London Schools Excellence Fund

Self-Evaluation Toolkit

Final report

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Evaluation Final Report Template

Introduction

The London Schools Excellence Fund (LSEF) is based on the hypothesis that investing in teaching, subject knowledge and subject-specific teaching methods and pedagogy will lead to improved outcomes for pupils in terms of attainment, subject participation and aspiration. The GLA is supporting London schools to continue to be the best in the country, with the best teachers and securing the best results for young Londoners. The evaluation will gather information on the impact of the Fund on teachers, students and the wider system.

This report is designed for you to demonstrate the impact of your project on teachers, pupils and the wider school system and reflect on lessons learnt. It allows you to highlight the strengths and weaknesses of your project methodology and could be used to secure future funding to sustain the project from other sources. All final reports will feed into the programme wide meta-evaluation of the LSEF being undertaken by SQW. Please read in conjunction with Project Oracle's **'Guidance to completing the Evaluation Final Report'**.

Project Oracle: Level 2
Report Submission Deadline: Round 2 - 30 September 2015
Report Submission: Final Report to the GLA / Rocket Science
Project Name: Accelerating Knowledge and Pedagogy in Further Mathematics Teaching
Lead Delivery Organisation: King's College London Mathematics School (KCLMS)
London Schools Excellence Fund Reference: Project Number 21
Author of the Self-Evaluation: John Partridge
Total Approved LSEF funding for Project: £73,806
Total Lifetime Cost of the Project: £92,831
Actual Project Start Date: 01/12/13
Actual Project End Date: 30/09/15

1. Executive Summary

This should be a brief summary of what information is included in the report, the evaluation methods and analysis used and a summary of the key findings from your project evaluation. (maximum 500 words)

This report evaluates a project run by the King's College London Mathematics School to "accelerate knowledge and pedagogy in further mathematics teaching".

The project consisted of a number of participants who had little or no experience of teaching further mathematics but, in most cases, were not new to teaching. These participants attended six training days during a one year period, and on these days the knowledge required was discussed in detail on a topic-by-topic basis. Whilst acquiring this knowledge, participants were given numerous opportunities to discuss pedagogy with course leaders and with their peers as well as plenty of time to attempt and analyse questions that they were then encouraged to use with their own students.

Approximately half of the participants were also visited in their own school on multiple occasions (up to six); lessons were observed and subsequently discussed and targets for their own pedagogy were set.

The project had four target outcomes, each of which was evaluated differently - the outcomes and findings are summarised below:

Outcome A – Teachers participating will have improved knowledge of the advanced mathematics necessary to teach Further Mathematics

> Participants completed a test at the start and end of the course, consisting of adapted Further Mathematics examination questions. The results showed a significant improvement and furthermore participants all agreed, or strongly agreed, that their knowledge had improved as a result of the course.

Outcome B – Teachers participating will have improved understanding of, and expertise in, the pedagogy of advanced school mathematics.

> Participants completed a "concept-map" and a "beliefs survey" at the start and end of the course. The results were not significantly different. However, all participants agreed, or strongly agreed, that their understanding and expertise had improved as a result of the course. There is a large amount of anecdotal evidence from visits and observations to suggest that many participants improved in this area.

Outcome C: In participating schools, there will be increased take up, retention and attitudes of students in Further Mathematics A-level. (Secondary outcome.)

> From the outset, it was stated that there would not be any significant changes in numbers during the lifetime of the project: a time lag was expected. Thus this report reaches no conclusion for this outcome.

Outcome D: The project will establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School.

> As this report shows, this network has been established but true success can only be measured over a longer period of time.

2. Project Description

Much of the detail for this section can be drawn from your Stage 2 funding application. Please note that if you do copy this information from your original application, funding agreement, or interim report, be sure to update it as appropriate (e.g. including tense change).

Provide a full project description (approximately one side of A4), in particular:

- *Why was the project set up? / What need was it seeking to address? (e.g. because teachers lacked confidence in their subject knowledge? Because pupil attainment was lower in this subject area in this borough/cluster/school/than in other boroughs/clusters/schools?).*
- *What were the circumstances into which it was introduced (e.g. existing networks of schools/ expert partner offering a new approach etc.)?*
- *What project activities have been put in place?*
- *Where has the project been delivered geographically?*
- *Who delivered the project?*
- *Who were the target beneficiary groups of the project and why?*

This project aimed to strengthen Further Mathematics teaching in London by improving mathematics teachers' subject knowledge and associated teaching expertise. It combined central training sessions with in-school coaching by experienced teachers. Course alumni now form the core of a London-wide network at King's College London Mathematics School.

For many pupils in the state sector, particularly in disadvantaged areas, A-level mathematics teaching is poor and there is a national shortage of specialist mathematics teachers. The problem of teacher subject knowledge is particularly acute for Further Mathematics. Too many pupils in London state schools do not have the opportunity provided in the best schools to develop a deep understanding of mathematics, and this prevents their progress onto degree courses which require Further Mathematics.

To address this problem, the project provided in depth professional development for teachers who wished to improve their subject knowledge and teaching of Further Mathematics A-level. The project involved two elements: central sessions led by expert teachers and academics, and individual mentoring visits to the schools and classrooms of the participants. After a year, participants developed a confident and extended understanding of the material concerned, and were becoming proficient in delivering this material to pupils. Alumni from the course continue to be encouraged to participate in an on-going local network of A-level Further Mathematics teachers hosted by King's College London Mathematics School**.**

The project aims, as stated at the start of the application process, were to:

1. Improve teachers' subject knowledge of advanced school mathematics together with the more pedagogically focused aspects of teaching this in classroom. Whilst the primary focus is on the Further Mathematics content, we anticipate that teachers' understanding of the advanced mathematics curriculum as whole will improve as a result of a more academically-focused and coherent understanding of mathematics.
2. Increase both the extent and quality of teachers' repertoire of rich tasks, techniques and other resources for teaching Further Mathematics.
3. Establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School, and supported by academics from the

mathematics and education departments of King's College London, as an advanced mathematics knowledge hub.
4. Identify a group of expert teachers of Further Mathematics who can contribute to establishing and sustaining a centre of excellence in advanced school mathematics.
5. Increase the take up, retention and attainment of students in Further Mathematics A-level in the schools involved.

The project recruited teachers from schools from all over London. The central training days were delivered either at King's College London or at King's College London Mathematics School. The majority of training sessions were delivered by Dan Abramson (Head Teacher, King's College London Mathematics School) and John Partridge (Assistant Head, King's College London Mathematics School); King's College London academics and targeted other relevant individuals lead a minority of training sessions. The in-school visits were conducted by John Partridge.

The target group for this project was teachers who are new or relatively new to the teaching of Further Mathematics, currently teaching at state-funded schools in London boroughs.

2.1 Does your project support transition to the new national curriculum? No

The project is aimed at Key Stage 5.

2.2 Please list any materials produced and/or web links and state where the materials can be found. Projects should promote and share resources and include them on the LondonEd website.

A large number of resources have been produced and shared with participants. The majority of resources are well-structured questions which enable students to develop understanding by working though questions which develop through both procedural and conceptual variation.

Resources are available on request; we have not listed them here because they do not support transition to the new national curriculum as they are all looking at KS5 material.

3. Theory of Change and Evaluation Methodology

Please attach a copy of your validated Theory of Change and Evaluation Framework.

Throughout the report it would be useful if you make reference to these documents. Where appropriate we would also encourage you to include any assumptions you have made from previous research.

3.1 Please list **all** outcomes from your evaluation framework in Table 1. If you have made any changes to your intended outcomes after your Theory of Change was validated please include revised outcomes and the reason for change.

