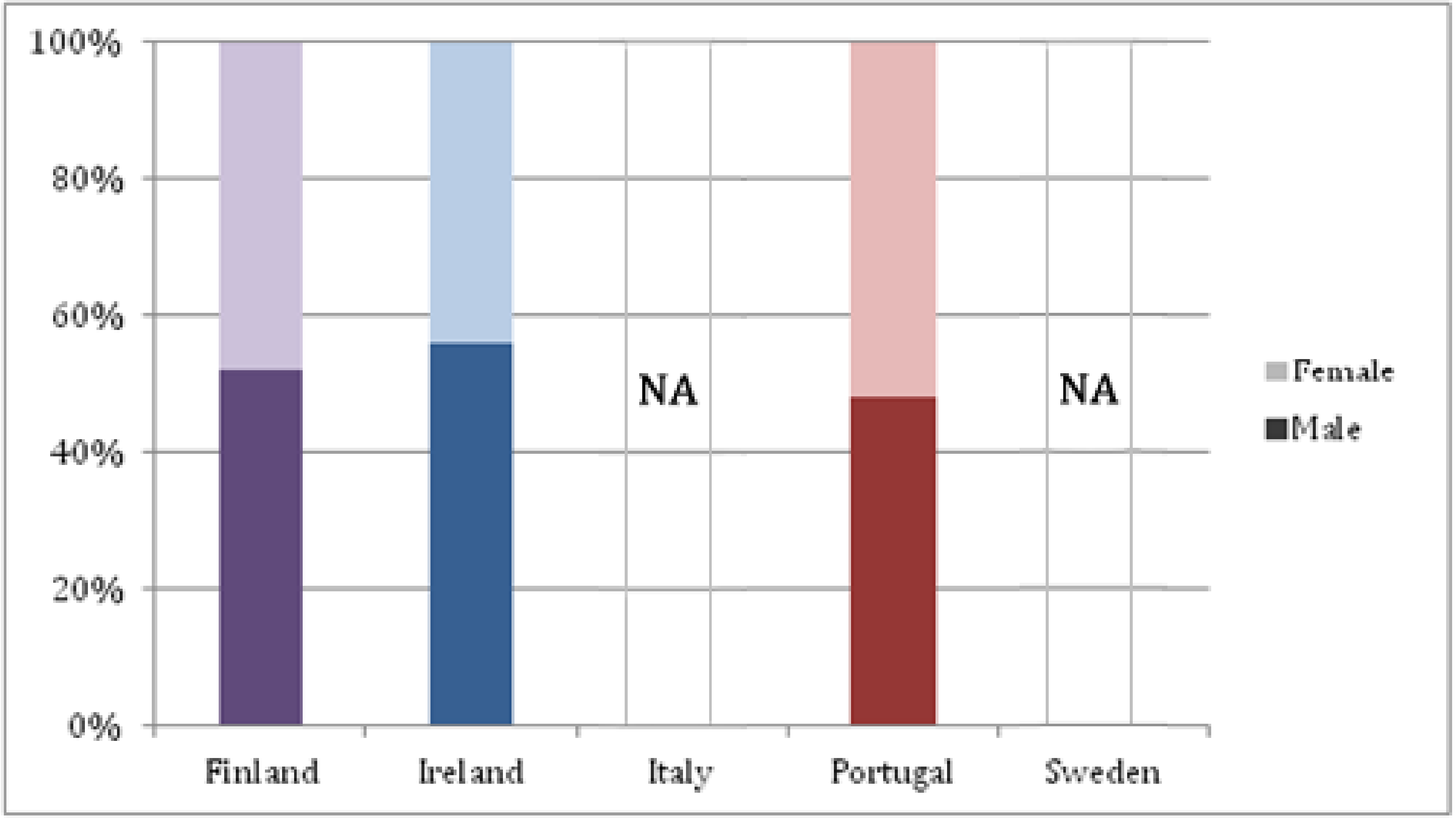

100%
80%
60%
40%
20%
0%
NA
NA
Female
Male
Finland
Ireland
Italy
Portugal
Sweden

Fig. 11: Gender breakdown