1.6 Research Report

Keeping open the door to mathematically-demanding F&HE programmes

Background

The project belongs to the HEFCE-funded ESRC-TLRP programme on Widening Participation (hereafter TLRP-WP) and contributes to the aims of that programme by “aiming to understand how cultures of learning and teaching can support learners in ways that help widen and extend participation in mathematically-demanding courses in F&HE”.

We explored this in the context of the national take-up of a new “Use of Mathematics” (hereafter UoM) AS course that is designed to help keep learners engaged in mathematics who might otherwise not persist. The UoM Programme contrasts with the ‘traditional’ AS level “Mathematics” (hereafter TRAD) by being focused on ‘uses’ and modelling, and is supported by innovative coursework and other assessment practices, use of technology, and specially-designed texts.

The study proposed to empirically ground this investigation in a large survey of students’ learning outcomes (LOs) using bespoke instruments where necessary (e.g. to measure dispositions), thus producing analyses of ‘effectiveness’. Close investigation in contrasting classrooms/Colleges was added to gain insight into how different cultures play out in practice, and interviews with students were undertaken to understand the impact of practice on learner identities that might explain LO effects.

Early on in the pilot stage of our study, however, another important context of innovation emerged in the AS Mathematics context: the then DFES (now DCSF) and the NCETM were encouraging new, more inclusive and ‘connectionist’ teaching strategies as a means of supporting students, influenced by the work of Swan inter alia. (Connectionist teaching implies learners become actively engaged in making mathematical ‘connections’, across the subject and between mathematics and what they already know). We therefore responded to this context, by including relevant teachers/Colleges in our study, and by constructing a new measure of teachers’ self-reported frequency of pedagogic practice in our survey design.

The theoretical conceptualisation of our study arose from recent developments in Cultural-Historical Activity Theory (CHAT) that seek to incorporate cultural theorisations of identity into understandings of agency and activity. Our work in this area has been in continuous dialogue with the CHAT community, including the second Manchester ScTIG conference and a working residential with leading sociocultural theorists of identity (with Roth, Sfard, and Wenger who has served as critical friend throughout the project). Thus the project has provided a grounding for theoretical developments regarding CHAT and subjectivity, first signalled in several papers in Williams and co-investigators. This work has contributed a

1 But see also section 8 of this report.
2 For brevity, we put the names of first authors in the main body of this text for project practitioners only.
conceptualisation of ‘value’ of mathematics, which we have found helpful in sociocultural analyses of learners’ and teachers’ subjectivities.

Objectives

We met our proposed objectives by analysing data from: (i) the questionnaire survey of a robust sample of students from 6th Form and Further Education Colleges (6fFEC) nationally, with adequate numbers of students following ‘Use of Mathematics’ (UoM) versus the traditional ‘Mathematics’ (Trad) programmes at AS with an appropriate range of different backgrounds; (ii) ethnographic-style fieldwork in five 6fFECs with diverse approaches to Programmes and pedagogy in mathematics, mostly in areas of relative deprivation, including 3 Colleges in metropolitan, one in deprived urban and one in mixed communities, and (iii) serial interviews with 40+ students from 10 classrooms observed in these 5 Colleges.

The methods and analyses described below led us to address fully our research questions as specified in the proposal, and so provide (1) measures of effectiveness of UoM with matched TRAD students of overlapping background, (2) explanations and insights into how different teaching and learning (T&L) cultures mediate outcomes for different learners, and (3) narrative accounts of different learners’ trajectories of identity, their experiences of pedagogy, their aspiration for further study, and how these are influenced by sociocultural, gendered, classed, and ethnic positionings.

These have so far led to the following outcomes, as originally proposed. [See page 8 of our project proposal.]

