The purpose, role and impact of additional 'extension' papers for entry to mathematics courses at English universities: a small study

Jennie Golding

Assoc Professor Mathematics Education, UCL Institute of Education

Structure

- Background
- What is generally known?
- What would ‘we’ like to know?
- How am I trying answer those questions?
- What are some initial findings?
- How might you contribute?
- Questions?

Background

There has been a recent (3/4 years) increase in number and use of such additional papers, and consequent unease expressed to JMC

Related published work includes accounts of impact on u/graduates (Darlington), and a MATH taxonomy (Smith *et al.*, 1996) that analyses the demand profiles of different papers

We know little about impact on school students, school teachers, students 'unsuccessful' with papers, equity of access and WP issues

We know little about reasons for HE use, or HE perceptions of impact of engagement with additional papers

Transition to HE mathematics involves shifts in epistemological rigour, formalization & abstractness, in forms & purposes of organisation and in personal capacities (Gueudet, 2008)

What are the focus papers?

- STEP I, II, III, June y13 (based on AL Ma, AS FM, AL FM respectively, grade S,1,2,3,U. Six best responses to 11 or 12 qus). *STEP II and III used for Cambridge mathematics entry (2:1 offers: places); STEP I used by e.g. Cambridge Econ, Eng, ~10 others as part of offer options.*
- MAT (based on first 4 terms of A Level Ma) MC*10, plus 4 extended qus, Nov y13. *Used by Oxford and Imperial, and as an option associated with modified offers, by a small number of others.*
- TMUA (from 2017, *2: MT/MR. Each 75 mins, 20 MC qus, based on AS Ma+), Nov y13. *Ma, Econ, Comp Sci: Cambridge CS, Warwick, Bath, Durham, LSE, Sheffield, Lancaster, Southampton, Nottingham, Cardiff (FM not always reqd). Usually not compulsory, can choose whether to release results.*
- AEA , June y13: based on A Level Ma. D/M/P/U
- Advantage of Autumn papers for secure outcomes, less stressful summer season
- Advantage of summer papers for those who decide HE applications later

For example:

KCL : A*AA: Must include a grade A* in Mathematics and Grade A in Further Mathematics. We will accept Further Mathematics AS-level grade A only if you additionally achieve a 3 in any STEP paper or a Merit in AEA Mathematics.

Durham: A*A*A/A*AA Ma/Fm/ano including a score over 6.5 in TMUA or equivalent in MAT or getting a 1 in any STEP. Or A* in Ma, A in FM AS-level, and two further A levels at grade A plus above TMUA/MAT/STEP

UCL: A*A*Ain Ma/FM/ano or A*AA + 2 in STEP or D in AEA

Small study funded by JMC. JMC RQs:

- How and why are the papers being used by universities?
- What support is available to students in different settings?
- What are the benefits to students who succeed with these papers? What are the benefits (or costs) to those who enter for them but do not succeed?
- What is the range of students who would benefit from preparing for such papers, and what support would they require? (Is it beneficial for a wider range of A-level students to embed consideration of the questions in STEP, MAT, AEA and TMUA in their regular classwork?)

Methodology: Jan-April 2020

- Synthesis of related 'grey' data (websites, reports…), with existing specific and wider literature
- Interviews with a variety of providers of external support for paper preparation (AMSP, SSP…)
- Theoretical sampling from young people in year 13 who have applied for reasonably competitive mathematics-intensive university courses, and their teachers, in 6+ *state* 11-18 schools, 6+FE colleges (potential for 'telling' sample of *mathematically strong* depts): student FGs and teacher interviews.
- Interviews with HoDoMs and/or mathematics admissions tutors and/or academics teaching first year mathematics at a small purposive sample of 6+ institutions *encouraging, or mandating, additional papers*, plus two others who reasonably might.
- Three googlesurveys, one for year 13 students applying for such courses, one for their teachers, one for HE mathematics academics, promoted via social media and professional networks (close 30 April)
- All interviews and focus groups recorded and transcribed. Analysis by RQ, then grounded themes.
- *Exploratory* rather than exhaustive or representative

Data to 16.04.20

What?	Source	17.04.20, n =
Year 13 teacher interview transcription	11-18 state funded school	10 (8 schools)
	FE college	11 (7 colleges)
Year 13 student focus group transcription	11-18 state funded school	19+ (3+ schools)
	FE college	25+ (4+ colleges)
Interview transcription	Provider of preparation support	5 (SSP, AMSP, nrich)
Mathematics academic interview transcription	University (Oxbridge or…..)	11 (9 universities)
Year 13 student g-survey	Various school or college	37+
Year 13 teacher g-survey	Various school or college	17+
Academics g-survey	Various HE	3+

Emerging messages: How and why are the papers being used by universities?

- Mixed reasons for use given by HE: selection, mathematics awareness/experience then better aligned with that in HE, status and competitive edge (numbers control/reputational edge).
- (Wide recognition that) the *most* competitive (~5) mathematics departments need additional *selection* tools, beyond A Levels. Sometimes required (potential and commitment) where no FM A Level. Otherwise only Oxf, Cam, Imp *require* paper; otherwise if used it's nominally optional but sometimes heavily encouraged, with one-grade reduction in offer. Some others say they'd consider a good performance if an offer were just missed.
- (Wide recognition that) engagement with these papers can provide (differential) enrichment and challenge reasonably aligned with the changes in approach to mathematics valued at university: successful engagement in addition to A Levels is thought to support transition.
- Respondents valued problem solving skills, deeper mathematical thinking, getting stuck, development of resilience, some mention of communication skills.
- Little mention of near-demise of AS Levels (summer tests do not in any case address that) or new A Levels
- Little evidence of direct transferable benefit in HE (e.g. no tracking apparent where papers are optional)

What support is available to students in different settings?