Table 1- Outcomes

Description	Original Target Outcomes	Revised Target Outcomes	Reason for change
Teacher Outcome 1	Increased subject knowledge and greater awareness of subject specific teaching methods		
Teacher Outcome 2	Improved understanding of, and expertise in, the pedagogy of advanced school mathematics, by having (i) increased understanding of how students learn advanced school mathematics (ii) increased the extent and quality of their repertoire of rich tasks (iii) developed their ability to use dialogic and connectionist approaches to teaching		
Pupil outcome 1	Increased take up, retention and attitudes of students in Further Mathematics A-level (NOTE: This is a secondary outcome of the project and that there will be a time lag in achieving this outcome.)		
Pupil outcome 2			
Pupil outcome 3			
Wider system outcome 1	Establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School		
Wider system outcome 2			
Wider system outcome 3			

3.2 Did you make any changes to your project's activities after your Theory of Change was validated? No

3.3 Did you change your curriculum subject/s focus or key stage? No

3.4 Did you evaluate your project in the way you had originally planned to, as reflected in your validated evaluation plan?

Consider changes to evaluation tools/methods, sample sizes, and anticipated outcomes. If applicable, please explain what changes you made and why, and provide some commentary on how they affected your evaluation.

It proved difficult to collect reliable data from schools for "pupil outcome 1" – participants were encouraged to fill in a survey showing numbers of pupils sitting Mathematics and Further Mathematics at AS and A2 level for the past 3 years as well as the present year. They were also asked to estimate figures for the next academic year. For many participants, who did not, in general, hold managerial positions within their schools, this data proved difficult to collect and collate reliably. Some schools appeared to have considerably more robust records than others, both of past numbers and of future expectations. We have evaluated the data that we were able to collect but question whether or not this entirely represents the full spectrum of participants.

4. Evaluation Methodological Limitations

4.1 What are the main methodological limitations, if any, of your evaluation?

This can include data limitations or difficulty in identifying a comparison group. In order to get a realistic idea of the strength of your evaluation, and identify possible improvements, it is essential that you reflect on the strengths and weaknesses of your evaluation.
You should address limitations of the evaluation only, not the project itself - *Every evaluation has limitations, so please be honest. This could include limitations relating to:*

- *The kinds of data you could/ could not collect (and the response rate for surveys)*
- *The size of the sample/ group you are evaluating*
- *The extent to which you felt able to assess the impact of activity on beneficiaries (what changes in attitudes/behaviours/attainment were caused by the intervention and what has been caused by other factors)*
- *Also include mitigating actions for methodological limitations where possible* ***–*** *e.g. alternative approaches or solutions and also how these limitations will affect the evaluation of the project (particularly pupil and teachers outcomes).*

The main methodological limitation relates to the aims of the project and the focus on teacher knowledge. The project aims to increase teacher knowledge of Further Maths and, as noted in our original application, the impact on students is likely to show a considerable time lag. In addition, the number of teachers involved is small and hence it is not possible to conduct inferential statistical analysis. Moreover, it was not possible to construct a control group, because of limited resources. We were not, for example, able to offer incentives for teachers in the form of a wait list design. Finally, there are no existing instruments designed to measure teacher knowledge at this level. Hence, during the Phase 1 Pilot, we constructed and validated our own instruments. Note, however, the validation was only on a small scale. We were also able to use a previously validated attitudes questionnaire developed by researchers at the University of Manchester (Pampaka et al, 2012).

Teacher outcome 1: subject specific knowledge
Instrument: A timed test based on Further Mathematics examination questions

The tests were piloted in Year 1 and, as a result the tests were amended to reduce the number of questions to be completed within the time limit.

Teacher outcome 2: pedagogy
Instrument: A concept mapping exercise

The concept mapping exercise was designed to assess teachers' understanding of the connections between concepts within a topic. We chose to focus on the topic of "Coordinate Systems" because this brought together many concepts covered on the course. The concept maps were piloted in Year 1 in conjunction with the comparative judgment marking process (see section 8 below). Reliability statistics for the comparative judgment were low, but, following consultation with Dr Ian Jones of Loughborough University, these were judged to be acceptable as a secondary impact measure.

Teacher outcome 2: dialogic and connectionist approaches
Instrument: Connectionist Views of Teaching

This instrument had been previously validated. As a result of difficulties with online delivery in the Phase 1 Pilot, we administered the questionnaire on paper during a session.

Pupil outcome 1: take-up

As outlined in the evaluation framework, there is an expected time lag in achieving this outcome. The data collected comes from a small sample and comparison figures are not readily available.

Ideally, figures for take-up of Further Mathematics in the schools that we have worked with (or, more specifically, the schools in which the teachers we have worked with are employed), would be collected overall several years and be compared to London / borough / national averages. We could then get a sense of whether the take-up has been affected by having a teacher in the school who has been a course participant.

Wider outcome 1: network

Evaluating this outcome has proved difficult to date because there have only been two "network meetings". This, again, needs evaluating over time to establish whether or not we have been successful in achieving this outcome.

4.2 Are you planning to continue with the project, once this round of funding finishes? Yes

If **yes**, will you (and how will you) evaluate impact going forward? As yet undecided

5. Project Costs and Funding

5.1 Please fill in Table 2 and Table 3 below:

Table 2 - Project Income

	Original[1] Budget	Additional Funding	Revised Budget [Original + any Additional Funding]	Actual Spend	Variance [Revised budget – Actual]
Total LSEF Funding	£73,806	£0	£73,806	£69,630	£4,176
Other Public Funding	£0	£0	£0	£0	£0
Other Private Funding	£0	£0	£0	£0	£0
In-kind support (e.g. by schools)	£19,025	£0	£19,025	£19,025	£0
Total Project Funding	£92,831	£0	£92,831	£88,655	£4,176

List details in-kind support below and estimate value.

Venue hire during the first year of the project when training days were ran at KCL: £3,000
Account management by the Department for Education and Professional Studies: £2,225
Project Head and other KCLMS staff additional and uncharged time: £8,800
KCLMS premises costs (including on Saturdays when school is otherwise closed): £1,000
Evaluation support and management from DEPS: £4,000

Table 3 - Project Expenditure

	Original Budget	Additional Funding	Revised Budget [Original + any Additional Funding]	Actual Spend	Variance Revised budget – Actual]
Direct Staff Costs (salaries/on costs)	£17,500	£0	£17,500	£19,829	-£2,329
Direct delivery costs e.g. consultants/HE (specify)	£0	£0	£0	£0	£0
Management and Administration Costs	£38,688	£0	£38,688	£34,755	£3,933
Training Costs	£8,848	£0	£8,848	£4,355	£4,493
Participant Costs (e.g. Expenses for travelling to venues, etc.)	£0	£0	£0	£0	£0
Publicity and Marketing Costs	£0	£0	£0	£0	£0
Teacher Supply / Cover Costs	£0	£0	£0	£0	£0
Other Participant Costs	£0	£0	£0	£0	£0
Evaluation Costs	£8,770	£0	£8,770	£10,691	-£1,921
Others as Required – Please detail in full	£0	£0	£0	£0	£0
Total Costs	£73,806	£0	£73,806	£67,542	£4,176

[1] Please refer to the budget in your grant agreement

5.2 Please provide a commentary on Project Expenditure
This section should include:

- *commentary on the spend profile*
- *budget changes that have occurred, including the rationale for any changes*

(Maximum 300 words)

The overall cost of delivery from the LSEF funds represents an underspend of 5.7%. This results from a number of factors including no real charges incurred from speakers that we brought in to the central training sessions and a general efficiency of cost that kept the significant charges to key personnel and evaluation. There was a significant saving in the predicted cost of schools invoicing us for cover costs (note that this was built into our initial budget as part of the "direct staff costs" budget line and we have left it as such to ensure readability between this report and the budget claims), and a significant but comparable increase in the cost of the Project Head (Dan Abramson), who spent more time on the course than was planned at the original budget stage: he effectively co-planned and delivered the content of the course with the Project Manager (John Partridge). Evaluation costs were also somewhat higher than initially predicted. The management and administration budget line is somewhat misleading – costs here are largely associated with John Partridge's time and would better have been planned and reported as direct staff costs. John's time was in the main used to conduct the many in-school visits, and also to plan and deliver the central training days.