in Basic Mathematics at second-level

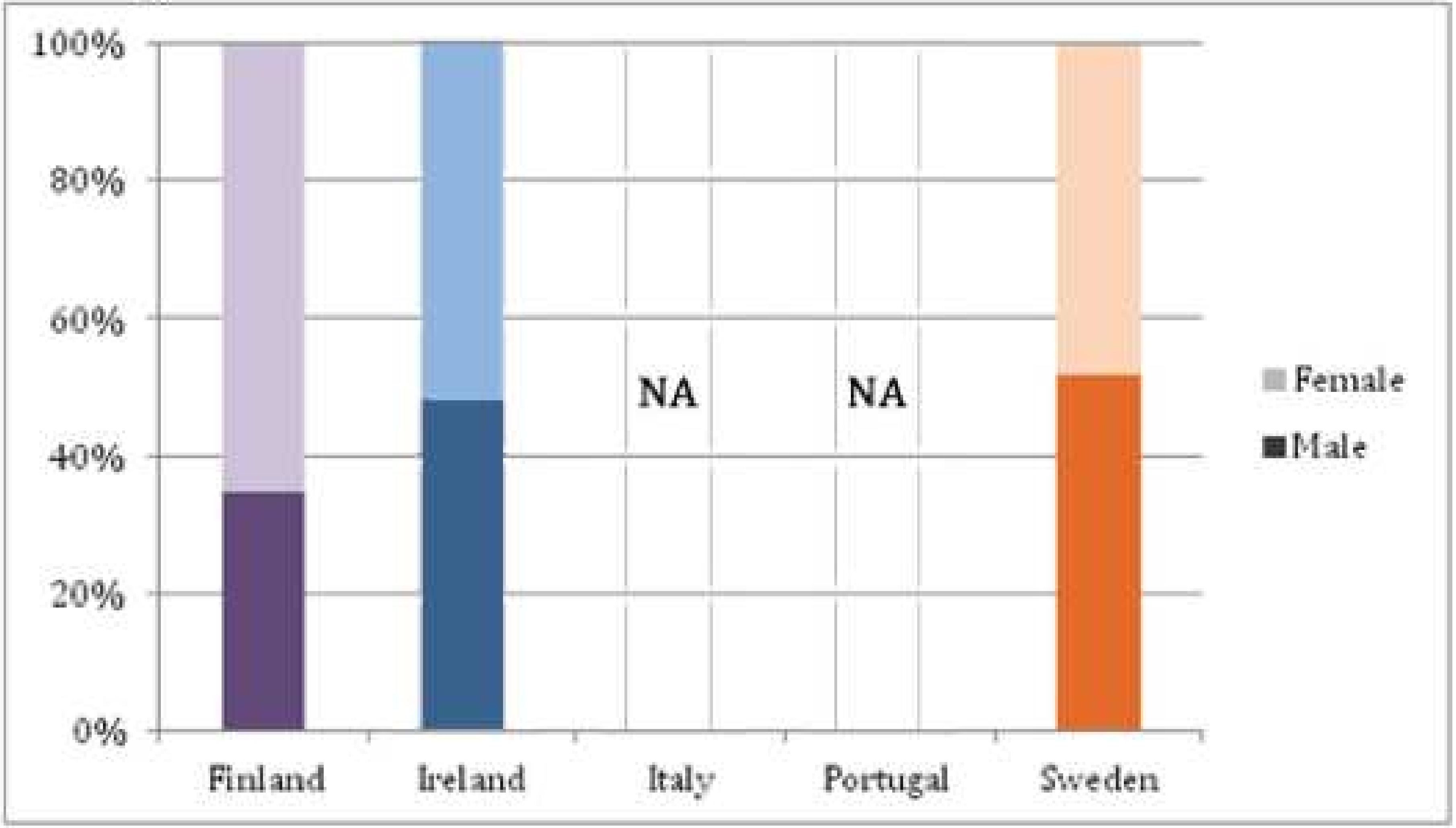


Fig. 12: Gender breakdown in Physics at second-level

