Factors Affecting whether Students in England Choose to Study Physics once the Subject is Optional

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only slightly over half of what it was in 1982. In 2010 (during the mid-point of this study), physics entrees only constituted 3.6% of the entire cohort sitting A Levels, with 6.2% of males who sat A-Levels having taken physics compared to only 1.4% of females who sat A-Levels.

Our approach presumes that once students are no longer required to do certain subjects, participation in such subjects depends at least in part on how students see both themselves and the subjects. Neither of these is fixed. Each can shift as a result of experiences both inside and outside the classroom (Black *et al.*, 2009). When students encounter school mathematics and physics, they respond to them in a variety of ways. Understanding the reasons for these varied responses may help make sense of the

Whilst there is abundant literature pertaining to extrinsic factors affecting choices and achievement, comparatively little has been reported on the relationship between intrinsic factors, such as personality and attitudes to, and achievement in, mathematics and science and their relationships to subject choice, achievement and post-16 participation. Accordingly, we designed student questionnaires to include items from established psychological constructs alongside validated subject-specific conceptual tasks so that possible relationships between performance, confidence and intrinsic and extrinsic factors could be explored in each subject and across the two subjects. Mindful of criticisms (e.g. Blalock *et al.*, 2008) that science attitude surveys typically possess weak psychometric properties, a high proportion of the items for the student questionnaire were taken from well-validated constructs in the literature that it seemed reasonable to hypothesise might be related to participation / intention to participate in mathematics and/or physics post-16. In addition, much of the research in science attempts to explain factors that shape

Our analysis of the quantitative strand was undertaken using multivariate methods (multilevel modelling) as well as exploring the data using bivariate and univariate analyses constructs: self-concept, perception of lessons, emotional response to lessons, advice-pressure to study physics, intrinsic motivation in physics, extrinsic material and social gain motivation, perceptions of physics teachers and home support in physics learning. All differences referred to are statistically significant at $p < 0.01$.

The relationship between constructs measuring 'physics education' in 2011 compared to 2009

We conducted correlation analysis in order to explore the relationship between students perceptions of their physics education in 2009 compared to 2011. The strongest association over the two years was the physics self-

extrinsic value of physics. Further details about how changes in these two constructs pan out are detailed in figures 1 and 2 below. There was a statistically significant association

for the following physics-specific constructs: physics self-concept (r=.505 p<01); extrinsic material gain motivation (r=.414 p<01); intrinsic value of physics (r=.409 p<01); perceptions of physics lessons (r=.380 p<01); home support for achievement in physics (r=.379 p<01); advice-pressure to study physics (r=.344 p<01); perceptions of physics teachers (r=.329 p<01) and emotional response to physics lessons (r=.289 p<01). However, these associations are not strong and this suggests that there are considerable changes in perceptions over the two years.

from 2009 to 2011. A score of 0 indicates that there were no changes in responses; scores above 0 are equivalent to positive changes, whereas scores below 0 indicated negative changes in perceptions. The table indicates that though students intrinsic and extrinsic motivation/value of physics increased over the years, their perceptions of their physics education (lessons, self-concept and teachers) saw a decrease.