- The AMSP organises Problem Solving Matters, 6 venues, each 3 Saturdays £60/£0, peer group benefit
- (AMSP big investment incl. professional devt: online short or f2f, one day)
- Underground Mathematics (STEP qus with solutions)
- NRICH Advanced Problem Solving modules
- STEP support programme online, structured
- Advanced Problems in Mathematics by Dr Stephen Siklos, downloadable book.
- Past papers from 1998 with many solutions, plus some videos, for STEP, MAT, TMUA
- Meikleriggs Mathematics: Dr Peter Mitchell's website includes complete solutions to STEP papers from past years.
- *Informal or formal support in school/college, from negative 'we discourage our students from making any applications that would need additional papers', to twice-weekly expert, increasingly selective and focused support from age 11. Note many depts do not have a teacher confident to teach FM AS, even, and many more do not have a mathematics (major) graduate. When they do, support for these papers is competing with other additional calls.*
- *The range of teachers and students who've engaged with these papers talk about their 'teachability' and 'learnability' – particularly for STEP and TMUA.*
- *Targeted WP support in some areas.*
- *UNIQ SS, 'Opportunity Oxford', It All Adds Up for y9-12 girls, initiatives.*

What are the benefits to students who succeed with these papers? What are the benefits (or costs) to those who enter for them but do not succeed?

- *HEIs:* PS skills, deeper mathematical thinking, getting stuck, development of resilience, some mention of communication skills. Typically said papers offer differentiated experiences – but don't distinguish in use.
- *Teachers:* Depth of conceptual understanding, some additional material especially approaches to PS, experience of getting stuck, development of independent learning (for some), communication skills ('the lazy boy'). Can affect student confidence either way.
- *Year 13 students:* Challenge, enjoyment and satisfaction, reinforcement of progression intentions for some, disillusionment or change of intentions for others (+/-), stress (esp. for STEP), cost to other A Levels for some. Commitment: mixed responses (some apparently not aware, for others school/college made the commitment)

What is the range of students who would benefit from preparing for such papers, and what support would they require? (Is it beneficial for a wider range of A-level students to embed consideration of the questions in STEP, MAT, AEA and TMUA in their regular classwork?)

- *HEIs:* Most A Level students would benefit from engaging with more accessible of any of these questions. (Few seemed aware of UKMT activity benefits).
- *Teachers:* Only the most academic depts. considered use beyond those students seriously considering applying for HEIs requiring, or strongly recommending, such papers, and those, largely in year 12. One teacher at one such included use of such questions in his regular A Level lessons. Teachers in all depts. aware of potential cost to other A Levels, widespread attitude of 'only for those already very confident with standard material'.
- *Students:* They can be very interesting, but MAT and STEP (esp. II and III) are hard. You need to be 'on top of' all your A Levels before you think about adding in one of these. Parallel learning of A Level Ma and FM, necessary in many centres, is a real difficulty in accessing any STEP papers before end of year 13.

Are there related equity, including WP, issues? (What are the disadvantages and costs for students who could benefit from preparing for such papers but are not supported to do so?)

- *AMSP courses* aimed at state centres, additional subsidy in target LP areas.
- *In-centre support:* As above, highly variable. Two 'strong' depts said their students 'don't do' additional papers. Several others were apparently very unfamiliar with processes, timescales, commitment needed ('If they get a Cambridge offer, we'll look at web support with them'), and with e.g. Cambridge offers:places ratio. Competing priorities a real issue: 'If we support these students, we can't support those struggling to get an A Level'. 'We don't let them apply to Cambridge: STEP is too hard and we've not had any success with applications.'
- *Gender:* Female study participants often said the MAT model was most constructive (though not if it falls at half term!): MC seems risky, and STEP is perceived to be very competitive, as well as having outcomes late in the application process. Note Oxford admits ~30% F, in line with FM participation. STEP/TMUA entry stats, including gender split, not in the public domain.
- *Cost:* some state centres ask candidates to pay paper entry fees, plus invigilation/admin fees (£54 per paper, TMUA £31, up to £70). Other centres pay, for at least disadvantaged students.
- *Regulation*: some concerns from HEIs these papers are high stakes but are not regulated.

Thank you.

Academics' views on the purpose, role and impact of additional 'extension' papers for entry to mathematics-intense courses at English universities (for university mathematics academics any time before May 2020): **https://tinyurl.com/rr68e93**

And/or email me at j.golding@ucl.ac.uk

Questions/points for discussion?

For reference only:

Cambridge Colleges like to make offers involving STEP for the following main reasons:

- STEP is a far better predictor of success in the Mathematical Tripos than A-levels. One reason for this is that the questions are less standard and less structured, which helps to distinguish between ability (or potential) and good teaching. ???
- Preparation for STEP serves as useful preparation for our course.
- The STEP marks and the scripts themselves are available for inspection by college staff. This means that it is possible to make allowances for a near miss and to make judgements on the actual work rather than on just the marks or grades.
- The meaning of A-level grades may differ significantly between the different boards, so STEP provides a fairer 'across the board' comparison.???
- 2019: ~3000 MAT, 300 AEA, stats for TMUA and STEP n/a