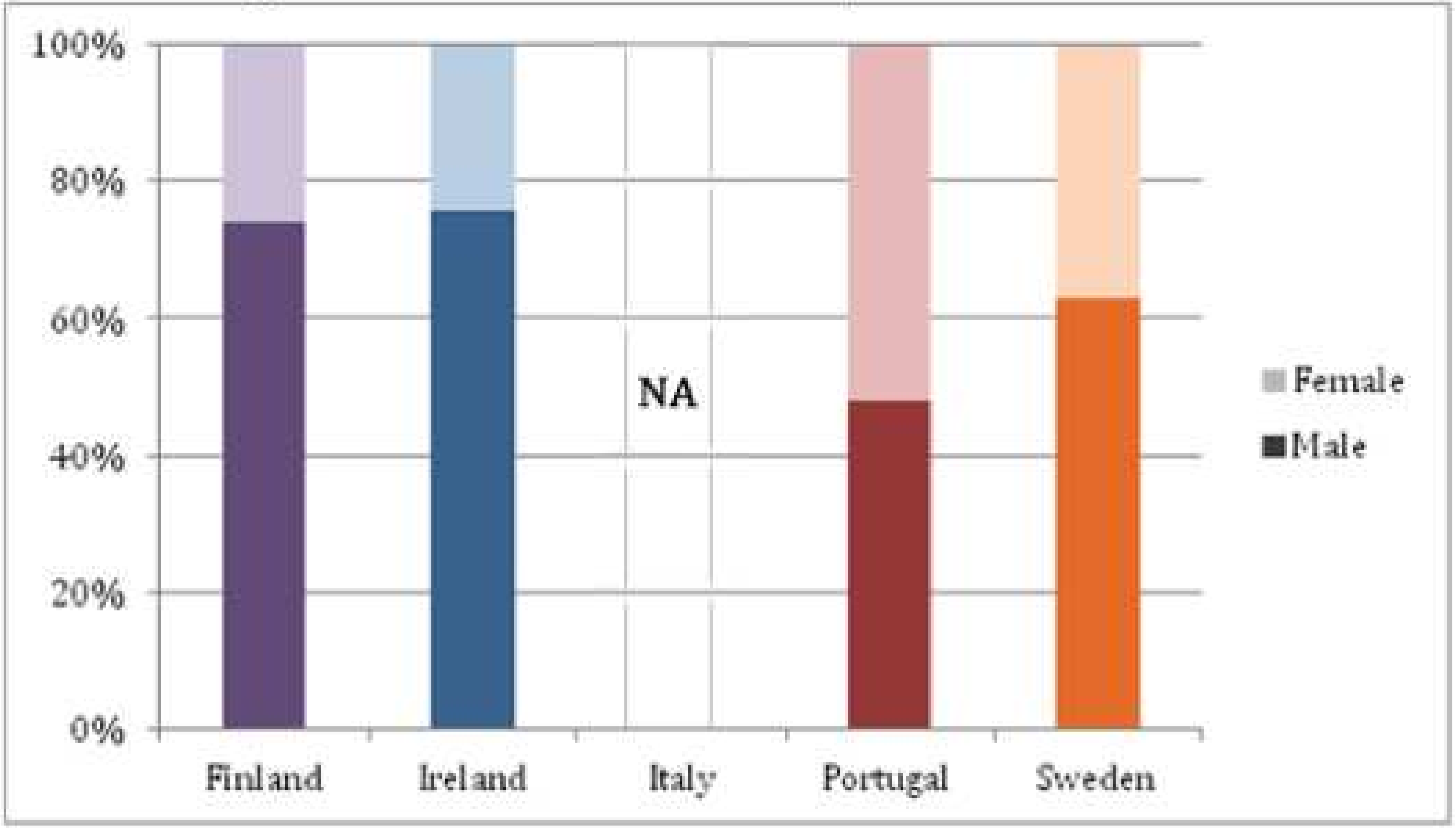


Fig. 13: Gender breakdown in Chemistry at second-level

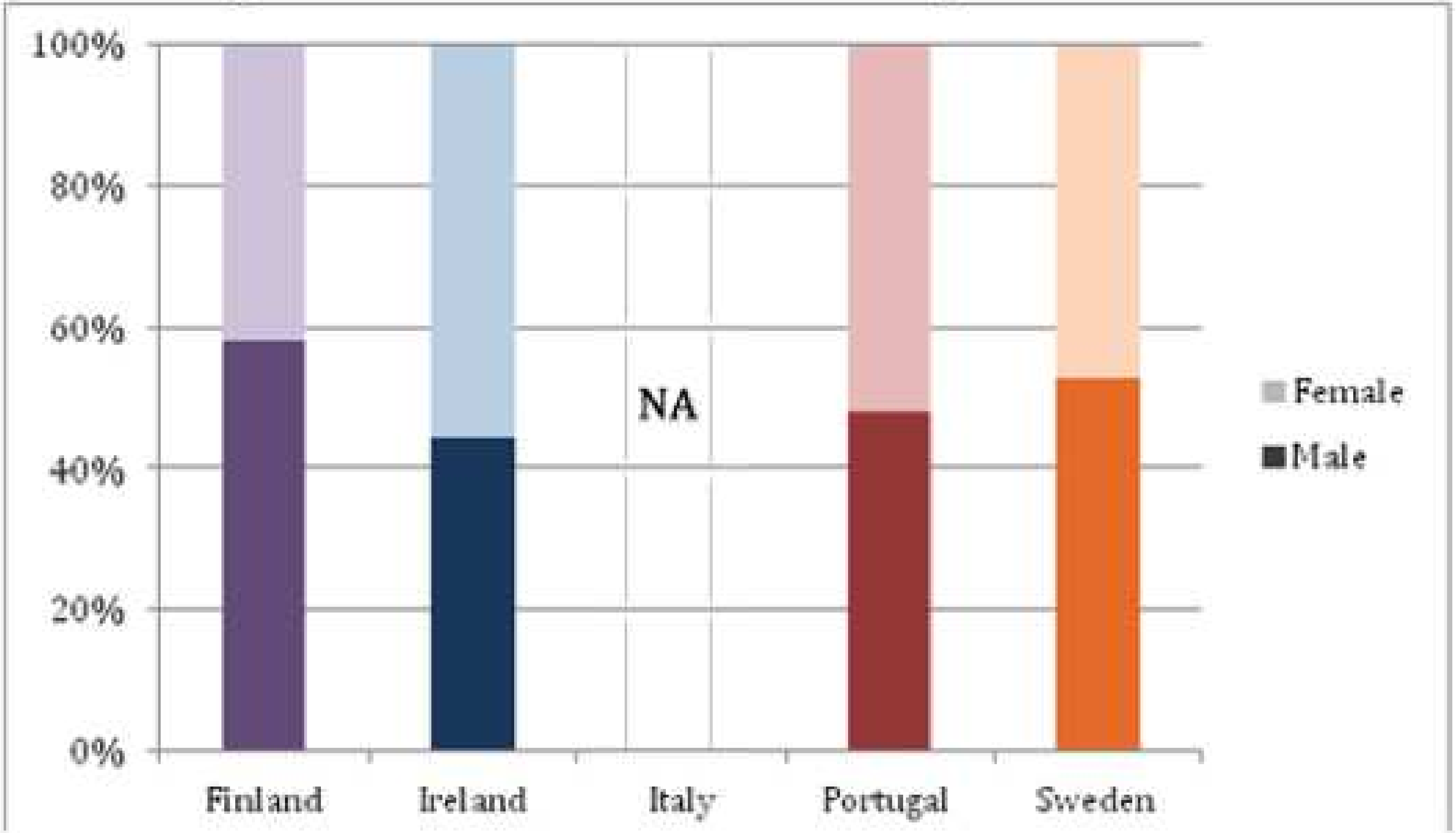


