Examining Students’ Interest in Physics at Second Level in Ireland

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Abstract. This study examines students’ interest in physics within the culture and context of the Irish education system, at both lower and upper second level. In Ireland, the majority of students (aged 12-15 years) complete an integrated science curriculum at lower second level that encompasses learning outcomes across the disciplines of physics, chemistry, biology and earth and space. Students can choose what subjects they continue with at senior cycle and typically, 13-14% of students (aged 15-18 years) continue to study physics. This study reports on the student’s interest in physics and presents collated responses from 563 lower second level science students and 142 upper second level physics students. The findings of this study denote the differences between males and females interests in studying Physics at each level and in particular, highlight the effect that school type has on females’ interest in physics.

1. Introduction
In Ireland, the majority of students complete an integrated science curriculum at lower second level that encompasses learning outcomes across the disciplines of physics, chemistry, biology and earth and space. In 2019, 59,538 students (49% female, 51% male) completed the end of lower secondary (Junior Cycle) science examination, which represented 93% of the national student cohort taking science despite science not being a compulsory subject at this level [1]. In order to be qualified to teach science at lower second level, teachers must be qualified to teach Physics, Chemistry or Biology at upper second level. Students continuing to upper second level education can choose what science subjects (physics, chemistry and biology), if any, they would like to continue at upper second level. Students normally choose 7 subjects from a range of over 36 subjects available, as part of the Leaving Certificate Examinations (state examinations at the end of second level), which must include English, Mathematics and Irish. However, the participation of students in physics at upper second level remains stubbornly low, particularly among girls. In 2019, the State Examinations Commission recorded 14% (7942) of the total student cohort (56,008) taking physics for the Leaving Certificate Examination and only 4% (2116) of this total student cohort were girls [1]. In comparison biology was the most popular subject selected at upper second level with 61% (34,109) of the total student cohort sitting the final examination, of which 37% (20,636) of the total student cohort were girls. This situation is not unique to Ireland, with many countries reporting low numbers of students continuing with physics when it is no longer a compulsory subject.

Recent research has focused on examining the barriers to student participation and persistence in science, technology, engineering and mathematics (STEM) subjects. Hazari exemplifies a theoretical framework which explores students’ physics identities to examine student persistence in physics careers.
She investigates predictors of physics identity development and reports that students who take on the role of an expert through teaching others in class are reported to feel like they belong in the expert group. Hazari also outlines that the discussion of female under-representation is positively related to females’ physics identity, while having no effect on males [2]. Wonch Hill et al. attribute differences in science confidence and science possible selves (belief in being able to become a scientist) to gender gaps in science among (11-14 year-old) students. They call out for efforts to increase science confidence and maintain science interests and career aspirations and consideration of socioeconomic status as a measure of science confidence [3]. Mujtaba and Reiss report that extrinsic factors, such as material gain motivation (measures the belief that getting a qualification in physics would be useful) in physics was the most important indicator of intention to participate in Physics after the age of 16 years [4]. The influence of teachers and parents were associated with students’ intentions to persist in physics after the age of 16. Mujtaba and Reiss report that students who said that their families did not provide encouragement for physics learning were less likely to continue to study physics after it was no longer compulsory [4]. Ito investigates whether upper secondary females feel a lower sense of belonging in physical sciences, technology, engineering and mathematics (pSTEM) than males [5]. Ito’s hypothesis that females feel less socially accepted than males in their pSTEM classes was supported and evaluation of female self-efficacy and ability in pSTEM classes was also lower for females than for their male counterparts. This study originates from the work of Walton and Cohen, who suggest that a sense of belonging is a stronger predictor for females, more than males, to persist in STEM [6].

Considering each of these factors (identity, belonging, intentions to persist, science confidence) within different educational constructs is reported to influence student interest in STEM subjects. Thompson supports the hypothesis that girls who graduate from all-girls secondary schools are more likely to progress in non-traditional female fields versus highly-female fields, compared with girls who graduated from coeducational second level schools. School effect was not due to coursework or test scores but the effect of these school types on female attitudes towards feminist gender roles. They suggest that all-girls’ high schools appear to be encouraging women out of traditional female majors, such as health science, library science, and education, and into integrated majors, such as social science, life science, and business and management [7]. Kessels reports significantly higher self-concept of ability in physics of girls being taught physics in an all-girls class [8]. However, a deeper understanding of the underlying factor to explain these benefits, identifies students in coeducational classrooms respond faster to gender stereotypes and reinforce the barrier of stereotypes more than in a single-sex school for females only.

In this study, we will investigate student interest in physics within the culture and context of the Irish education system, at lower and upper second level (Junior Cycle and Leaving Certificate, respectively). The aim of this research is to examine:

1. What are the interests of secondary school students (males and females) in physics at lower and upper second level?
2. What is the effect of school type on female interest in physics at upper and lower second level?

