ECONOMIC AND SOCIAL RESEARCH COUNCIL
END OF AWARD REPORT

For awards ending on or after 1 November 2009

This End of Award Report should be completed and submitted using the grant reference as the email subject, to reportsofficer@esrc.ac.uk on or before the due date.

The final instalment of the grant will not be paid until an End of Award Report is completed in full and accepted by ESRC.

Grant holders whose End of Award Report is overdue or incomplete will not be eligible for further ESRC funding until the Report is accepted. ESRC reserves the right to recover a sum of the expenditure incurred on the grant if the End of Award Report is overdue. (Please see Section 5 of the ESRC Research Funding Guide for details.)

Please refer to the Guidance notes when completing this End of Award Report.

<table>
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<tr>
<th>Grant Reference</th>
<th>RES-062-23-1213</th>
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<tr>
<td>Grant Title</td>
<td>Mathematics learning, identity and educational practice: the transition into Higher Education</td>
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<td>Grant Start Date</td>
<td>1/Apr/2008</td>
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<td>Grant End Date</td>
<td>30/Apr/2010</td>
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<td>Total Amount</td>
<td>£663590.32</td>
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<td>The University of Manchester</td>
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<td>Institution</td>
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<td>Grant Holder</td>
<td>Prof. Julian Williams</td>
</tr>
<tr>
<td>Grant Holder's Contact Details</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td>University of Manchester School of Education B4.8 Ellen Wilkinson Bd. Oxford Road Manchester M13 9PL</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:Julian.Williams@manchester.ac.uk">Julian.Williams@manchester.ac.uk</a></td>
</tr>
<tr>
<td>Telephone</td>
<td>01612753412</td>
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Co-Investigators (as per project application):  

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1. NON-TECHNICAL SUMMARY

Please provide below a project summary written in non-technical language. The summary may be used by ESRC to publicise your work and should explain the aims and findings of the project. [Max 250 words]

The project aimed to understand how 6th form and Further Education (6fFE) students can acquire a mathematical disposition and an identity that supports their engagement with mathematics in 6fFE and in Higher Education (HE).

We hypothesised that the quality of a student's experience of, and engagement in, mathematics is critical to their developing disposition and 'identity', and so to their choices and subsequent success in mathematically demanding programmes (MDP) in HE. This project therefore focused on how different mathematics educational practices in transition to HE influence students' developing dispositions towards and decisions about MDP in HE. We tracked students longitudinally across the transition, surveying a cohort of diverse students in over a dozen cases, mostly involving STEM subjects. Additionally we repeatedly interviewed over 50 students in depth, and analysed practices and associated experiences across case studies.

Overall, we found significant problems with motivating some students’ mathematical engagement: the ‘new rules’ at university can cause a ‘shock’. The link between school and university systems operates as a market place where certificates provide ‘exchange’ value rather than necessarily shaping useful learning such as (rarely seen) mathematical modelling for STEM. More generally, schooling does not prepare for university learning practices, and the university academy may not see students’ ‘learning to learn’ as its core business.

Transitional practices that students found effective involve student-centred or student-led activity and a ‘dialogical’ pedagogic culture, but perceived efficiencies of teaching scale militate against these.

Our Research Briefings offer more implications for policy and practice.

2. PROJECT OVERVIEW

a) Objectives

Please state the aims and objectives of your project as outlined in your proposal to the ESRC. [Max 200 words]

We aimed to understand how 6th form and Further Education (6fFE) students can acquire a mathematical disposition and an identity that supports their engagement with mathematics in 6fFE and in Higher Education (HE).

The project achieved this through the following objectives: (i) providing explanations and measures of the effectiveness of 6fFE & transitional HE practices regarding mathematics for variously positioned students over a period of three years (in part by integrating results with our previous ESRC-TLRP study) and (ii) providing rich, cross-case study accounts of and insights into institutional and educational cultures and how...
they afford individual student trajectories of identity.

The integration of the projects afforded general findings of relevance to the intervals and critical moments (a) from GCSE to AS/A2, and (b) in transition across the 6fFE/HE boundary, and (c) relations between these. Thus, findings about students' mathematics in HE were thereby traceable in part to transition, but also to roots in pre-university experiences.