1. Measurements of effectiveness (for various LOs) of the different Programmes for different students;

2. Understandings of how T&L cultures can support better participation for some students;


Specifically, we have produced

4. the qualitative and quantitative data sets required for the study and proposed analyses (deposit with ESRC is in progress);

5. narrative case accounts of students’ identities and cross case analyses of discourses, aspirations, and pedagogy (Hernandez et al., 2008; Davis et al., 2008a&b);

6. case studies of classroom cultures and how they relate to Programme, pedagogy, and institutional cultures and geo-demographics (see e.g. Williams et al., 2007; Wake et al., 2008);

7. evaluations of effectiveness and implications for policy and practice (see Research Briefing TLRP-38 for further details).
Beyond the proposal’s original plan we added:

(i) to the sample size to ensure sufficient numbers in the sample after attrition (thus we initially had 1700+ questionnaires, so we achieved 1000+ at the end of the year when measurement of effectiveness was carried out, and c600 in the following year’s sample);

(ii) a telephone and College database survey of student destinations to ensure an analysis of student ‘drop out’ and university aspirations and decision-making (see also Davis et al., 2008a)5;

(iii) a teacher survey of their ‘self-reported practices’ to explore the effect of more-or-less teacher-centred practices and how this interacts with the Programme of study. This has produced an important new instrument not originally foreseen, and added a new dimension to the analyses, findings and implications for policy (Pampaka et al., 2008 under review)6;

(iv) to the interviews in most cases a fourth interview, to provide extra data on students subjectivity in regard to their experience of different pedagogies and programmes;

(v) a cross-interview cluster analysis using SPSS, allowing us to explore the generality of categories of student subjectivity across the interview cohort and revealing a new layer of evidence for the importance of our ‘theory of mathematics value’ and of ‘deep/surface’ learning approaches (Davis et al., 2008c; Williams et al, 2008)7;

(vi) to the Advisory Group’s meetings and PI Nicholson’s contributions a further four meetings of participating and invited teachers and other professionals to expanded seminars/conferences to support interpretation and validation, including one residential.

Our follow-up field work prioritised validity checks that were deemed most critical for the interpretation and validation of our main study results. This involved (a) in depth ‘biographical’ interviewing of three of our case study teachers exploring their professional career and construction of identity as pedagogues; (ii) pursuing a telephone-survey of students who were lost to us (n=c250) and (iii) collecting anonymised but comprehensive sample data on drop out and examination grades from Colleges and from the 18+ government database (N= 622 AS grades; 1347 GCSE grades) to check the validity of our sample, especially for ‘mortalities’ (see Methods below).

Methods

Our initial questionnaire survey sample of 1792 students was acquired from 39 Colleges in England, 20 of which involved ‘UoM’ as well as ‘TRAD’ AS courses (and 2 UoM with BTEC engineering): this cohort shrank to 1047 at the end of the AS year, and 598 in the A2 year – though our sample numbers on key variables were swollen by the telephone survey and the addition of information from College databases, so we have key outcome data for drop out and AS grades for c1500
students and final university choice data for 787. The cohort is approximately 40% female, ¾ GCSE grade B or C, over 1/2 EMA, ¾ first-generation HE, ¾ ‘English-speaking-only’, and 1/2 ‘white’. About ¼ were from Low Participation Neighbourhoods/ HEFCE social group 4.

The survey instruments were developed and calibrated during a pilot stage (with 300+ students). We validated three scales of ‘disposition to study in HE’, ‘disposition to study more mathematics’ and ‘self-efficacy in use of mathematics’. The first two were analysed with the aid of partial credit Rasch Models. Results suggested robust measures in the first two cases, but also the need for additional items on the first measure due to a ceiling effect (Williams et al, 2007)\textsuperscript{8}. The Mathematics Self Efficacy (MSE) scale was analysed with the Rasch Rating Scale Model and multidimensionality and DIF were explored (Pampaka et al, 2007; Wake and Pampaka, 2007)\textsuperscript{9}. The teachers’ self-reported pedagogic practice instrument developed items validated by Swan with a national cohort of 6fFEC teachers of GCSE Mathematics. Our analysis of his data indicated that a one-dimensional construct was acceptable, and this was confirmed in our sample of 110 cases (from the 95 teachers of most of our student sample). See Pampaka et al., under review (a nominated output)\textsuperscript{10}.

The models were hypothesised on the basis of theoretical considerations and were tested for statistical significance using appropriate generalized linear models (after Hutcheson and Moutinho, 2008; also Fox 2002)\textsuperscript{11}. The challenge is to select models that are: ‘best fitting’; theoretically relevant; practically useful; and derived using the most reliable data. "All models are wrong, but some are useful." (Box, 1979)\textsuperscript{12}.