6. Project Outputs

Please use the following table to report against agreed output indicators, these should be the same outputs that were agreed in schedule 3 of your Funding Agreement and those that were outlined in your evaluation framework.

Table 4 – Outputs

Description	Original Target Outputs	Revised Target Outputs *[Original + any Additional Funding/GLA agreed reduction]*	Actual Outputs	Variance [Revised Target - Actual]
No. of schools	24	24	27	3
No. of teachers	30	30	27	-3
No. of pupils	n/a			
Enter additional output name *add extra lines as necessary*				

7. Key Beneficiary Data

Please use this section to provide a breakdown of teacher and pupil sub-groups involved in your project.

Data must be provided at project level. However, if you wish to disaggregate data by school then please add additional rows to the tables below. Please also confirm at what point this data was collected.

Please add columns to the tables if necessary but do not remove any. N.B. If your project is benefitting additional groups of teachers e.g. teaching assistants please add relevant columns to reflect this.

7.1 Teacher Sub-Groups (teachers directly benefitting counted once during the project)

Please provide your definition for number of benefitting teachers and when this was collected below *(maximum 100 words).*

A "benefitting teacher" was any teacher who signed up to the course and attended at least 3 of the 6 training days. Thus the data was collected at the end of each training year.

Since no two teachers on the course were from the same school, numbers in the table are shown by year rather than by school.

Table 5 – Teachers benefitting from the programme

	No. teachers	**% NQTs** ***(in their 1st year of teaching when they became involved)***	**% Teaching 2 – 3 yrs** ***(in their 2nd and 3rd years of teaching when they became involved)***	**% Teaching 4 yrs +** ***(teaching over 4 years when they became involved)***	**% Primary (KS1 & 2)**	**% Secondary (KS3 - 5)**
Project Total	*27*					*100*
Year 1 (Pilot phase)	*8*		*3/8=38%*	*5/8=63%*		*100*
Year 2	*19*	*2/19=11%*	*6/19=32%*	*11/19=58%*		*19/19=100%*

7.1.2 Please provide written commentary on teacher sub-groups e.g. how this compares to the wider school context or benchmark *(maximum 250 words)*

As was clear in the Theory of Change, our target group was "London teachers who are already teaching advanced mathematics, but lack the knowledge, expertise and confidence to teach Further Mathematics". Teachers were signed up on this basis: most were teaching "Further Pure 1" to pupils in year 12 or 13 for the first time and were able to use course materials "in real time" with their classes back at school.

Given the goal of having teachers with some experience of teaching advanced mathematics, we focused on those who had moved beyond their NQT year – as the above figures show,

we had 2 teachers in their first year of teaching, but the majority of our participants fell into one of the other sub-groups. Many of the teachers falling into the "4+ years" category had a great deal of experience in teaching, and in teaching A-level mathematics, but only two had previously taught the FP1 module.

7.2 Pupil Sub-Groups (these should be pupils who directly benefit from teachers trained)

Please provide your definition for number of benefitting pupils and when this data was collected below *(maximum 100 words)*

For the purposes of the table below, a "benefitting pupil" is any pupil being taught Further Mathematics by a full participant on the course, as observed when visiting schools. It was never the intention to collect more extensive data on pupils than that shown.

This definition has been selected because these data can be justified by our own experience of observing lessons; arguably the number of benefitting pupils is greater than this because those being taught by part participants (who were not visited) have not been included. This is because we have no reliable numbers here.

Tables 6-8 – Pupil Sub-Groups benefitting from the programme

	No. pupils	**% LAC**	**% FSM**	**% FSM last 6 yrs**	**% EAL**	**% SEN**
Project Total						
School 1	*3*					
School 2	*6*					
School 3	*3*					
School 4	*6*					
School 5	*5*					
School 6	*15*					
School 7	*1*					
School 8	*19*					
School 9	*11*					
School 10	*9*					
School 11	*6*					
School 12	*13*					
School 13	*5*					
School 14	*11*					
School 15	*14*					
School 16	*5*					

	No. Male pupils	**No. Female pupils**	**% Lower attaining**	**% Middle attaining**	**% Higher attaining**
Project Total					
School 1	*2*	*1*			
School 2	*5*	*1*			
School 3	*2*	*1*			
School 4	*0*	*6*			
School 5	*5*	*0*			
School 6	*13*	*2*			
School 7	*0*	*1*			

School 8	*13*	*6*			
School 9	*4*	*7*			
School 10	*2*	*7*			
School 11	*5*	*1*			
School 12	*11*	*2*			
School 13	*4*	*1*			
School 14	*6*	*5*			
School 15	*11*	*3*			
School 16	*4*	*1*			

	% Asian Indian	**% Asian Pakistani**	**% Asian Bangladeshi**	**% Asian Any Other background**	**% Black Caribbean**	**% Black African**	**% Black Any Other Background**	**% Mixed White & Black Caribbean**	**% Mixed White & Black African**	**% Mixed White & Asian**	**% Mixed Any Other Background**	**% Chinese**	**% Any other ethnic group**
Project Total													
School 1													
School 2													
School 3													
School 4													

	% White British	**% White Irish**	**% White Traveller of Irish heritage**	**% White Gypsy/Roma**	**% White Any Other Background**
Project Total					
School 1					
School 2					
School 3					
School 4					

7.2.1 Please provide a written commentary on your pupil data e.g. a comparison between the targeted groups and school level data, borough average and London average *(maximum 500 words)*

Useful links: London Data Store, DfE Schools Performance, DfE statistical releases

It is not uncommon for Further Mathematics groups to be small; many schools struggle to put a group together, or to justify staffing for a small group. Thus it was good to see some small groups going ahead with the course. The group of size 1 was of a teacher who was working with a pupil after school once a week; he used materials from the course and was expecting to have a timetabled group of more pupils in the following year. Some schools, clearly, had a bigger uptake and were able to staff and timetable Further Mathematics lessons for larger groups.

National figures show that participation in Further Mathematics is not equal between genders, with over 65% of those sitting Further Mathematics at A2 being male. This was reflected in the schools that we worked with, and the figures above show that in the classrooms we visited 66% (87/132 pupils) were male. It is interesting to note, however, that just over half of the teachers of these groups were female and that just over half of the participants on the course were female.

It was never the intention of this particular project to collect further pupil data or to carry out further analysis by category; thus it is difficult to comment further here.

8. Project Impact

You should reflect on the project's performance and impact and use **qualitative and quantitative** data to illustrate this.

- Please complete the tables below before providing a narrative explanation of the impact of your project.
- Please state how you have measured your outcomes (e.g. surveys) and if you are using scales please include details.
- Please add graphical analysis (e.g. bar charts) to further demonstrate project impact on each teachers, pupils, wider system outcomes etc. If you use graphs, please ensure that all charts are explained and have clear labels for the axes (numeric data or percentages, for example) and legends for the data.

Please add columns to the tables if necessary but do not remove any. N.B. If your project is collecting data at more than two points and may want to add additional data collection points.