The project achieved these outcomes through (i) development of existing and new measures and achieving a large longitudinal survey sample, and (ii) multiple HE case studies and longitudinal learner's interviews; (iii) mixed analyses and cross-case analyses of practices, and (iv) building professional user networks.

b) Project Changes

Please describe any changes made to the original aims and objectives, and confirm that these were agreed with the ESRC. Please also detail any changes to the grant holder's institutional affiliation, project staffing or funding. [Max 200 words]

We did not change aims and objectives, but conditions changed that led to a modification in the data collected and analytical methods.

First, the delay in the approval of the project and the large scale drop out of students from the previous project had two implications for the survey sample and its link to the previous project, presenting us with some methodological challenges. Resolving these involved: (i) integration of the statistical modelling with qualitative work with 'link' students, and (ii) analysis of comparative models with both project datasets and their link, with potential methodological challenges but also new outcomes and impacts.

Second, we doubled the initial survey and interview sample and developed further instruments to survey 'transitional practices' that were not foreseen in the original proposal. We also widened the HE cases to include multiple cases of Mathematics and Engineering Schools: we were enabled to do this due to the extra help of attached post-doctoral (Harris) and doctoral scholars (Jooganah/Kleanthous).

In terms of staffing, we added staff (Farnsworth) to replace one co-I on maternity leave (this was agreed with ESRC), and we added RAs to replace some of the fieldwork of the co-Investigator who went overseas.

c) Methodology

Please describe the methodology that you employed in the project. Please also note any ethical issues that arose during the course of the work, the effects of this and any action taken. [Max. 500 words]

One of the strengths of our project is that it draws on a variety of methods. It used a large-scale questionnaire survey, case studies, and longitudinal interviews, providing a rich base of data for analysis.
The survey involved initially 1600+ students in five universities studying mainly Mathematics, Science, Engineering and Medicine (with some social science students with no mathematical demand). Specially constructed instruments were used to measure important new learning outcomes, including the mathematical self-efficacy of students, their disposition to completing HE and disposition towards studying mathematics in future. Additionally, due to the main outcomes of the TLRP project, we constructed self-report instruments that measure the degree of transmissionist/connectionist practice the students were exposed to during their pre-university and university mathematics-relevant experience. The survey data analysis uses Generalised Linear Modelling (GLM) of learning outcome (LO) variables over time intervals. The results include models of the effects of background variables (e.g. GCSE/GCE grades, gender, proxies of class such as EMA grants, postcode and parental education) and earlier ‘input’ measures (including LOs from previous time intervals) and conditions during each time interval.

Our case studies take the form of mainly qualitative investigations and involve classroom/lectures observations with interviews of students and teachers/lecturers. Triangulation is also supported by the collection of other university documents and interviews with other stakeholders such as Heads of Departments or Admissions Officers.

The biographical interviews with 100 students initially interviewed before university (or during induction week), at the end of first year and finally at least 40 at the beginning of second year, give us rich narrative accounts for students’ trajectories of transition into HE. We have also interviewed some students who we interviewed in our previous TLRP study which gives us their transitional experience and story from earlier on (i.e. AS study). The foci of these interviews were (i) the students’ accounts of their engagement in and self-efficacy with mathematics in their programmes and classes, and (ii) their developing plans, choices and disposition towards mathematics and MDP, past, present and future.

Our methodological approach is imbued with the notion of generating practical knowledge in partnership with students and lecturers as informed and knowledgeable participants. This partnership approach also provides an ethical (and triangulating) basis for all the empirical, analytical and reporting work. A series of workshops with partner case studies has assisted in this respect, as well as helping to validate findings.

Throughout the project we adhered to our ethical principles as per the proposal: all participants were informed about the anonymity of the project’s outcomes and students signed a consent form; we supported the “voice” of all participants by being “on their side” helping them to tell their stories; and, all explanations and theorisations were “grounded” in the data “reality”.