Models of outcomes (e.g. Maths-Disposition\textsuperscript{2} in Table 2) were derived by attempting to include indicators of distinct factors (e.g. Programme, pedagogy) whilst controlling for interactions (e.g. previous examination grades, OtherSubjects, MSE\textsuperscript{2}) and "background" variables (e.g. gender and ethnicity) – thus giving the model for Table 2. The change in an outcome variable over time was similarly modelled, but with the inclusion of the previous recorded value (e.g. replacing, or adding to MSE\textsuperscript{2} by Maths-Disposition\textsuperscript{1} in the above model).

In order to check for the possible distorting effects of mortality between the data points (a number of students left during the study), models on the complete data set were tested and confirmed against those on the college survey data subset for which we had 100% data on some of the outcome measures.

The case study work in Colleges consisted of interviews with teachers and managers, lesson observations (videotaped for later analysis), analysis of relevant texts and artefacts, and student interviews. The approach was initially led by (i) the proposal’s hypotheses, e.g. that the Programmes make a difference to classroom cultures, and (ii) the teachers’ and students’ claims. Pilot studies however, led us to examine ‘transmissionist versus connectionist’ pedagogies (and hence to the pedagogy instrument). Our analyses of lesson observations included microanalyses of talk, analysis of ‘whole lesson’ narratives, and analyses of mathematical discourses that are best conceptualised on longer timescales (over the whole Programme, and the life course).
Interviews with 40+ students were held that sought to explore (i) the students’ trajectories of their learner identity (including aspirations and choice-making, and the value of mathematics to them etc), and (ii) their experience of mathematics learning in practice, and hence the influence of pedagogies on subjectivity and identity. The ATLAS.ti thematic coding framework was developed accordingly; with open codes such as ‘coursework’, ‘technology’, ‘memorising’, ‘uses’ and later axial codes reflecting ‘learner-approach’, ‘pedagogy’, ‘aspirations’, and ‘maths-values’. This facilitated our analysis of coursework, modelling and technology (see Hernandez-Martinez et al, 2008b)\(^\text{13}\). Cross-case analyses with the student as unit of analysis then allowed us to explore ‘clusters of students’ connected by axial code-sets, such as the sets exchange-use and learner approach-participation, and how these change over time.

Early on (at the first data point: see Hernandez-Martinez et al., 2008\(^\text{14}\)) we identified characteristic ‘repertoires’ of aspiration, and aspirational ‘style’. Examining the whole series of interviews, however, we found ‘canonical narratives’ of students’ trajectories in relation to mathematics. We have sent these to students as they are completed to encourage them to contradict/validate them.

**Results**

The results are being produced in internal working papers that, after internal review are posted on our website and subsequently sent to D-space (TLRP) and so linked to ESRC SocietyToday. All these and other references to these in what follows can be found in the appended list of publications. We choose now to report results under three categories (survey- case study – interviews) of data /data analysis that most strongly inform the particular result, though most results draw on triangulation from more than one data source and type.

**Survey results**

We have developed instruments and one-dimensional measurement scales for students’ *disposition to study in HE, disposition to study more mathematics, and self efficacy in using AS mathematics*; and for teachers a self-reported measure of *teacher- versus student-centred teaching practice* (Pampaka et al., 2007; Williams et al., 2007\(^\text{15}\)). We have shown that these give good psychometrics for our sample, and provide us with evidence of Learning Outcomes that complement GCSE/AS grades, university subject choice, and drop-out. The analyses of these results are of interest in themselves; thus we report in Pampaka et al (2008)\(^\text{16}\) how teachers’ self-report a high incidence of ‘teacher-centred’ practices (as defined originally by Swan). See Figure 1, which shows the distribution of 110 scores and those reported by our 8 case study teachers: note their spread.

The case study work and teachers’ interviews have led us to associate the self-reported teacher-centred practices at the top of the scale with ‘Transmissionism’ and the bottom with ‘connectionism’ (Pampaka et al., 2008)\(^\text{17}\). Further, Differential Item Functioning analyses proved interesting; thus, it seems that UoM teaching practices of ‘using the text book’ are different from the traditional, as could be expected given that they use a quite different, innovative text\(^\text{18}\).
Some Generalised Linear regression Modelling (GLM) results of significance follow:

1. The UoM programme is significantly more effective in helping students in our sample who have low grades to complete their AS level; see table 1. To this we can add that students on the AS UoM generally get about one grade higher than their GCSE-grade predicts on the traditional AS Mathematics course.