Fig. 14: Gender breakdown in Biology at second-level

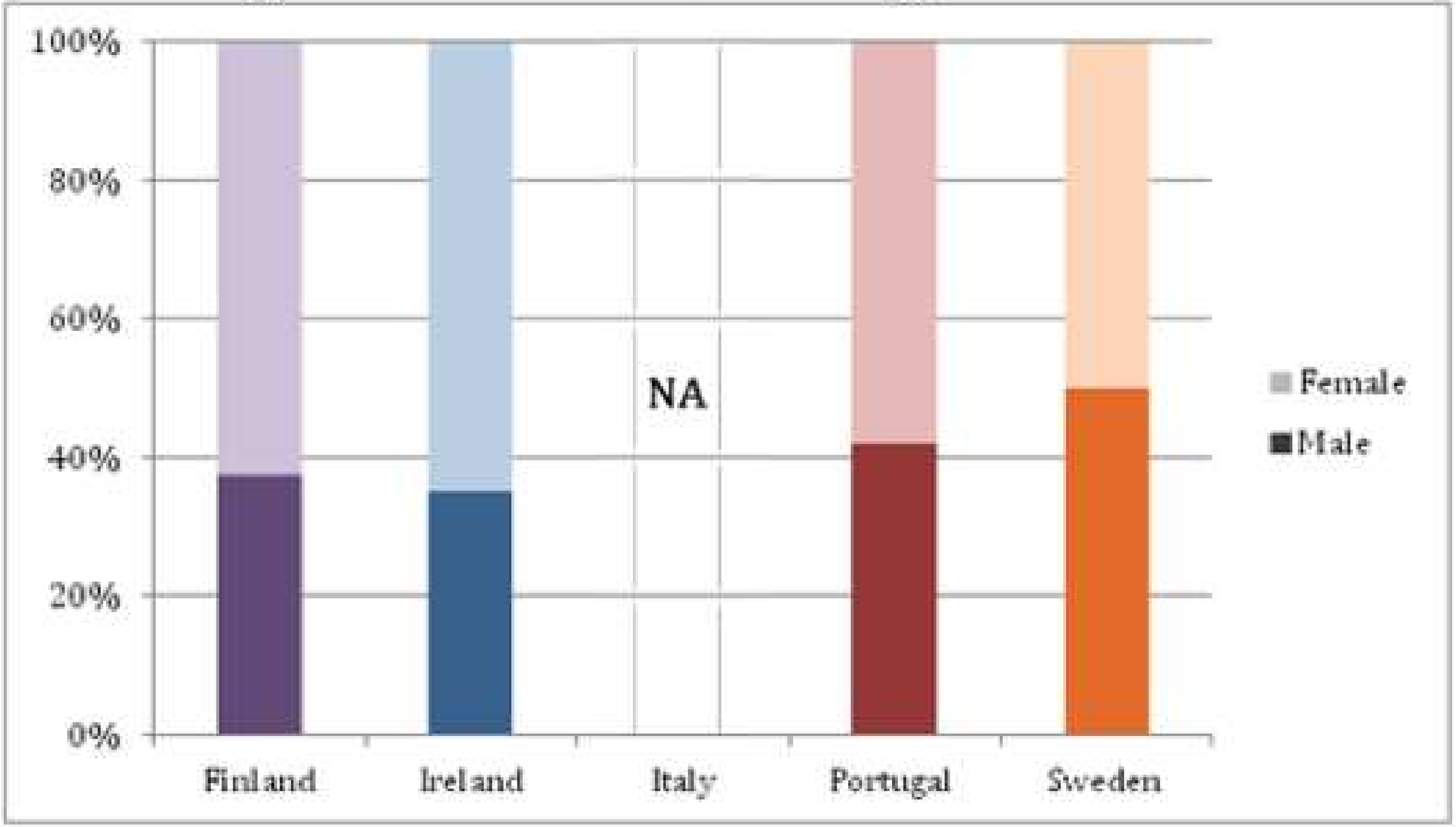


Fig. 15: Gender breakdown in 'Other' STEM subjects at second-level[4]