8.1 Teacher Outcomes

Table 9 – Teacher Outcomes: teachers benefitting from the project

The 1st Return will either be your baseline data collected before the start of your project, or may be historical trend data for the intervention group. Please specify what the data relates to.

Target Outcome	Research method/ data collection	Sample characteristics	Metric used	1st Return and date of collection	2nd Return and date of collection
e.g. Increased Teacher confidence	*e.g. E-survey*	*e.g. 100 respondents from a total of 200 invites.* *The profile of respondents was broadly representative of the population as a whole.*	*e.g. Mean score based on a 1-5 scale (1 – very confident, 2 – quite confident, 3 neither confident nor unconfident, 4 - quite unconfident, 5 – very unconfident)*	*e.g. Mean score- 3.7, collected September 2015*	*e.g. Mean score- 4.5, collected June 2015*
Increased subject knowledge and greater awareness of subject specific teaching methods	Test	In year 1, 10 participants completed the pilot pre-test, and 6 completed the post-test. In year 2, 20 participants completed the pre-test, and 14 completed the post-test.	Year 1: as in the evaluation framework, this was primarily used as a pilot; the test was altered slightly for year 2. Year 2: participants were given time to attempt up to 3 questions, each of which was marked out of 8; thus the total mark available was 24. Results are shown only for 12 teachers who took both pre- and post-tests.	Year 2: mean score (July 2014) 10.8 out of 24	Year 2: mean score (July 2015) 16.1 out of 24
Improved understanding	Concept map	As above.	See main body for a full explanation.	Year 2: mean score (July	Year 2: mean score (July 2015)

of, and expertise in, the pedagogy of advanced school mathematics, by having increased understanding of (i) how students learn advanced school mathematics, and (ii) the extent and quality of their repertoire of rich tasks			Results are shown only for 13 teachers who completed both pre- and post-concept maps.	2014) 0.15	0.39
Improved understanding of, and expertise in, the pedagogy of advanced school mathematics, by having increased understanding of (iii) developed their ability to use dialogic and connectionist approaches to teaching	Beliefs survey	1.1.1.1 21 teachers completed the initial questionnaire, 13 of whom completed the post-questionnaire	*1.1.1.2* *A 'total' scale was used taking account of reverse-coded items.* *1.1.1.3* Results are shown only for teachers who took both pre- and post-questionnaires.	*1.1.1.4* Year 2: mean score (July 2014) 79.8	*1.1.1.5* Year 2: mean score (July 2015) 79.4

Table 10 – Comparison data outcomes for Teachers *[if available]*

No data available

Target Outcome	Research method/ data collection	Sample characteristics	Metric used	1st Return and date of collection	2nd Return and date of collection
e.g. Increased Teacher confidence	*e.g. E-survey*	*e.g. 100 respondents from a total of 200 invites.* *The profile of respondents was broadly representative of the population as a whole.*	*e.g. Mean score based on a 1-5 scale (1 – very confident, 2 – quite confident, 3 neither confident nor unconfident, 4 - quite unconfident, 5 – very unconfident)*	*e.g. Mean score*	*e.g. Mean score*

8.1.1 Please provide information (for both the intervention group and comparison group where you have one) on:

- Sample size, sampling method, and whether the sample was representative or not
- Commentary on teacher impact (please also refer to table 5 re impact on different groups of teachers)
- Qualitative data to support quantitative evidence.
- Projects can also provide additional appendices where appropriate.

(Minimum 500 words)

The assessment of project impact was carried out by Professor Jeremy Hodgen (University of Nottingham), who was aided by a research assistant, George Peacock. We have collected pre- and post-test data for Phase 1 of the project relating to the Timed Further Mathematics Examination Questions and to the Co-ordinate Geometry Concept Maps.

As noted above, both instruments were specially constructed for the project since there were no suitable existing, validated instruments available to measure teacher knowledge at this advanced level.

Marking the examination questions was straightforward. A mark scheme was developed when the test was designed. Test scripts were blinded and an expert teacher who marked the scripts. In order to mark the concept maps, we used a novel system of Comparative Judgement currently being developed by Dr Ian Jones at Loughborough University (Jones et al, 2013). This system allows a scale to be constructed in cases where no mark scheme is available and is well-suited to conceptually oriented tests. In brief, the approach involves judges making repeated paired comparisons of pieces of work and these judgments are then statistically analysed. The process is automated through the website www.nomoremarking.com. On the advice of Dr Jones, 6 judges were recruited who had no knowledge of the project and each made 50 paired comparisons.

Teachers made positive gains on both cognitive outcomes:

- FM Exam: A score gain of 5.3 marks for the 12 teachers who took both tests, which equates to a very large effect size of 1.22
- Concept Map: A score gain of 0.24 for the 13 teachers who took both tests, which equates to a small effect size of 0.14

The results of both aspects are positive and the gain on the FM Exam is very promising. However, as we have already noted above these need to be treated with caution due to the small samples of self-selecting teachers involved. In addition, only a small number of the participant teachers completed both tests: 12 for the FM Exam, 13 for the Concept Maps and attitude questionnaire. Because of the small sample size, inferential statistics have not been calculated. The difference in the two measures is likely to be explained by their different foci: the FM Exam is more focused on procedural knowledge, whereas the Concept Map is more focused on conceptual knowledge.

The teacher attitude questionnaire showed no meaningful difference between the pre- and post- administrations. This may reflect a lag between changes to attitudes and changes to knowledge and teaching practice.

Effect sizes (Cohen's *d)* were calculated by dividing the gain by the pre-test standard deviation as an estimate of population spread. Cohen's rule of thumb is that gains of the order of 0.2 considered small, 0.5 medium and 0.8 large. Effect sizes tend to be inflated in small studies, although it is rare in education to achieve effects greater than 1.

Jones, I., Inglis, M., Gilmore, C., & Hodgen, J. (2013). Measuring conceptual understanding: The case of fractions. In A. M. Lindmeier & A. Heinze (Eds.), Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education (Vol. 3, pp. 113-120). Kiel, Germany: PME.

At this point it is also worth highlighting some quotes from end-of-course evaluation forms - though anecdotal, these demonstrate increased confidence in both knowledge and pedagogy:

- I am more able to stand with my pen and my brain in front of a class and guide them to mathematical success, as opposed to "here is an example which I will show you how to do; now you try…" type teaching
- I understand the links between different areas of Further Mathematics
- I try to get pupils to discover/think through things on their own [rather than just telling them what to do]
- I have more confidence when delivering the content
- I have gained insight into some mathematics which I have previously not understood
- I allow time to get the students to work out methods for themselves
- Where possible, I am planning lessons with discovery/exploration in mind
- I feel free to approach topics in a different way from that in the textbook; I have greater confidence in my own understanding
- I plan my lessons to contain segments of investigation, and proofs that students are not necessarily tested on
- The way I approach starting topics has changed – there is more emphasis on a conceptual understanding through the questions set up at the start (and this is only possible through the added subject knowledge gained through the course)

8.2 Pupil Outcomes

Table 11 – Pupil Outcomes for pupils benefitting from the project

The 1st Return will either be your baseline data collected before the start of your project, or may be historical trend data for the intervention group. Please specify what the data relates to.