2. The students who study the Traditional AS course as opposed to the UoM are rather different geo-demographically and in a number of other respects such as in their higher GCSE grade distribution and their disposition to study more mathematics and mathematically-demanding subjects in HE. Ethnicity played an important role in course selection, as the literature suggests e.g. Asian students are significantly more likely to favour a STEM subject in HE, and to join a traditional AS Mathematics Programme, even after controlling for GCSE grades (see Figure 1 below and Hutcheson et al., 2008a\textsuperscript{20} for full details).

3. Whilst the disposition to study in HE is generally high for this sample, disposition to study mathematically-demanding subjects in HE declines for all over time, and ‘White British’ students show a significantly lower mathematics disposition at all time points. Similarly native English speakers have significantly lower dispositions at all time points and also show a significantly greater rate of decline (see Hutcheson et al., 2008b\textsuperscript{21}).

\textit{Figure 1: the distribution of scores on the teacher-centred frequency of pedagogic practice scale.\textsuperscript{iii}}

\textsuperscript{iii} N.B. all names are pseudonyms.
Table 1: Drop-out by GCSE grade (figure in brackets is drop-out + U grade at end of AS year as a %) based on sample of c1500 students

<table>
<thead>
<tr>
<th>Drop-out, U grade</th>
<th>GCSE grade = A* and A</th>
<th>B Higher</th>
<th>B Intermediate</th>
<th>C Higher</th>
<th>C Intermediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS Trad</td>
<td>10% (21%)</td>
<td>19 (52)</td>
<td>31 (60)</td>
<td>26 (64)</td>
<td>46 (81)</td>
</tr>
<tr>
<td>AS UoM</td>
<td>6%* (13%*) IV</td>
<td>15 (22)</td>
<td>8 (23)</td>
<td>25 (53)</td>
<td>21 (46)</td>
</tr>
</tbody>
</table>

* indicates frequencies too small to securely report.
4. The disposition to study more mathematics is also significantly negatively related to the strength of teacher-centred pedagogy reported. This is clearest in the traditional AS teaching group, in which the range of practices is greatest. However, this negative regression becomes insignificant if the few, most strongly student-centred (presumed connectionist) classrooms are removed from the analysis: thus we conclude that these classrooms are where the effect is being created, and follow this up in the qualitative analysis results below.

5. A significant effect of gender, ethnicity, other subjects studied and grades is found on self-efficacy with mathematics. As expected, self-efficacy in mathematics is a significant explanatory variable accounting for disposition to study more mathematics, even when attainment grades are accounted for in the models.

These results of the survey modelling are as yet incomplete, but will serve to illustrate how our findings emerge from qualitative analyses interacting with such survey findings. See Hutcheson 2008a,b23.

Table 2: Regression table for modelling of Maths-disposition at end of AS (Asian ethnicity = 0, MSE2 and “course” subsumes MathsDisp1 in this model)

| Coefficients:                  | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------------|----------|------------|---------|---------|
| (Intercept)                    | -0.11448 | 0.19091    | -0.600  | 0.54892 |
| Ethnicity[T.BLACK]             | 0.13523  | 0.24637    | 0.549   | 0.58326 |
| Ethnicity[T.CHINESE]           | -0.09018 | 0.43301    | -0.208  | 0.83508 |
| Ethnicity[T.OTHER]             | -0.26626 | 0.29450    | -0.904  | 0.36626 |
| Ethnicity[T.WHITE]             | -0.36373 | 0.18212    | -1.997  | 0.04620 |
| Language[T.ENGLISH]            | -0.42708 | 0.19118    | -2.234  | 0.02581 |
| Language[T.OTHER]              | 0.41815  | 0.28278    | 1.479   | 0.13968 |
| Course[T.UoM]                  | -0.77903 | 0.12870    | -6.053  | 2.35e-09 ***
| MSE2                           | 0.46390  | 0.05344    | 8.681   | < 2e-16 ***
| AveragePed                     | -0.26541 | 0.09521    | -2.788  | 0.00546 **
| OtherSubjectsMathsDP2          | 0.14801  | 0.03604    | 4.107   | 4.50e-05 ***

Multiple R-squared: 0.268, Adjusted R-squared: 0.2572
F-statistic: 24.9 on 10 and 680 DF, p-value: < 2.2e-16

College case studies and lesson analyses

Each case provided a distinct combination of Programme, departmental and institutional culture, community geo-demographics, and thus market-position situating the phenomenon under study, viz. teaching and learning mathematics. These provided us with insight into how pedagogy and discourses of ‘values’ came to be mediated (e.g. by the object of activity, pace, interactional norms, tools and texts).