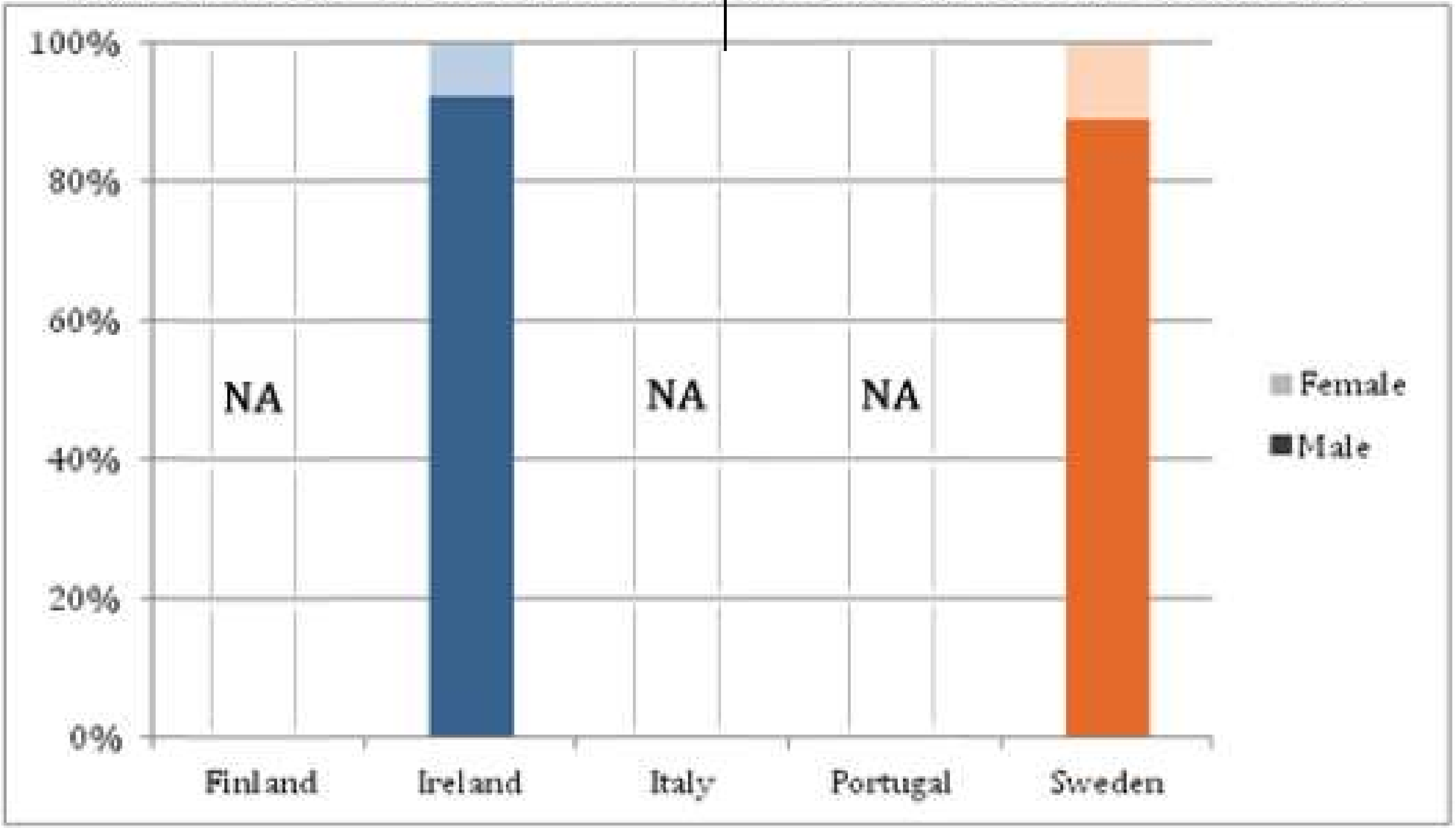


Table 2: Career Guidance

	Finland	Ireland	Italy	Portugal	Sweden
Standardised Counselling System	Yes[5]	No (currently under review)	No	No	No
Qualifications required to become a guidance counsellor	Teaching qualification with additional specialised training OR Masters degree in Education	Primary degree plus 1-year postgraduate	Qualified psychologist	Teaching qualification with additional specialised training OR Qualified psychologist OR Social Service specialisation in upper-second level	Social & Science specialisation in upper-second level Primary degree (Arts) Work experience
Primary background	Humanities	Humanities	n/a	n/a	Humanities/ Social Science

Table 3: University admissions practices in partner countries

		Finland	Ireland	Italy	Portugal	Sweden
Centralised Admissions (Y/N) [6]		Y	Y	Y	Y	Y
Does the university have power over student selection?		Yes	No	No	No	No
Alternative routes of entry to university	Prior experience/ Qualifications (Mature Student Entry)	Yes	Yes (for over 23s)	n/a	Yes (for over 23s)	Yes
	Access or Foundation programme	Yes	Yes	n/a		Yes
	Aptitude tests	n/a	n/a	n/a	n/a	Yes
	Other	n/a	n/a	None	Yes [7]	n/a
% of students who enter via alternative routes		~ 5%	?	n/a	~7% over all universities	Prior experience: 7.5%. Science Foundation Year: 10% [8] Aptitude test: 33.3%

Table 4: University admissions requirements in partner countries

		Finland	Ireland	Italy	Portugal	Sweden
General admission requirements	School certificate exams	Yes	Yes	Yes	Yes	No
		and/or	-	-	*and/or*	-
	Ongoing performance at second-level	Yes	No	No	Yes	Yes
		and/or	-	-	*and/or*	-
	Entrance exams	Yes	No	No	No	No
		-	-	-	*and/or*	*and*
	Other	n/a	n/a	n/a	Yes [9]	Yes [10]
Additional admission requirements for Engineering courses	Maths	Yes*	Yes – 55% +	No	Yes*	Yes
	Physics	Yes*	Approx. 10% of courses require one additional science subject	No	Yes*	Yes
	Chemistry	Yes*		No	Yes*	Yes
	Biology	No		No	No	Required in certain courses
% of students who meet Engineering requirements		Advanced mathematics: 42% Physics/ Chemistry: 17%	12%	n/a	38%	11%