Target Outcome	Research method/ data collection	Sample characteristics	Metric used	1st Return and date of collection	2nd Return and date of collection
e.g. Increased educational attainment and progress in Writing	*e.g. Pupil assessment data*	*e.g. Characteristics and assessment data collected for 97 of 100. The profile of respondents matches that initially targeted in the Theory of Change.*	*e.g. mean score or percentage at diff National Curriculum Levels or GCSE grades*	*e.g. Mean score- 3.7, collected September 2015*	*e.g. Mean score- 4.5, collected June 2015*
Increased	Participants	Small sample	Mean number of	Historical	Future data:

take up, retention and attitudes of students in Further Mathematics A-level NOTE: This is a secondary outcome of the project and that there will be a time lag in achieving this outcome.	in year 2 were asked to complete a survey showing pupil numbers.	due to availability of data – only 5 participants submitted a full return giving the required figures.	pupils per school sitting Further Mathematics A2.	data: 2012 – mean 7.0 pupils 2013 – mean 6.3 pupils 2014 – mean 8.2 pupils	2015 (expected) – mean 6.6 pupils 2016 (estimated by each school) – mean 9.0 pupils

Table 12 - Pupil Outcomes for pupil comparison groups *[if available]*

No data available

Target Outcome	Research method/ data collection	Sample characteristics	*Metric used*	1st Return and date of collection	2nd Return and date of collection
e.g. Increased educational attainment and progress in Writing	*e.g. Pupil assessment data*	*e.g. Characteristics and assessment data collected for 97 of 100. The profile of respondents matches that initially targeted in the Theory of Change.* *Please find detailed analysis of the profile of respondents in Section 7.2*	*e.g. mean score or percentage at diff National Curriculum Levels or GCSE grades*	*e.g. Mean score- 3.7, collected September 2015*	*e.g. Mean score- 4.5, collected June 2015*

8.2.1 Please provide information (for both the intervention group and comparison group where you have one) on:

- Sample size, sampling method, and whether the sample was representative or not Commentary on pupil impact (please also refer to table 6-8 re impact on different groups of pupils)
- Qualitative data to support quantitative evidence.
- Projects can also provide additional appendices where appropriate.

(minimum 500 words)

This was a secondary outcome for the project and we expected a significant time lag prior to any increased take-up or retention. The data shown was collected from a very small sample (5 schools) and the figures suggest fluctuation from year to year in group sizes. There is no conclusion to be reached regarding pupil impact at this point.

8.3 Wider System Outcomes

Table 13 – Wider System Outcomes

Target Outcome	Research method/ data collection	Sample characteristics	*Metric*	1st Return and date of collection	2nd Return and date of collection
e.g. Teachers/schools involved in intervention making greater use of networks, other schools and colleagues to improve subject knowledge and teaching practice	*e.g. Paper survey*	*e.g. Surveys completed by all participating teachers*	*e.g. average number of events attended per teacher per year before the project and over the course of the project*	*e.g. Average number of events attended in the academic year 2012-2013: 3.2*	*e.g. Average number of events attended in the academic year 2013-2014: 4.3* *Average number of events attended in the academic year 2014-2015: 4.5*
Establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School	Number of attendees at King's Mathematics Forums	n/a	Number of attendees	February 2015 – 26 attendees	July 2015 – 14 attendees

8.3.1 Please provide information on *(minimum 500 words):*

- Sample size, sampling method, and whether the sample was representative or not
- Commentary on wider system impact qualitative data to support quantitative evidence.
- Projects can also provide additional appendices where appropriate.

Again, this outcome is difficult to assess fully at present: the network that we hope to establish will necessarily build over time. As well as having run two sessions, with attendance as shown, we have established a large mailing list and have committed to hosting one meeting per term where we hope to see attendance grow. Though the second session had fewer attendees, there is not sufficient evidence here from which to draw any conclusions.

Though we plan to establish a larger network, with more regular attendees at our meetings, perhaps it is sufficient here to demonstrate impact by quoting feedback from attendees to date:

- Great CPD, thank you!
- Good to see how differently things can be done
- Brilliant – lots of good ideas
- Interesting to know how other schools produce a Scheme of Learning
- Interesting session, good speaker
- Fun, lovely to see how maths is used and relates to real life
- Excellent resources
- Great advice on problem solving
- The variety kept me engaged all the way through after a busy teaching day!

8.4 Impact Timelines

Please provide information on impact timelines:

- At what point during/after teacher CPD activity did you expect to see impact on teachers? Did this happen as expected?
- At what point during/after teacher CPD activity did you expect to see impact on pupils? Did this happen as expected?
- At what point did you expect to see wider school outcomes? Did this happen as expected?
- Reflect on any continuing impact anticipated.

Teachers: as explained above, most of our target outcomes were teacher-related. The data suggests that subject knowledge improved for teachers attending the course, and that there was a slight impact on conceptual knowledge. The questionnaires showed no meaningful change in teacher attitude over the duration of the course.

Pupils: a secondary target outcome was to increase take-up and retention in Further Mathematics at A Level; it was always expected that there would be a time lag here and that we would not be able to reach a conclusion, even at the end of the course.

Wider outcomes: again, we did not expect our target outcome to be achieved by the end of the course; a network has been established but we now need to nurture it and to ensure that it grows over time.

Thus there is a significant amount of anticipated continuing impact: many of the teachers who have attended the course are now teaching FP1 or FP2 with a different mind-set and as their comments show, they are enjoying the challenges that this brings, both to them and their students. The success of the course has enabled us to continue to run it independently of the LSEF, and a cohort of 15 teachers have signed up for 2015-16. A number of teachers have stated that they have discussed many of the ideas and topics covered on the course with colleagues and subject leaders; there is some anecdotal evidence to suggest that some schools have changed their scheme of learning, and even their approach to learning, as a direct result of this course.

Network meetings continue on a termly basis; a number of attendees have been colleagues of those who have been on the course and feedback has been overwhelmingly positive. Any opportunity to discuss the teaching of mathematics has been welcomed, and the future of these meetings looks bright. Thus the impact of the course will continue as this network continues to grow and as attendance at meetings increases.

The impact on pupils is undoubtedly harder to measure and considerably more subtle. However, with the course now established, and termly forums for teachers of mathematics to

discuss the subject and the pedagogy involved in its delivery, we hope to have a continuing impact on the experiences of pupils in the classrooms of teachers who have attended the course or our meetings: as the number of teachers we work with grows, so too should the number of pupils who benefit from our involvement.

9. Reflection on overall project impact *(maximum 1,500 words)*

In this section we would like you to reflect on:

- The overall impact of your project
- The extent to which your theory of change proved accurate
- How your project has contributed to the overall aims of LSEF
- Whether your findings support the hypothesis of the LSEF
- What your findings say about the meta-evaluation theme that is most relevant to you

Please illustrate using the key points from the previous detailed analysis.

All the evidence should be brought together here (achievement of outputs and outcomes, and the assessment of project impact) to produce well informed findings, which can be used to inform policy development in a specific area as well as the meta-evaluation of the LSEF.

The London Schools Excellence Fund (LSEF) is based on the hypothesis that investing in teaching, subject knowledge and subject-specific teaching methods and pedagogy will lead to improved outcomes for pupils in terms of attainment, subject participation and aspiration.

The aims of the Fund:
I. Cultivate teaching excellence through investment in teaching and teachers so that attention is re-focused on knowledge-led teaching and curriculum.
II. Support self-sustaining school-to-school and peer-led activity, plus the creation of new resources and support for teachers, to raise achievement in priority subjects in primary and secondary schools (English, mathematics, biology, chemistry, computer science, physics, history, geography, languages).
III. Support the development of activity which has already been tested and has some evaluation (either internal or external), where further support is needed to develop the activity, take it to scale and undertake additional evaluation.
IV. In the longer term, create cultural change and raise expectations in the London school system, so that London is acknowledged as a centre of teaching excellence and its state schools are among the best in the world.