Finally, our warrant was also enriched by the project’s advisory group, which consisted of academics and practitioners with relevant experience, and which met regularly with the project team.
d) Project Findings

Please summarise the findings of the project, referring where appropriate to outputs recorded on ESRC Society Today. Any future research plans should also be identified. [Max 500 words]

Our preliminary findings are summarised as follows: Overall, we saw significant problems with first year students’ engagement/disengagement, and with motivating student engagement in mathematics for STEM in particular. The ‘new rules of the game’ can cause a ‘shock’ to students in transition. Particular findings follow:

- The transitional link between school and university systems is structured as a market place where certificates such as A level / BTEC provide ‘exchange’ value as access to university rather than provide information about learning that is necessarily useful.
- Mathematical modelling for its application in STEM is not generally prominent on either side of the transition.
- Students’ experience at A-level does not prepare them well for university learning, e.g. how to autonomously manage the many resources available. This subject may be addressed sporadically in the university 1st year also, and not well integrated into core courses.
- University academe may not see teaching - or responsiveness to students’ learning - as its core business/identity: as a result their development of knowledge and know-how in teaching can sometimes be rudimentary, and the development of a ‘pedagogical culture’ under-valued (e.g. ‘teachers’ may be marginalised).
- Transitional practices found effective involve student-centred or student-led activity whereby the students’ own mathematics become focal and teaching is responsive and dialogical; and
- Apparent efficiencies of teaching scale (e.g. transmission in large lectures) can lack responsiveness to the diversity of student needs and prior experience and learners’ capacity to connect: squaring this circle requires imaginative management and the fostering of a dialogical, pedagogic culture.

Implications of the above relate specifically to policy and practice in the various sectors:

- The ‘6th form curriculum’ needs a complete re-think of what A-level Mathematics experience should involve to prepare students for university study, especially as far as ‘mathematical modelling’ and ‘learning how to learn’ is concerned.
- For transitional systems: There is a need for better flows of information and coordination between school/College and university systems, and AS/A level exam and feedback systems could help.
- For universities: (a) What are universities for? The challenge to the academic ‘rationale’ suggests a move towards a culture of mathematics education (including pedagogic R&D) as well as research; (b) This involves learning how students learn to learn, how they learn mathematics for its use in STEM, and how to develop dialogic Teaching and Learning led by students’ activity; (c) Use of ‘teachers’ in HE can help, but a cultural shift towards helping ‘academics’ to become ‘teachers’ is the real challenge.
- For policy: performance drivers in institutions, especially schools and Colleges encourage ‘teaching to the test’ that is damaging to mathematical understanding and to students’ dispositions.
Future plans include a follow-on project that will synthesise the findings from this project together with those from two previous projects that investigated transitions from school to college (RES-000-22-2890) and through first year of college (RES-139-25-0241) and work with STEM networks and other key partners to stimulate increased participation in STEM related courses at all levels.

e) Contributions to wider ESRC initiatives (eg Research Programmes or Networks)

If your project was part of a wider ESRC initiative, please describe your contributions to the initiative’s objectives and activities and note any effect on your project resulting from participation. [Max. 200 words]

This project was not part of an ESRC programme initiative, but we were invited to participate in the ESRC Science and Maths Initiative programme meetings. Also, a dissemination conference (“Participation, progression and pedagogy in Post-14 Mathematics: implications for policy and practice”) was held on June 24th, 2010, in which this and other three ESRC funded projects presented results to practitioners and policy makers (including one from this ESRC programme).

We will also be working on the dissemination programme with the ESRC Science and Maths Initiative impact project (chaired by Professor Louise Archer). PI Williams has been invited to join the Steering Committee.

3. EARLY AND ANTICIPATED IMPACTS

a) Summary of Impacts to date

Please summarise any impacts of the project to date, referring where appropriate to associated outputs recorded on ESRC Society Today. This should include both scientific impacts (relevant to the academic community) and economic and societal impacts (relevant to broader society). The impact can be relevant to any organisation, community or individual. [Max. 400 words]

The project— in the spirit of Pasteur’s quadrant— has sought throughout to achieve the highest standards of social science research while simultaneously optimising impact on policy and professional practice.

Scientific impact

Our main academic impacts have been and will continue to be made at national (e.g. BERA, BSRLM, BCME) and international educational research conferences (e.g. ECER, AERA, ISCAR, PME), and relevant journal papers developed from these:


BERA, Manchester, 2009: Six papers (Black, Davis, Hernandez-Martinez, Jooganah, and Harris: first authors’ names provided only).

ECER, Vienna 2009: One refereed paper (Pepin).