Programme influences

UoM Programme practices offered students some different learning opportunities by virtue of the assessment scheme (which includes coursework and comprehension tasks that require students to communicate mathematically) and the technologies it encourages (the text books that emphasise modelling and ‘uses’ activities, and the use of graphic calculator and spreadsheet/IT tools). These can encourage learner agency and a variety
of different interactional norms between students and their peers and between students and teachers. Coursework in particular was appreciated by many, though not all, students, mainly as an aid to understanding; some students particularly noted that coursework demands that the learner explains and ‘when you can explain it you really know you’ve got it’. Coursework is also described as helping students to get a pass grade (especially by those who say they don’t do well in examinations). Teachers however say that some students fail because they are ‘not organised enough’ to hand in coursework, and it imposes extra work on themselves.

In some cases the UoM study complemented BTEC engineering courses: in these cases the modelling and coursework could allow mathematics to be tailored to students’ engineering interests. Such students’ learning experience can be directly connected to a different learner identity (see below, next section).

Analysis of students’ interviews revealed a sharp distinction between UoM students and Traditional AS students’ discourse: the former made many references to uses of mathematics in real non-trivial examples, e.g. in their other subjects. In general UoM does impact on the quality of participation (Davis et al., 2008c). For engineers in particular mathematics and its use were often perceived to be seamless: and they saw mathematics as essential because they used it everyday in their engineering. In contrast, in all but one of the interviews with ‘Trad’ students, the only ‘real life use’ of mathematics was in everyday use such as ‘shopping’.

Influences of pedagogy

A few classrooms we observed were dominated by more student-centred practices that – given the account of their practices by the teachers involved and our analysis of observed practice - we attribute to ‘connectionist’ pedagogies. In one such case we analysed a number of Sally’s lessons closely: we saw how a more social and cooperative pedagogy was developed that encouraged students’ confidence and their ability to communicate in small groups and then with the whole class (Davis & Williams, accepted). Learners were thus gradually encouraged to publicly share ‘mathematical productions’ including many mistakes, to evaluate them collectively and learn from these reflections. A small incident that typifies this approach involved Sally asking the class for formulae that might represent a (transformed) graph – having elicited 5 or 6 different responses including some well-known misconceptions, she says “well, presumably they can’t all be right, how will we decide which are correct?” Her use of the pronoun ‘we’ here invites the class to evaluate the mathematics on offer – ‘traditionally’ a teacher’s function in whole class, public interactions. Thus, mathematical procedures tend to be publicly developed, justified or debugged by appeals to conceptual underpinning and ‘connections’.

Additionally however, in this classroom study we saw ‘public’ evidence of:

(i) problem-solving and ‘guided re-invention’ taking place in the design of the whole lesson;
(ii) the use of ‘memory’ artifacts (e.g. posters and whiteboards) crystallise and socialise learners’ mathematical productions across lesson boundaries;
(iii) an ‘inclusive’ discourse of learners being ‘mathematicians’ and practical agency affording mathematical subjectivities: students were told what it means to behave ‘mathematically’ and invited to experience an identity associated with a mathematical community of practice.
This analysis of classroom discourses suggests that a ‘deep’ approach to learning was being explicitly encouraged by making mathematical processes and concept-formation more publicly ‘visible’ and meaningful.

In contrast transmission pedagogy appears to generally make ‘surface approaches’ publicly visible: reference to what the examiners (‘they’) want from the learner in the exam is often prominent. Students who are already well-prepared and well-disposed can thus be taught apparently ‘efficiently’, and pedagogy is fast-paced, teacher-centred, and procedure-orientated. Explanations and concepts underpinning the procedures tend to be enunciated by the teacher, in their public exposition and private explanations. Students often work alone or in pairs to help each other, or get help from the teacher one to one, and so conceptual aspects of mathematics are ‘privatised’. Those who don’t understand may respond by rejecting maths as ‘hard’.