To get a sense of the overall impact of the project, attendees in year 2 were asked to respond to a series of statements at the end of the final training day, and the results were as follows:

- 92% *strongly agree* and the remainder *agree* that “this course has improved my knowledge of the advanced mathematics necessary to teach further mathematics”
- 92% *strongly agree* and the remainder *agree* that “this course has improved my understanding of the pedagogy of advanced school mathematics”
- 58% *strongly agree* and the remainder *agree* that “this course has improved my expertise in the pedagogy of advanced school mathematics”
- 67% *strongly agree* and the remainder *agree* that “I have improved as a mathematics teacher as a result of attending this course”
- 83% were *neutral*, whilst 17% *agree* that “this course has improved the take up, retention and attitudes of students taking further mathematics at my school”

Let us revisit the theory of change submission for this project:

> *The project will strengthen Further Mathematics teaching in London by improving mathematics teachers’ subject knowledge and associated teaching expertise in order to increase take up, retention and attitudes in Further Mathematics A-level. Course*

alumni will form the core of a London-wide network at King's College London Mathematics School.

The data collected and discussed in previous sections of this report, coupled with the survey results summarised above suggests that the desired impact has been achieved for those teachers who have been participants on the course. It is too early to conclude that we have been successful in increasing take up, retention and attitudes amongst pupils but this was a secondary outcome and we always expected a time lag in achieving this outcome.

There were 4 outcomes described in the theory of change and we will discuss each of these in turn:

Outcome A – Teachers participating will have improved knowledge of the advanced mathematics necessary to teach Further Mathematics

All responses to the end of course survey were positive here: those participating certainly felt that their knowledge had improved, with 92% "strongly agreeing". Furthermore, there was a score gain of 5.3 marks per person for the 12 teachers who sat both the pre- and post-tests. This corresponds to a large effect size of 1.22. Without a control group, and with such a small sample, it is difficult to attribute this to the course exclusively, but it seems clear that the structure of the training days, or at the very least, the opportunity to spend six days discussing mathematics and looking at examples, has improved the knowledge of those involved. Clearly other factors may have come into play here: for those teachers who were on the course whilst simultaneously teaching the material for the first time, for example, the very fact that they were delivering topics to their classes will certainly have contributed to their knowledge-gain. Equally, however, there were teachers who had taught this material in previous years who saw improvement in their scores between the pre- and post-tests despite the fact that they were not delivering the material whilst attending the course.

Outcome B – Teachers participating will have improved understanding of, and expertise in, the pedagogy of advanced school mathematics

As the survey results show, all teachers agreed that their understanding and expertise and improved at the end of the course. This is not fully supported by the data collected: there was a slight improvement in performance on the cognitive map task between pre- and post-test and no discernable difference in the questionnaire responses. This possibly suggests that the improvement has been difficult to quantify or to test successfully!

On the training days, and in classroom visits, a significant amount of "improvement" has been witnessed, though this necessarily is witnessed on an individual basis. On the training days, participants were encouraged to use Socratic questioning with their students; on initial visits it was evident that some were more comfortable with a highly didactic approach, running through an example with the aid of a textbook and then leaving students to complete similar questions themselves. For example, with one teacher, an early mentoring visit resulted in the target "try asking more directed questions"; later in the year their visit write-up included the line "most of the key ideas came from them, and lots of your questions were directed at individuals – they were all involved, at one point or another".

The training days were scheduled so that those teaching Further Pure could use the resources shared in their own lessons. These resources were often designed to promote explorative learning – "let's do some questions and see what we can conclude" rather than teacher delivered facts – "today I'm going to show you how to multiply together complex numbers". On several early visits, these resources were being used with some trepidation but teachers were certainly keen to try out the approaches that had been discussed. By the end of the course, it was evident from visits that some participants had either adapted

resources to suit their classes, or even created their own resources that they subsequently used to encourage the types of learning that had been promoted on the course. For example, one teacher used a course resource for the lesson that was observed during the first visit; by the sixth visit her lesson involved a challenging matching exercise, an equation-categorisation process and an open-ended task requiring students to suggest possible equations for given curves. The lesson was extremely student-driven: there was very little "teaching from the front" but a vast amount of individual questioning and probing to elicit some difficult mathematical ideas from the students.

Therefore, there is certainly evidence, if non-numerical, to suggest that understanding of, and expertise in, pedagogy improved as a result of participation in the course. Certainly the survey indicates that participants identified this improvement within themselves, and the mentoring visits provide a large amount of support for this claim.

Outcome C: In participating schools, there will be increased take up, retention and attitudes of students in Further Mathematics A-level. (Secondary outcome.)

There is no evidence to suggest that this increase has occurred as of yet, though it was clear from the start a time lag was expected here. Furthermore, relevant data has proved to be extremely difficult to collect: whilst the individual participants have been enthusiastic to contribute where possible in many schools the data required was not at their fingertips and thus collecting extensive data was a challenge.

It was certainly the case with some participants that "I've been trying out some of these approaches with my year 11's" or that "I have the top set in year 10 and I'm raving about Further Mathematics"; thus on a one by one basis there is some hint that participation on the course has had an effect on the enthusiasm of the teacher and for the advertising of Further Mathematics as an option but overall it is difficult to demonstrate any increases or to attribute these to the course.

Outcome D: The project will establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School.

In the crudest of terms, we have been successful here: before we ran the course, there were no network meetings, and now there are. These have been attended by course participants and perhaps more importantly by colleagues of course participants – this suggests that our network is known not just by the individuals with whom we have worked but also by other members of their departments. To tick off this outcome as "achieved" would be premature however; the goal is to provide regular network meetings that are well attended and well received and it will be several more terms before we can truly judge our success here.

It is worth noting that the introduction of "Maths Hubs" by the NCETM is a new initiative and that these did not exist when we first applied for LSEF funding. As a new school, we were not in a position to bid to be a hub, but we are working in conjunction with our local hub and the link with them should certainly ensure that the network that we are building is well publicised.

So, to conclude: there is strong evidence here to suggest that the investment of time and resources into cultivating excellence in teachers and teaching by discussing subjects together, preparing and adapting resources, attempting questions and sharing experiences is extremely valuable and can have a positive effect on those teachers and their opinions of themselves. Whether or not this has an immediate effect on "secondary stretch" in the form of pupil take up and retention is beyond the scope of the two-year life-span of this project. We would argue that by providing teachers with more extensive subject knowledge along

with time to think about, and to develop, their pedagogy, we have encouraged them to engender a curiosity in their pupils that, we hope, will inspire the most able and enthusiastic to study Further Mathematics to A-level.

10. *Value for Money*

A value for money assessment considers whether the project has brought about benefits at a reasonable cost. Section 5 brings together the information on cost of delivery which will be used in this section.

10.1 Apportionment of the costs across the activity

Please provide an estimate of the percentage of project activity and budget that was allocated to each of the broad activity areas below. Please include the time and costs associated with planning and evaluating those activity areas in your estimates.

Broad type of activity	Estimated % project activity	£ Estimated cost, including in kind
Producing/Disseminating Materials/Resources	15%	£13,000
Teacher CPD (face to face/online etc)	30%	£26,000
Events/Networks for Teachers	5%	£4,300
Teacher 1:1 support	40%	£34,700
Events/Networks for Pupils	0%	£0
Evaluation	10%	£10,700
TOTAL	100%	£ 88,700

Please provide some commentary reflecting on the balance of activity and costs incurred: Would more or less of some aspects have been better?

The balance was as planned, and we feel appropriate to the aims and intended outcomes of the programme.

10.2 Commentary of value for money

Please provide some commentary reflecting on the project's overall cost based on the extent to which aims/objectives and targets were met. If possible, draw on insight into similar programmes to comment on whether the programme delivers better or worse value for money than alternatives.