2. Methodology

This study was carried out with seven Irish secondary schools to investigate students’ interest and sense of belonging in the science and physics classrooms as part of a wider research study aimed at implementing a whole-school approach to addressing gender balance as described in related publications [9,10]. A total of 509 (199 male, 310 female) lower second level science students (aged 15-16 years) in their third year of an integrated science course comprised the first student sample. 140 (100 male, 40 female) upper second level physics students (aged 16-18 years) who had already completed science at lower secondary and elected to study physics for two-year course at upper secondary level were included as the second student sample. The students were attending seven different public secondary schools (2 all-girls, 5 co-educational) and two of these schools had disadvantaged designation. Students completed a 22-item questionnaire to investigate social belonging, ability belonging, self-efficacy and intentions to persist in science subjects and was adapted from Ito’s questionnaire used to measure these factors [5].
Student responses to the questionnaire item where students were asked to rank the three science subjects (Physics, Chemistry and Biology) in terms of their interest (3-point Likert scale was used where 1 = Most Interested, 3 = Least Interested) in science and physics subjects are examined in this study.

3. Findings

Lower Secondary Students
At lower secondary level, 509 (199 male, 310 female) students’ interests were compared by gender (with 54 students that did not identify a gender excluded from this analysis). Students who selected 1 (Most Interested) to each of the science subjects were represented as follows: 43% of males were most interested in Biology, 26% of males were most interested in Chemistry and 31% of males were most interested in Physics. Aligning with the national trend in uptake of science subjects at Leaving Certificate level, findings showed that 67% of females were most interest in Biology, 24% females were most interested in Chemistry and only 9% were most interested in Physics, see figure 1.

Further analysis evaluated the effect of school types on female interest in the three science subjects (with 185 females attending co-educational schools and 125 females attending all-girls school). 60% of females from all-girls school were most interested in Biology versus 72% of females in a coeducational school. 26% of females in an all-girls school were most interested in Chemistry compared to 22% in of girls in a coeducational school. 14% of females from an all-girls school were most interested in Physics compared with 6% of females in a coeducational school, see figure 2.

Upper Secondary Students
At upper secondary level responses from 140 students (100 male, 40 female) were analysed by gender (only two cases that did not indicate gender were excluded from the data set). The students in this data set had opted to study Physics (and possibly also Biology and/or Chemistry) at upper second level. Students who assigned 1 (Most Interested) to each of the science subjects were represented as follows: 21% of males were most interested in Biology, 12% of males were most interested in Chemistry and 67% of males were most interested in Physics. 42% of female students were most interested in Biology, 23% were most interested in Chemistry and 35% of females were most interested in Physics, see figure 3.

![Figure 1: Students’ Interest in Science Subject by Gender (lower secondary level)](image1)

![Figure 2: Students’ Interest in Science Subject by School Type (lower secondary level)](image2)
When the females students were classified by school type (27 females attended coeducational school, 13 females attended all-girls school), 31% of females in an all-girls school were most interested in Biology compared with 48% of females in a coeducational school. 23% of females from all-girls schools were most interested in Chemistry versus 22% of females in coeducational schools. Finally, 46% of females from all-girls schools were most interested in Physics compared to 30% of females from coeducational schools, see figure 4.

![Figure 3: Students’ Interest in Science by Gender (upper secondary level)](image1)

![Figure 4: Students’ Interest in Science by School Type (upper secondary level)](image2)

4. Discussion

Much research has reported the effect of school type on student interest in physics or STEM (science, technology, engineering and mathematics) subjects at second level and third level [8,9]. The data presented in this study found that Biology is the most popular science subject for both male and female lower secondary students. Lower secondary female students attending an all-girls school were found to have higher interest in the Physics and Chemistry than females attending a coeducational school. All lower secondary, females attending coeducational schools had more interest in Biology than females attending all-girls schools. This indicates that school type is a distinguishing factor in influencing female student interest in science subjects. However, it is acknowledged that this study examines students’ self-reported interest in physics and does not report on the other factors, e.g. student socioeconomic background or science teacher specialism. Hazari comments on the necessity of taking into account other contributing factors, such as, the dependence of the teacher, the curriculum and the classroom environment, in order to determine the effect of educational construct on student interest [2].

A limitation of this research to be considered is the small sample size, particularly in relation to the number of female participants. Taking into account the national statistics on the low numbers of females completing the Leaving Certificate physics exam each year, the number of females (40) in this study provides a representative sample of this cohort. However the authors acknowledge that it is not possible make any conclusions on such a small sample and data from a larger sample size of female students would contribute to more generalizable findings. For this reason, the discussion of findings is limited to discussing data collected from participants of this study and suggesting possible areas for further studies. At upper secondary level, those males who opted to study Physics had higher interest in the subject than their interest in Biology. However, this is not the case with their female counterparts - where female interest in Biology continues to be higher than that of Physics. It is important to note here that there is a high likelihood that these males and females are also studying Biology as a Leaving Certificate subject.
The data collected from this sample of 40 females shows that those attending co-educational schools tended to exhibit a stronger interest in Biology than the females attending an all-girls school. These findings raise further questions about how Physics is perceived and taught in co-educational schools compared to all-girl schools, nationally. Perhaps also, the approach to teaching physics at lower secondary level does not encourage or motivate continuation in physics at upper secondary level. Harker details the average academic attainment of girls who attend single-sex schools against girls who attend co-educational schools as more apparent than real when controlled for different ability levels and social and ethnic mix of the different school types (across English, Mathematics and Science) [111]. Therefore, further details are needed about subject options available, socioeconomic background, ethnicity, science teacher specialism, interest and identity, to complete a robust evaluation of students’ intentions to persist in physics after second level education. Further longitudinal studies that track student interest and belonging in physics are needed to inform the teaching and learning of physics at lower secondary level and maintain a steady uptake of physics among students, particularly girls, to upper second level and further education.

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