Institutional cultures frame the teachers’ accounts of their pedagogy: in some Colleges transmissionist teaching is justified by the performance management. This in turn is shaped by the institution’s market-position and demographics: some Colleges are more orientated to an ‘open access’ policy in relation to the community they serve, while others are more league table driven. An open access policy may encourage pedagogic innovation, either in the classroom with more student-centred pedagogy, or via other solutions such as one-to-one support and tuition outside the classroom. The latter is very expensive and usually carefully targeted.

The particular ‘connectionist’ teaching we observed flourished in one institution that served students from a deprived area with relatively weak prior GCSE grades: the institution had an open access policy, and ‘gave room’ to develop such a teaching approach, which was rationalised as being necessary for learners ‘from round here’.

**Interviews, narratives, and cross case analysis**

Narrative analysis of students’ biographies (a moving target through the AS year) reveal differences between students’ identity and the role of learning mathematics in these stories. Some students tell of a ‘leading’ identity (e.g. ‘becoming a scientist or engineer’) that shapes their story; we draw on the concept of ‘leading’ here in the sense of ‘leading activity’ of Leont’ev. The view of self implied in this designation of a future employment/work activity in some cases is sufficiently strong to ‘drive’ the story told (c.f. the ‘vocational’ and ‘fulfilling a dream’ repertoires below). In contrast some other students’ stories of their plans and futures, while also articulate and thoughtful, were initially more liminal: ‘let’s wait and see’, and firmed up only as decision-points approached.

Analyses of students’ discourses of aspiration revealed several distinct ‘repertoires’ in which their aspirations were mostly expressed; and indeed in most cases students could be assigned a particular repertoire ‘style’, although some made use of more than one. These are labelled “becoming a success”, “personal satisfaction”, “fulfilling a dream” and “vocational”, and our analysis of each of these suggests a somewhat different role for mathematics in each, with implications about how widening participation discourses might address them. We also found that repertoire styles tended to relate intersectionally to demographics/gender/ethnicity. Thus, for some
ethnic minority or migrant/EAL students ‘becoming a success’ in high status professions was important, which might explain survey results regarding their subject and Programme choices.

‘Canonical’ narratives (e.g. “when troubles come, aspirations adjust”) were constructed from 44 interviewees (accounts were also sent to students for respondent-validation). These allowed us to identify three categories of what Bruner calls ‘trouble’; troubles-about-maths (e.g. maths is hard), family troubles, and troubles with ‘value’ (e.g. A’ grade media studies is worth more UCAS-points than AS Mathematics). We found that students faced with troubles may re-negotiate their aspirations to resolve contradictions between values. Some students, though, persist with their vocation or ‘dream’ despite troubles, and may choose to spend another year in 6fFE, rather than adjust their aspiration.

These analyses point to the exchange value and use value of mathematical knowledge: we use CHAT, after Holland et al., to conceptualise cultural models, norms and values of mathematics as boundary objects coordinating the subject’s engagement in practice with the construction of a self-identity, a story that students tell themselves about who they might be and who they might become. Classroom pedagogy and teachers’ discourses about mathematics provide these cultural resources: hence we find the concepts of ‘use’ and ‘exchange’ value in teachers’ own discourse, and pedagogy. The exchange value of mathematics provides a motive for learning associated with grades/UCAS points, access to rewards and well-paid jobs, usually implying some delay in gratification. The use value of mathematics is in its eventual application or immediate gratification in terms of intrinsic satisfaction. The classic Marxist analysis of commodity implies that the contradiction between exchange and use provide for alienation of labour; and this analogy provides some insight.

For some, maths was studied mainly for exchange: even if the student has no sense of its ‘use’. For almost ALL students exchange value is highly relevant: strategic decisions regarding likely grades and the ‘cost’ in terms of effort sometimes leading to adjustments of their aspirations. For others, the satisfaction, enjoyment, or ‘consumption’ of their chosen subjects is more salient: this may count against mathematics if dispositions decline.

As might be expected, we see exchange value emphasised in institutions where the performativity discourse is strongest, and where the classroom pedagogy mediates exchange values. In such cases, the teacher may even refer to the pressure of the students’ performative voice themselves: ‘its more than my job’s worth ... not to finish the syllabus … (the students) could sue me’.