The statistical analysis shows a huge impact on subject knowledge for the teachers on the course. In both years that the course ran there was also a positive impact demonstrated on their conceptual understanding. Qualitative feedback is yet more impressive, and shows a genuine re-engagement with mathematics from so many of the participants; whilst the impact of this is harder to measure directly, an engaged, thinking, and enthusiastic teacher is clearly going to have a significant impact on the progress of their students. Classroom observation from the senior mentor on the project confirms this. The project has also launched a new Centre of Excellence for the Learning and Teaching of Mathematics, and the mathematics forums that have been run show a thriving community that is helping to inspire the highest quality of teaching at sixth form level.

The underspend of the project demonstrates good financial management. The overall cost of the programme corresponds to an approximate investment of £2,000 per teacher who participated on the course, and whilst that is a not insignificant amount this calculation does not account for the fact that the long term benefit is much greater: a course now exists that can be run at low cost (we have managed to continue the course and cover the costs through a mixture of charging for places and finding a £15,000 per year investment), and a

network of teachers exists and will continue to expand and act both as a support and an ongoing challenge to improve. As an investment costs therefore we view the LSEF funding as being very well spent.

A comparable course to ours is the Further Maths Support Project's "Teaching Further Maths" course. This costs £600 per person, involves a similar number of training hours, but involves no school visits. The course is also supported by the FMSP's funding from the DfE. Now that our Further Maths Course has been established, the effective costs is £1000 per person (but we charge them only £400) and that includes two days on which a senior mentors visits the trainee in their school to see them teach and give high-quality one-to-one support. We therefore see this as comparatively good value for money.

10.3 Value for money calculations
Note: This section is only required for projects with control or comparison groups

In order to demonstrate the cost effectiveness of the project we would like those projects who had control or comparison groups to provide some value for money calculations. Further guidance will be issued to support projects with this.

No control or comparison group were involved.

11. Reflection on project delivery

This section is designed to allow for a discussion of wider issues relating to the project. (maximum 1,500 words)

Please include reflection on the following:

11.1 Key Enablers and Barriers to Achievement

- *Were there internal and/or external factors which appear to have had an effect on project success, and how were these responded to (if applicable)?*
- *What factors need to be in place in order to improve teacher subject knowledge?*

This project was planned so that participants would attend six training days during the academic year. At each day, topics would be discussed and resources shared. In the ideal scenario, participants would then go away and cover this material with their class of Further Mathematicians, experimenting with resources and perhaps receiving a visit from a Senior Mentor. They would then come to the next training day, and the process would repeat.

It is not unreasonable to suggest that the project was most successful for those teachers with timetables, groups and departments that allowed them to follow this approximate schedule. Using shared resources to plan and deliver lessons consolidated the ideas and topics discussed on the training days and teachers were able to reflect, often with a mentor, on the success of these lessons.

However, this idealised set-up was very difficult to follow in practice for most participants. The logistics of being a full-time teacher often interfered! Some problems that arose were:

- Timetable changes meant that not all participants were teaching FP1
- Schemes of learning meant that some participants were not teaching FP1 from the start of the year
- Practicalities of timetable sometimes made it difficult to find a mutually convenient Further Mathematics lesson, with discussion time afterwards, for participant and mentor
- Busy schedules of participants meant that some mentoring opportunities were missed due to e.g. not responding to emails promptly
- Sudden changes at school (e.g. illness of other staff) meant training days were missed

On a more positive note, teacher subject knowledge improved dramatically on the training days: time was built in for “practice” and, much like their students, teachers became more confident and knowledgeable by attempting exercises and discussing any issues that arose with their peers or with course leaders.

11.2 Management and Delivery Processes

- *How effective were the management and delivery processes used?*
- *Were there any innovative delivery mechanisms and what was the effect of those?*
- *Did the management or delivery mechanisms change during the lifetime of the project and what were the before or after effects?*

The training days were, on the whole, highly effective: feedback was very positive and many teachers ended the day with “that was extremely valuable” or even “this is the best training I’ve ever done”. In fact, in the end of course survey, 100% responded “agree” or “strongly agree” to the statements “I would recommend this course to other teachers of mathematics interested in developing their knowledge of further mathematics content” and “I would

recommend this course to other teachers of mathematics interested in developing their teaching of further mathematics content".

As mentioned above, some teachers had to miss training days at short notice and this seems relatively unavoidable: dates were published in advance and problems can arise in any school. That said, attendance for Saturday sessions was noticeably lower than on other days – we had scheduled two Saturdays to minimise cover costs and inconvenience but very few schools claimed for cover costs.

Ironically, the fact that the course was free of charge for teachers probably meant that some felt more able to miss a day at short notice: if their school had been paying the story may have been different! Initially we had scheduled a day during the pre-examination revision period, after several requests from participants we rescheduled this day so as not to clash here.

Necessarily, when dealing with teachers from many different school across London, email was the main form of communication: scheduling visits by email proved difficult at times and ultimately some participants were not visited six times primarily because of these difficulties.

11.3 Future Sustainability and Forward Planning

- *Do you have any plans for the future sustainability of your projects?*
- *What factors or elements are essential for the sustainability of your project?*
- *How have you/will you share your project knowledge and resources?*

The six training day structure has been highly effective and we intend to retain this in future versions of the project. In fact, we have already run the first training days with a new group of teachers for 2015-16.

Whilst six visits were very useful for some individuals, the logistics of arranging so many visits proved difficult and future versions of the project will involve fewer visits. For the 2015-16 group, we will be using two visits (one towards the beginning of the course and one towards the end) and inviting participants to visit us in between these, to observe lessons and to see if we "practice what we preach" in our own school.

The major factor to consider when addressing sustainability was cost, and thus charge – how much would schools be willing to pay for six days of training plus two visits? Could we find other funding to replace that from the LSEF? How many participants did we need to make the course financially viable? Would people be willing to pay for a course that had previously been free of charge?

All of the resources that have been used on the course have been circulated to participants: many have used them immediately with their own classes whilst others have edited and rewritten to suit their own needs. Still more have religiously completed exercises themselves at home – on more than one occasion we've been emailed with "can I just check the answer to q4?" or similar!

12. Final Report Conclusion

Please provide key conclusions regarding your findings and any lessons learnt *(maximum 1,500 words)*.

Alongside overarching key conclusions, headings for this section should include:

Key findings for assessment of project impact

- *What outcomes does the evaluation suggest were achieved?*
- *What outcomes, if any, does the evaluation suggest were not achieved or partly achieved?*
- *What outcomes, if any, is there too little evidence to state whether they were achieved or not?*

There were four target outcomes for this project. Looking at all of the evidence collected and discussed in this report, it seems reasonable to suggest that one was achieved, two were partially achieved, and that there is insufficient evidence to state whether or not the fourth has been achieved. We will review these in reverse order:

Outcome C: In participating schools, there will be increased take up, retention and attitudes of students in Further Mathematics A-level. (Secondary outcome.)

It is simply too early to reach a conclusion here, and a time lag was expected when the project was set-up and initial funding was granted.

Outcome D: The project will establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School.

This network has been established, and the first meetings have occurred. The intention is for these to be termly. The numbers of teachers attending varied at these first two meetings, and clearly our contact list for invitations extends beyond the scope of teachers who have participated on our course: these meetings are open to all teachers of mathematics in London and our aim is to advertise to as many of them as possible. However, attendance figures have certainly been assisted by the course: both sessions included attendees who were either course participants, or colleagues of course participants.

Outcome B – Teachers participating will have improved understanding of, and expertise in, the pedagogy of advanced school mathematics.