BCME, Manchester, 2010: Three refereed/published papers to the British Congress on Mathematics Education (Pampaka, Jooganah, Black)

AERA, Colorado, 2010: One refereed paper (Black).

PME-30, Brazil, 2010: Two refereed and published papers (Wake, Williams).

In addition the team has proposed symposia at ECER (accepted for 2010), BERA (accepted for 2010), AERA (under review for 2011) and ISCAR (under review for 2011) which include papers led by all the team.

A new related project (funded by HiST) will collect comparative data on university transition in Norway: comparative analysis aims to broaden generalisations and validity, as well as serve to impact internationally. Similarly a first grant ESRC application (Pampaka, under review) will seek to develop the survey and measurement methodology in mainstream schooling (inter alia).

Societal/professional impact

Seminars for HE users in several Schools of Engineering, Mathematics, Physics and Medicine were held in 2010, and further meetings with Mathematics and other Schools are planned. Formal meetings and presentations have also been held so far with:

HEA MSOR, 2010: the HE Academy for Maths, Stats and OR (Warwick, 2010: the presentation is on the website).

The HE-STEM Directorate and colleagues (2010, Birmingham): this meeting led to a plan for the HE-STEM network to disseminate five project “Research Briefings” in 2011-12 (see below).


A proposed ESRC ‘follow on’ project aims to develop this work with the HE STEM and school STEM/Maths-science networks further (Wake, under review).

Finally the (proposed) project data archiving and the website development are in progress.
b) Anticipated/Potential Future Impacts

Please outline any anticipated or potential impacts (scientific or economic and societal) that you believe your project might have in future. [Max. 200 words]

Scientific impact

A ‘scientific’ publication plan for the next 12 months includes outputs reporting on (i) substantive contributions to mathematics education (papers led by Pepin, Wake, Williams, Hernandez-Martinez), (ii) and to other specific issues regarding transition into Higher Education (Farnsworth, Harris, Jooganah), and (iii) to learner identity (Black, Davis), (iv) contributions regarding the measurement and assessment of attitudes and perceptions of transition (Pampaka) and (v) methodological problems in longitudinal work in education (Hutcheson, Pampaka) and (vi) specific contributions to social theory (Davis, Williams).

Further outputs are also in preparation, including a second book proposal (in preparation) for Kluwer-Springer Mathematics Education series that will complement the current book (in preparation: for 2010) that arose mostly from the ESRC-TLRP output that preceded this project.

Societal/ professional impact

Additionally, we have been commissioned by the national HE STEM network to provide five Research Briefings on aspects of our findings for professional audiences interested in impacting on policy and practice in HE-STEM: the plan is that these will be used to influence HE policy and to initiate practical projects.

Similar plans have been negotiated with the Schools STEM networks and are detailed in the ‘follow-on’ ESRC project proposal (under review).

You will be asked to complete an ESRC Impact Report 12 months after the end date of your award. The Impact Report will ask for details of any impacts that have arisen since the completion of the End of Award Report.
4. DECLARATIONS

Please ensure that sections A, B and C below are completed and signed by the appropriate individuals. The End of Award Report will not be accepted unless all sections are signed.

Please note hard copies are NOT required; electronic signatures are accepted and should be used.

A: To be completed by Grant Holder

Please read the following statements. Tick ONE statement under ii) and iii), then sign with an electronic signature at the end of the section.

i) The Project

| This Report is an accurate overview of the project, its findings and impacts. All co-investigators named in the proposal to ESRC or appointed subsequently have seen and approved the Report. | ☒ |

ii) Submissions to **ESRC Society Today**

| Output and impact information has been submitted to **ESRC Society Today**. Details of any future outputs and impacts will be submitted as soon as they become available. | ☒ |

**OR**

This grant has not yet produced any outputs or impacts. Details of any future outputs and impacts will be submitted to **ESRC Society Today** as soon as they become available.

**OR**

This grant is not listed on **ESRC Society Today**.

iii) Submission of Datasets

| Datasets arising from this grant have been offered for deposit with the Economic and Social Data Service. | ☒ |

**OR**

Datasets that were anticipated in the grant proposal have not been produced and the Economic and Social Data Service has been notified.

**OR**

No datasets were proposed or produced from this grant.