This interpretation was further warranted by a cluster analysis of students by relevant code-sets, which signalled two, perhaps three clear differences in orientation towards the value of maths by different students: ‘exchange’, and ‘use’, and also perhaps a ‘mixed’ group. The most strong ‘exchange value’ group of students were characterised as choosing maths for its currency as an entre to a successful career or university subject: some even disliked mathematics while seeing it as ‘good for the cv’, as a way of gaining an edge over competitors. Then a ‘use’ value group included many of the BTEC engineers and UoM students. The third group is more complex and contradictory, and still under study. (See Davis et al., 2008c).
Cluster analysis also examined ‘procedural/surface/memorisation’ as against ‘conceptual/understanding/deep’ learner approaches. A significant cluster emerged around the ‘surface learner’ construct: this group is procedural, exam orientated, and sees mathematics itself, rather than applications, as being the object of learning. A second cluster is identified but cannot be definitively interpreted as yet. However, there is NO equivalent cluster around deep approaches to learning, though one can see in some of the students’ interviews a deep approach being adopted (Davis et al., 2008c).

Conclusion

The ongoing analytical and interpretative work of the project has led us to the importance of the cultural model of ‘value(s) of mathematics’ as a significant conceptual thread throughout all this work. It ties the institutional and policy culture of performativity to the teachers’ professional subjectivities and to pedagogic practices, and hence to the activity of the classroom and its ‘joint object’, and so to students’ subjective experiences of agency and learning in the classroom, and finally to students’ narratives of identity, and their strategic decision-making. Policy and practical implications follow (see TLRP research briefing, http://www.lta.education.manchester.ac.uk/TLRP/Research%20Briefing.pdf).

Activities, Outputs and Impacts

Four dissemination and verification seminars involving practitioners have been held during the project and one more is planned for the autumn, 2008, when the new ESRC Transitions project will launch its first conference (RES-062-23-1213). In addition to this, the project has been very active within 6 TLRP Conferences (including one policy-orientated conference in Glasgow) and peer reviewed British and international conferences: 3 BERA, 2 AERA, 1 CERME, and 2 PME conferences.

The project team has further participated:

- in the ESRC seminar series on ‘Mathematical Relationship: Identities and Participation’, including the plenary paper to the 2006 conference, University of Manchester;
- regularly in the Manchester ScTIG seminar series and its international conference in 2007, (plenary paper presented);
- in the Nuffield seminar series on “Subject Knowledge for Mathematics Teaching” (paper presented);
- Research in Higher Education (Brighton 2008: symposium with 3 papers presented)

Planned events include: ISCAR (symposium in 2008); and AERA (April 09).

A full list of publications is on the website and with ESRC SocietyToday. Particularly important are the journal papers to date are Black et al (under review), Hernandez-Martinez et al (2008), Pampaka et al. (under review) and book chapters Davis and Williams (in press), and Williams et al (accepted, 2008). These report the early work of...
the project: the emerging range of expected publications is indicated by the full set of project working papers on the website.

A key dissemination meeting with HEFCE was held in June 2008 for the whole Widening Participation programme of TLRP: the content was essentially that of the “Research briefing” document, to be found on our website.

Future Research Priorities

Three proposals have developed from the work of this project to date: two funded (RES-000-22-2890 and RES-062-23-1213, PIs Williams and Hernandez-Martinez) and one under review (RES-000-22-3084, PI Pampaka).

The first two extend the study of students in transition to first year university (Williams’), and from GCSE (school) to Post-compulsory education (Hernandez’). The third proposes to extend the promise of the measurement of pedagogy (Pampaka’s).

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Appendix: Publications


http://www.lta.education.manchester.ac.uk/TLRP/academicpapers.htm

http://www.lta.education.manchester.ac.uk/TLRP/academicpapers.htm


http://www.lta.education.manchester.ac.uk/TLRP/BERA%202007%20Maria_final.pdf

http://www.lta.education.manchester.ac.uk/TLRP/BERA%202007%20measuring%20dispositions%20to%20enter%20HE_JSW.pdf

http://www.lta.education.manchester.ac.uk/TLRP/Multi-dimensional%20structure%20of%20self%20efficacy%20instrument.pdf


http://www.lta.education.manchester.ac.uk/TLRP/academicpapers.htm

http://www.lta.education.manchester.ac.uk/TLRP/academicpapers.htm

22 As above in 20/21

http://www.lta.education.manchester.ac.uk/TLRP/academicpapers.htm


multicultural settings) of the tenth Conference for European Research in Mathematics Education, Cyprus.


32 See above, 31