Table 5: Student fees & available grants

		Finland	Ireland	Italy	Portugal	Sweden
Do students pay tuition fees?		No	No – but they must pay registration fees	Yes	Yes	No
Are grants available?		Yes	Yes – Means tested	Yes	Yes	Yes
Average amount of grants		€3,101[11]	€3,180	€2,184 (resident student) €3,194 (commuter student) €5,793 (non-resident student)	€2,582	€3,708[12]
Factors determining grant eligibility	Income	Yes	Yes	Yes	Yes	-
	Family dependency	Yes	Yes	-	-	-
	Proximity to university	-	Yes	Yes	Yes	
	Credits gained	Yes	-	-	-	-
	University course	-	-	-	-	Yes
	Disability	-	-	Yes	-	-
	Age	-	-	-	-	Yes
% of students qualifying for grants		100% of those who meet credit requirements	40%	13%	18%	~100%
% of students who live in family home during term time		4%	70%	Data not available	66%	Data not available
Average proximity to university			<30 mins (52% of students) <1 hour (75% of students)	Data not available	<30 mins (42% of students) 1 hour (30% of students) >1 hour (18% of students)	Data not available
GDP per capita		€34, 585	€37, 300	$30,165	€23,222	€36, 502
Tuition fees as a % of GDP per capita		0%	3%	5%	6%	0%

Table 6: Third-level fees and available financial assistance

	Finland	Ireland	Italy	Portugal	Sweden
University fees	None	€1,735	Min: €227 Max: 20% of state grant Average: €1084	€996	None
Annual cost of living for independent EU student (includes accommodation)	€8,040 - €12,433	€9,252 - €13,994 (excl. fees)	€6,716 (resident student) €11,953 (non-resident student)	€10,884	€9,021
Grants available	€264 - €3,390	€364 - €3,955		€2,582	€1,303 per 20-week semester
Housing supplement	€353 - €2,617	€4,210 - €7,217		Included in grant	€1,600 - €3,163
Additional funding	Study Loan: €3,926	Grant for payment of fees	Educational materials: €616 - €1,848 University services: max €2,107	Student loans	Study loan: €3,207 per 20-week semester

Note: All figures are per year unless otherwise specified

Note: All figures given for Section 5 have been normalised to the 2010 Purchasing Power Parities.

