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Summary Report on National STEM Educational Policies in Relation to Girls' Experiences in Physics across Europe and to the Engineering Pipeline (0252)

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Paper

Across Europe today far fewer women participate in engineering than men, and the percentage of women working as professional engineers is lowest in Ireland and the United Kingdom. Just 7% of professional engineers in the UK are women (Institute of Engineering and Technology, 2013). In Ireland the figure is 9% and it is recognized that the male-centric culture of engineering is unlikely to shift until at least one-third of professionals are non-male (Fingleton et al., 2014).

The statistics are somewhat better when a wider sphere of workers is considered. Among members of the Organisation for Economic Co-operation and Development (OECD), for instance, the countries of Argentina, Estonia, Iceland, Italy, Poland, and Slovenia have achieved at least 33% participation by women in the overall sector of Engineering, Manufacturing, and Construction (OECD, 2013). Yet, in this sector across Europe, women still comprised just 27% of third-level graduates in 2014—Poland had the highest level (at 39%), and Ireland the lowest (15%), with countries like Portugal (33%) and the UK (22%) falling in between (Eurostat Press Office, 2016).

National policies are increasingly used to leverage change in tertiary education, in particular to encourage more enrollment in, and graduation from, science, technology, engineering, and mathematics (STEM) programs. Concurrently, employers and professional associations desire more participation by women in STEM as historically participation rates have lagged those of men. What remain unknown are the perceptions of women in STEM programs and the influence of policy on these students' experiences. Aiming to extend work by the UK's Institute for Public Policy Research (Silim & Crosse, 2014), we collected and analyzed narratives of women in culturally diverse corners of Europe. In-depth phenomenological interviews conducted in 2014-2015 with 47 women studying engineering at third-level in Poland, Portugal, and Ireland revealed stark differences in these women's school experiences in physics and other STEM subjects. Table 1 provides some demographic information about our participants.

Table 1: Sample Demographics

Interview location	Studying in home country	International with schooling in host country	International without schooling in host country	Total Number
Ireland	10	6	8	24
Poland	12	0	0	12
Portugal	10	0	1	11
Total	32	6	9	47

In this project, we compare experiences described by 16 women enrolled in engineering in Ireland with 11 women studying technology in Portugal and 12 women studying engineering in Poland. Of the students in Ireland, ten were born in Ireland, six were born outside Ireland but received some second-level schooling in Ireland, and eight women moved to Ireland from Oman or Kuwait after secondary school to study engineering.

In analyzing interview data, extremes surfaced that mirrored Eurostat (2016) findings and this contrast—between Poland and Ireland—forms the core of our current investigation. Drastic differences appeared between the Irish-born and Polish-born groups with regard to early enjoyment of physics, clarity of options, and direct forms of government support for third-level STEM studies. Surprisingly, a number of Irish-born participants described taking a stand to obtain physics at second-level because it was not going to be taught in their schools. Women from Poland described having the strongest foundation in physics—including the best access, the greatest enjoyment, and the most consistent exposure. They had the clearest conceptions of engineering pathways and careers.

Probing this, we discovered Poland's Minister for Science and Higher Education had developed an organized suite of majors, designed to streamline STEM access and routes into the technical universities that specialize in engineering and also to crystallize public definitions of engineering (National Research Program, 2008). The Ministry established a National Center for Research and Development in 2007 that began developing policy.[1] On October 1, 2010, a package of six laws reforming the science system came into force in Poland, including an act regarding principles of financing science.[2]

Our study seeks to identify and understand relationships between individuals' experiences and national policies guiding the educational systems they encounter. We aim to use this understanding to inform education policy in Europe. Our data include: (1) a review of STEM-related policies across Europe; (2) 47 interviews with women studying engineering in Ireland, Poland, and Portugal; (3) written policies from Poland; and (4) relevant Irish reports and proposals. We transcribed the interviews in full, first analyzing them holistically using principles of phenomenology. Then, after identifying this particular contrast, we zoomed in, extracting all mentions of 'school' and coding these descriptions thematically, using grounded theory methods from a critical feminist perspective. Policies we have analyzed come from Denmark, Estonia, Finland, Irleand, Portugal, Poland, and the UK.

1 http://www.ncbr.gov.pl/o-centrum/

2 The package is described in the *National Research Program: Assumptions of scientific and technical policy and an innovative country,* available at http://www.ncbr.gov.pl/o-centrum/programy-i-projekty-realizowane-w-narodowym-centrum-badan-i-rozwoju/

Interview data indicated that in Ireland, Leaving Certificate subjects like physics, engineering and construction studies were sometimes difficult to obtain for participants who had attended all-girls or Irish-speaking schools, particularly in rural areas. Women who had gone to larger, mixed schools didn't face the same barriers, and this disproportionately affected the women born in Ireland, who were more likely than international students to attend small rural and/or all-girl schools. Moreover, some of the support systems described by women in Poland, Portugal, Oman, and Kuwait were identified as lacking by some of the women born in Ireland. "About 1/3 of schools in Ireland are single-sex, a situation that is almost unique in Europe" and although girls in Ireland are taking chemistry, physics, and applied math in greater numbers, they are "still more likely to take home economics, French, Spanish and business studies" (McGuire, 2015) and the are much less likely than boys to enter engineering courses at third-level.

Findings highlight the influence of policy on educational structures and pathways. Our data suggest that girls have differential experiences when educational structures and public norms support their access to STEM. The full manuscript is in press with SRHE's *Policy Reviews in Higher Education*. The manuscript aims to summarize national STEM initiatives and policies from across the EU, identify themes in the interview data and highlight differences between groups, compare each group's experiences with its national policy, and assess alignment between policy intent and participants' lived experience. The manuscript identifies implications for research and policy, and we will report these at the SRHE conference.

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