Table 1: ir physics education between 2009 and 2011

Figure 1: Changes in studentsô perceptions of the physics self-concept

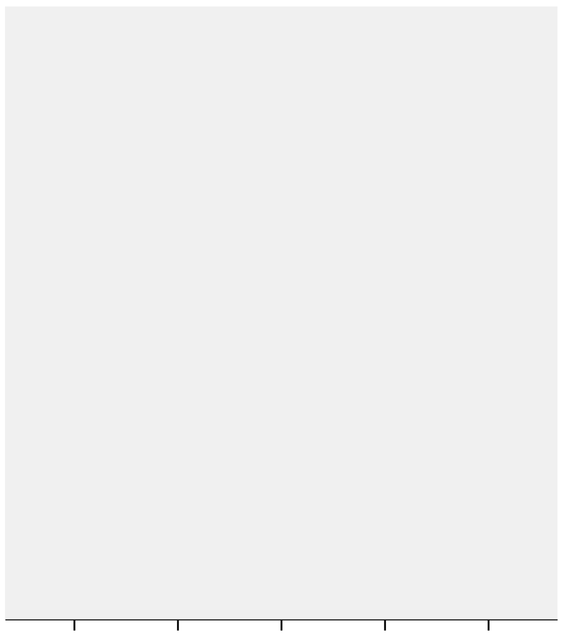

Figure 2: Changes in studentsô perceptions of the physics extrinsic value

Exploring factors that influence students' choice in physics at year 12

Physics choice model

We undertook multilevel modelling to explore the factors that influence physics choice at post-compulsory education in the first year of A Levels.

Ability: We found that current conceptual ability and prior attainment were not important in explaining physics participation in the final model once we controlled for attainment at GCSE (in physics/sciences), extrinsic motivation and home support for achievement in physics.

Support: Furthermore, home support for achievement in physics, though it does not have a high effect size

There was a statistically significant association between students perceptions of their mathematics and physics teachers at year 12 (.402, p<.01) and these associations were higher for these same students compared to their earlier year 10 associations (.241, p<.01). Further analyses conducted in order to test for differences in perceptions of their mathematics and physics teachers revealed the differences were statistically significant (t=12.093, p<.001), with students reporting more positive perceptions of mathematics teachers.

Support for learning

There was a statistically significant association between students perceptions of advice-pressure to study mathematics and physics post-16 at year 12 (.690, p<.01) and these associations were higher for these same students compared to their earlier year 10 associations (.425, p.<.01). Further analyses conducted in order to test for differences in perceptions of advice-pressure to study mathematics and physics post-16 revealed the differences were statistically significant (t=24.785, p<.001), with students reporting more advice-pressure to study maths post-16. There was a statistically significant association between students responses in their perceptions of home support for achievement in mathematics and physics for year 12 students (.821, p<.01) and these associations were higher for these same students compared to their earlier year 10 associations (.576, p.<.01).

Motivation (extrinsic and intrinsic)

There was a statistically significant association between students perceptions of mathematics and physics extrinsic material gain motivation at year 12 (.667, p<.01) and these associations were higher for these same students compared to their earlier year 10 associations (.442, p<.01). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant (t=30.389, p<.001), with students reporting higher levels of mathematics extrinsic material gain motivation.

There was a statistically significant association between students perceptions of mathematics and physics extrinsic social gain motivation at year 12 (.927, p<.01) and these associations were higher for these same students compared to their earlier year 10 associations (.496, p<.01). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant different (t=5.980, p<.001), with students reporting higher levels of mathematics extrinsic social gain motivation.

There was a statistically significant association between students perceptions of mathematics and physics intrinsic motivation at year 12 (.650, p<.01) and these associations were higher for these same students compared to their earlier year 10

There was a statistically significant association between students perceptions of their mathematics and physics self-concept at year 12 (.597, $p<.01$) and these associations were higher for these same students compared to their earlier year 10 associations (.506, $p.<.01$). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant ($t=16.713$, $p>.001$), with students reporting higher levels of mathematics self-concept.

There was a statistically significant association between students conceptual understanding of mathematics and physics at year 12 (.214, $p<.01$) and these associations were higher for these same students compared to their earlier year 10 associations (.160, $p.<.01$). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant ($t=27.285$, $p<.001$), with students reporting higher levels of conceptual understanding of mathematics.

There were statistically significant associations between students confidence in their ability in their conceptual mathematics and physics tasks in year 8 (.448, $p<.01$) and year 10 (.468, $p.<.01$). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant ($t=20.087$, $p<.001$), with students reporting higher levels of confidence in conceptual understanding of mathematics.

There was a statistically significant association between students attitudes towards mathematics and physics conceptual tasks in year 8 (.586, $p<.01$) and year 10 (.510, $p.<.01$). Further analyses conducted in order to test for differences in this construct revealed the differences were statistically significant ($t=12.274$, $p<.001$), with students reporting higher levels of conceptual understanding of mathematics.

whether or not a student was studying physics post-16. Other factors that were important in correlating with post-