Report on Formal Barriers

Preliminary overview of contents:

- Summary of barriers in partner countries
- History of barriers & any changes/developments
- Evidence to illustrate the impact of these barriers
- Highlighting good practice examples

Report on Formal Barriers

Main categories of existing barriers:

- Entry requirements for engineering courses
  - subject requirement, attainment levels
- Structures within the school system
  - e.g. specialised pathways at second-level
- Socio-economic factors
  - e.g. in Ireland maths achievement at second-level is significantly lower among students of lower socio-economic status (PISA 2003)

WP 6 Meeting

- WP 6 meeting on 16^{th} - 17^{th} February

Aims of meeting:

- To finalise barriers and agree on best practice
- To agree on the structure of the WP 6 final report

Purpose of Entry Barriers

1. Identification of student ability

2. Pre-requisite knowledge (i.e. university does not need to teach this!)

3. May be indicative of student motivation

Appropriateness & Effectiveness

- Reasons (historical) for design and implementation of barriers
- Evidence of whether (appropriate) and how well (effective) these barriers work
  - Pre-requisite knowledge – by definition it is effective. Appropriate is more difficult to say!
  - Students who pass barriers should do better than those who don't.
    - Those who don't pass barriers aren't let in!
    - Use excess of performance over barriers to measure how well these metrics capture ability to progress

Sample Analysis of Effectiveness

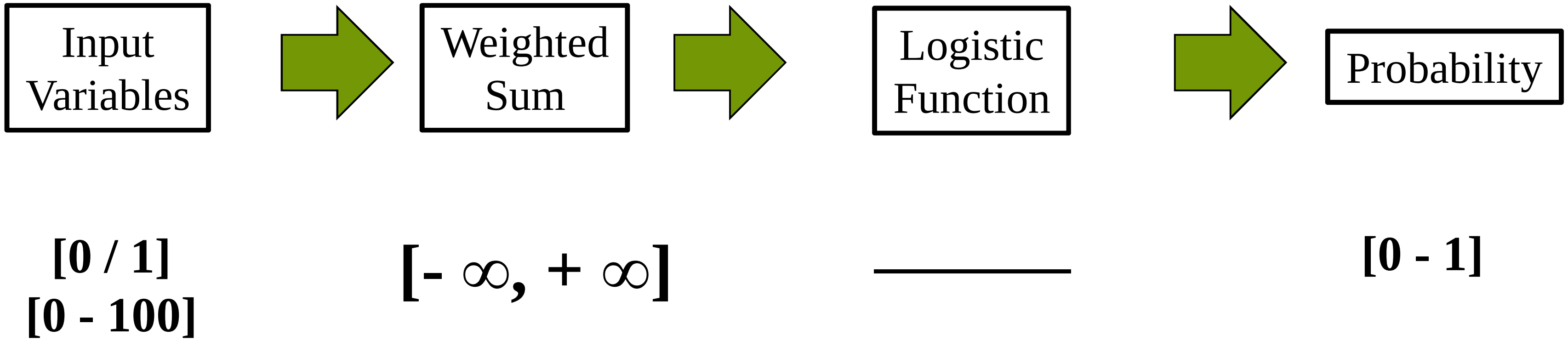
- Irish context – focussing on TCD engineering intake from 2000-2010
- Students finishing high school take between 6 and 10 subjects (7 most common) at one of two levels
- Irish, English & Mathematics are mandatory, with most students also taking 1 language (typically French). All other subjects are optional.
- Grades from the best 6 are added (higher level from 0-100 and lower level from 0-60) = 'CAO points'
- Demand for places in 3rd level managed using CAO points
- Some additional requirements may be present for certain courses – e.g. 55%+ in higher Maths required for engineering

Factors Analysed

- Inputs
  - Whether a student took a particular subject (binary)
  - Mark achieved in each subject (0-100)
  - Degree (one of two available) programme chosen (binary)
  - Gender (binary)
  - Year (have things changed over 10 year period) (1-10)
  - CAO mark (cumulative grade in best 6 subjects) (0-600)

- Outputs
  - Had to take second exam sessions (Binary)
  - Progressed to 2^{nd} year (Binary)

Logistic Analysis of Performance



Critical Value

Inputs

- By considering (in a linear combination) a binary variable (whether a student takes a subject) and a grade, we are going to have a critical value for each subject (where these variables are statistically significant)
- The value of this is the value above which the grade has a positive effect and below which it has a negative effect
- Alternatively,

  effect size = coefficient * (Student grade – critical value)

