Does numeracy count? Mathematics, STEM subjects and graduate outcomes (0306)

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UK government higher education (HE) policies since the Robbins Report in 1963 have been underpinned by the conviction that increased investment and participation in HE were essential prerequisites for continued economic growth, innovation and increased equality of opportunity (*e.g.* DIUS 2008, DTI 1998). In the subsequent waves of growth in participation in the 1960s and increasingly, since the late 1980s as access to HE evolved from an elite system into the current mass HE system, it appeared until the early years of the 2000s that the substantially increased numbers of graduates entering the labour market were integrating successfully into occupations where their investment in HE led to appropriate career opportunities and rewards. However, even before the 2008/9 recession, there was evidence that although the graduate premium was holding up, there was increasing polarisation in access to opportunity from the highest to the lowest–paid deciles of recent graduating cohort distributions (Green and Zhu 2012), rising levels of graduate unemployment, and more significantly, rising levels of graduate under-employment (reference withheld).

Financial responsibility for HE has progressively shifted from the state to individual learners and within the residual government funding, the distribution of resources has favoured universities and students on the courses developing skills identified as priority areas, where demand has consistently outstripped supply: Science, Technology, Engineering and Mathematics, collectively labeled as STEM subjects. Although there are differences among the subjects encompassed by this label and other significant attributes that strengthen or weaken the relative labour-market options available to such graduates, recent research indicates that students with degrees in these areas have a lower propensity to experience unemployment and underemployment (reference withheld).

Numeracy, defined as the ability to reason with numbers and other mathematical concepts and to apply these in a range of contexts to solve a variety of problems, is integral to effective performance in a wide variety of learning situations and occupations. In order to gain entry to study STEM subjects at degree level, higher education (HE) institutions specify that minimum levels of mathematical competence should have been achieved in secondary education. This raises the question as to whether the benefits of higher education in a STEM subject (de Vries 2014) relate to the subject area studied or to the minimum requirements for a qualification in mathematics gained during secondary education. In other words, how far does established numerical competence contribute to early graduate career trajectories and life chances, independently of the other key variables that influence access to opportunity: socio-economic background, being a first or second generation HE beneficiary, gender, ethnicity and the kind of university attended?

To shed further light on this question, the research outlined in this paper makes use of a major longitudinal study of people who applied for a place in a UK university in 2006. The *Futuretrack Study* collected information from such applicants at four points in time: immediately prior to entry to higher education; after completion of their first year of study; at the end of their third year of study; and finally at a point in time some four and a half years after their application to HE. An important addition to these data was the detailed information on the entry qualifications of applicants held by the Universities and Colleges Admission Service (UCAS), the higher education admissions service, through which all applicants apply for a place in higher education. Given that study for these entry qualifications began for most students in 2004, Futuretrack provides a six and a half year longitudinal account of their progress into, through and from higher education to the labour market.

The research draws on two theoretical perspectives in order to provide the analytical framework. Human capital theory (Mincer 1958, Becker 1993) informs the modeling of the post-graduation earnings of graduates. The capability approach developed by Nussbaum and Sen (1993) is used to examine constructs relating to the well-being and job satisfaction graduates.

The study is developed in two phases. In the first phase a basic model is developed in which the social background of the individual, proxied by the socio-economic status of his or her parents, parental education and the type of school attended by the graduate, is assumed to influence the choice of higher education institution applied for and subsequent access to that institution. This, together with the choice of subject studied, is then related to the degree outcome and to the nature of the labour market trajectory (earnings, type of occupation, job satisfaction) in the first two years after graduation. In the second phase, information is added to this analysis as to whether or not the graduate had one or more mathematics or statistics qualification at 'A' level (or Scottish Higher) prior to entry. This enables us to examine the effect of secondary school qualifications in mathematical subjects, taking account of a wide range of other factors that impact upon graduate labour market outcomes. In addition to statistical analyses of survey data, we draw on qualitative accounts of recent graduates about the post-graduation choices that they faced and their early career experiences.

The analysis complements work currently being undertaken by Vignoles, Shephard and Dearden, and by Smith and White, both of which are extending the work of de Vries (2014) to examine the role of STEM subjects in the labour market trajectories of graduates. However, our study examines the part played by mathematical qualifications in this process. We go beyond a focus on graduates who elected to study STEM subjects to look also at those who had the pre-requisites to enter STEM courses but elected to study different subjects.

Preliminary findings support earlier work indicating the strong relationship between social background, the study of STEM subjects to degree level and subsequent labour market outcomes. We reveal that the strength of this

relationship links back to the successful completion of one or more qualifications in mathematics at 'A' level.

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