Findings

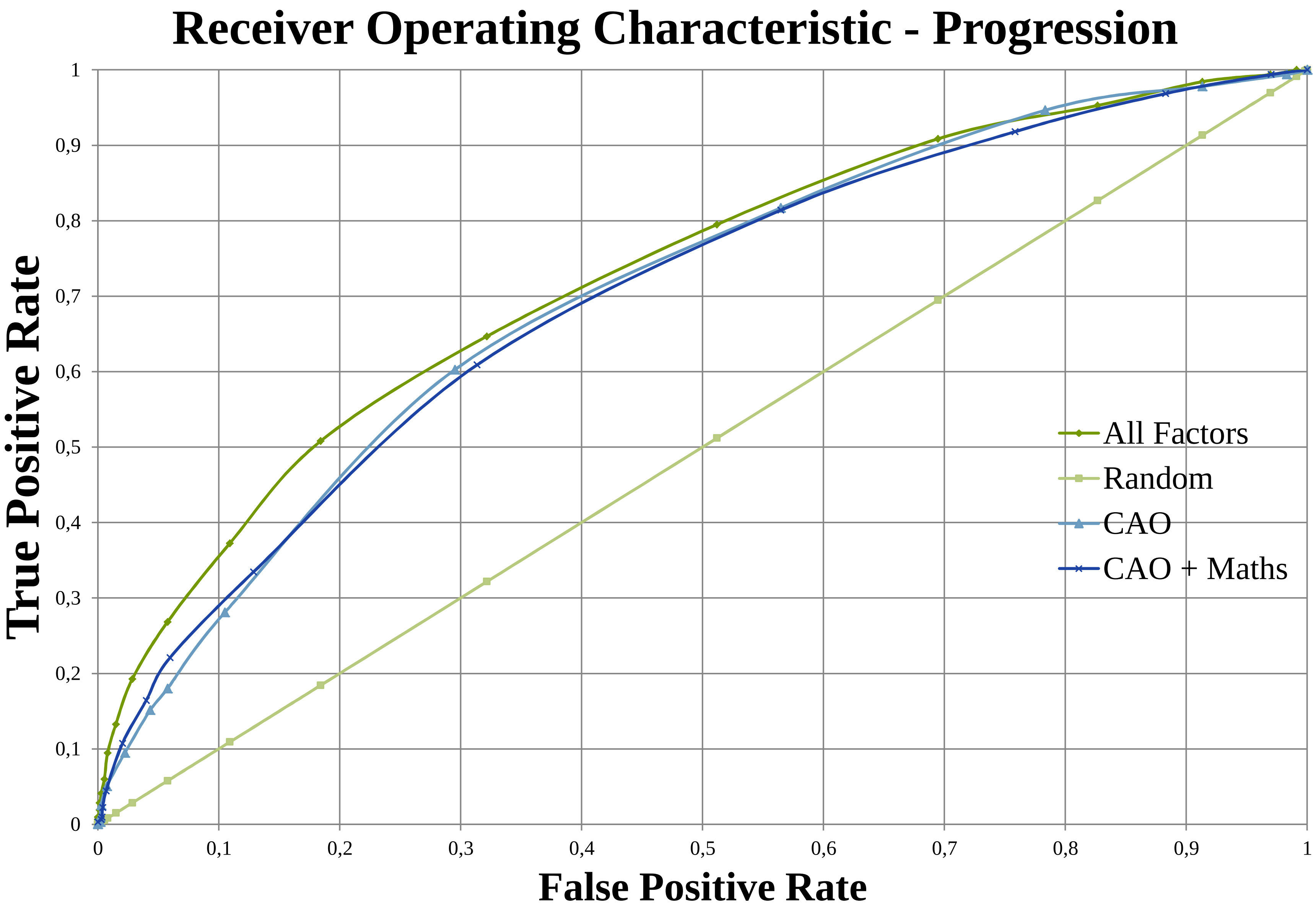
- Mathematics, physics & chemistry are factors
- Critical values are below average obtained by students – i.e. those taking those subjects typically get a benefit.
- Other cognate/numerate subjects – construction studies, technical drawing and accounting have a smaller influence
- Some interesting influence from other subjects – e.g. history, geography, music

Receiver Operating Characteristic

Plots false positive rate (x-axis) against true positive rate (y axis)

Example

Airport scanner – more sensitive implies that we detect more of the people with guns (true positive rate), but we also have more false alarms with belts, coins etc (false positive rate)



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Future Work

- More information on barriers in each country
- Evidence for these barriers
- Incorporate more factors into above model

Your Feedback

- What use could you make of these results?
- What use of these results could others (who are they?) make?
- What follow-on work do you think would be useful?