There is a significant amount of observed evidence to support the claim that this outcome has been achieved. However, the numerical data collected to test the claim is not quite so convincing. In the two tests used to measure this outcome (a "concept map" exercise and a "beliefs survey") the difference in scores between pre- and post-intervention were not significant.

100% of participants completing a questionnaire at the end of the course agreed (in fact, 58% strongly agreed) that "this course has improved my expertise in the pedagogy of advanced school mathematics". So it is certainly the case that attendance on the course increased confidence and prompted a belief in participants that their pedagogy had improved as a result of attendance. The fact that this is not fully supported by the figures is interesting: how does one measure "improvement in pedagogy"? To our knowledge, there are no known tests for this and it was necessary for us to design our own. Perhaps it is the case that the target outcome *has* been achieved, but a suitable method for testing and justifying this has not.

Outcome A – Teachers participating will have improved knowledge of the advanced mathematics necessary to teach Further Mathematics

There is a great deal of evidence to suggest that this outcome has been achieved. Performance in the pre- and post-intervention tests differed significantly, and it has been clear in our interactions with course participants that their knowledge has improved as the course has progressed. There are clearly external factors here and thus it is not possible to attribute this knowledge-gain to the course exclusively, but there is little doubt that the course has contributed to a marked improvement in the knowledge of the participants.

Key lessons learnt for assessment of project delivery

- *What activities/approaches worked well?*
- *What activities/approaches worked less well?*
- *What difficulties were encountered in delivery and how could they be mitigated in the future?*
- *Were there any additional or unintended benefits (e.g. increases in student attendance as a result of an intervention aimed at teachers)?*

On the six training days, participants completed a large number of activities "as students" and many commented on the value of these activities, both in furthering their mathematical knowledge, but also in assisting them to consider how their students might feel in their lessons and where difficulties of misconceptions may arise.

Participants experimented with working as individuals, pairs and groups on different tasks, again modelling how they might consider delivering material in their own room. They were often asked questions by name as we were trying to encourage them to take this approach with their students.

Teachers on the course were very good at switching mind-sets: having worked through examples or joined in group discussions where the course leader was "teacher" and they were "students" it was often helpful to then discuss "how might we use this in a lesson?" or "what would we you need to change to make this suitable for your own students?" – these pedagogical aspects were necessarily discussed with a "teacher mind-set" rather than with a "student mind-set" and participants found it very easy to move between the two.

With many participants not having taught the material covered before, and with some not having studied it at school themselves, it was inevitable that there would be points where teachers found some questions quite difficult, or some concepts rather challenging. Though not ideal, this was quite useful in helping them to realise what their students feel like when they do not understand what is going on in a lesson, and though course leaders were occasionally surprised by knowledge-gaps these usually provided an opportunity for further modelling of how we might use Socratic questioning to elicit the desired mathematics from students.

From a logistical point of view, some teachers were always going to find it difficult to attend six training days and arrange six visits even having signed up to the course knowing that this was the intention. Saturday training days proved to be less well-attended than those in the working week but it is difficult to justify moving these into the week since six days of "cover" is a big request for any teacher over the course of the year.

Informing future delivery

- *What should the project have done more of?*
- *What should the project have done less of?*
- *What recommendations would you have for other projects regarding scaling up and/ or replicating your project?*

The feedback from participants was extremely positive at the end of each training day – they enjoyed the structure of these, they enjoyed the opportunity to do some mathematics, and they enjoyed the subsequent discussions with their peers. Logistics aside, in most cases they would have quite happily come to more training days if we had offered them!

The mentoring visits were an important part of this course: there are very few opportunities in teaching to be observed and to receive feedback without some caveat attached (performance management, inspection, etc). These visits were useful to the participants, but we would recommend attempting fewer visits in the future and would also suggest restructuring these visits. Mutual observations, where possible, proved extremely beneficial – it is much easier to demonstrate pedagogical approaches whilst being observed rather than in the abstract – it may be worth, for example, trying to find opportunities for the visitor to observe one lesson and teach another before a two-way feedback discussion.

This was a highly specialised project involving carefully planned and delivered training days from Course Leaders with a great deal of experience in teaching using the techniques that we were trying to encourage. To develop the ability of others to use dialogic and connectionist approaches to teaching is not a straightforward undertaking and anyone seeking to replicate this project will need similarly experienced Course Leaders.

Appendix 1: Theory of Change Template

1. What is the long-term goal that you are working towards?

The project will strengthen Further Mathematics teaching in London by improving mathematics teachers' subject knowledge and associated teaching expertise in order to increase take up, retention and attitudes of students in Further Mathematics A-level. Course alumni will form the core of a London-wide network at King's College London Mathematics School.

This is important because, for many pupils in the state sector, particularly in disadvantaged areas, A-level mathematics teaching is poor and there is a national shortage of specialist mathematics teachers. The problem of teacher subject knowledge is particularly acute for Further Mathematics. Too many pupils in London state schools do not have the opportunity provided in the best schools to develop a deep understanding of mathematics, and this prevents their progress onto degree courses that require Further Mathematics.

2. What are the measurable outcomes, which you can affect, that contribute to the long-term goal?

Teachers participating in the project will have:

A. Improved knowledge of the advanced mathematics necessary to teach Further Mathematics
B. Improved understanding of, and expertise in, the pedagogy of advanced school mathematics, by having:
    - increased understanding of how students learn advanced school mathematics, in particular knowledge of common errors and misconceptions
    - increased the extent and quality of their repertoire of rich tasks
    - developed their ability to use a dialogic and connectionist approaches to teaching

In participating schools:

C. Increased take up, retention and attitudes of students in Further Mathematics A-level.

The project will:

D. Establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School.

Outcomes A, B, and C relate directly to the project's long-term goals but targeted at the teachers directly participating in the professional development. Outcome D is aimed at sustaining the initiative and extending its reach beyond the initial group of teachers.

3. What are the activities that contribute to the outcomes?

The project will provide in depth professional development for teachers who wish to improve their subject knowledge and teaching of Further Mathematics A-level. The project will involve the following activities:

Activity 1: Central sessions

Central whole day sessions led by expert teachers and academics, delivered initially at King's College London (Year 1) and subsequently at King's College London Mathematics School (year 2).

Activity 2: Individual mentoring visits

Individual mentoring visits to the schools and classrooms of the participating teachers conducted by an expert teacher. In Year 2, some of the teachers from the first year of the professional development programme will act as mentors.

Activity 3: Teacher mentors

Identify a group of teachers from the course participants with sufficient knowledge and expertise to enable them to lead in-school mentoring sessions.

Activity 4: Network meetings

Two network meetings will be organised during the final 6 months of the project targeted at a wider group of interested teachers of Further Mathematics and taking place at the King's College London Mathematics School.

Target Group / Population

The project will target a core group of 18 teachers from a total of 12 schools over two years. In addition, a further group of 12 teachers will be invited to join the central subject knowledge sessions. The target population is London teachers who are already teaching advanced mathematics, but lack the knowledge, expertise and confidence to teach Further Mathematics. 30 teachers will take part on the project:

- a core group of 18 teachers from a total of 12 schools over the two years will participate in both central sessions and receive mentoring visits.
- a further group of 12 teachers will participate in the central subject knowledge sessions.

4. Which activities contribute to each outcome?

The online system will ask you to select which activities contribute to each outcome.

Outcomes A and B: Improved teacher knowledge and understanding of Further Mathematics: Activities 1 and 2.

Outcome C: Increased student take up, retention and attitudes in Further Mathematics: Activities 1, 2 and 4. This will be a secondary outcome of outcomes A and B, although we expect a time lag in achieving this outcome.

Outcome D: Establish a network of Further Mathematics teachers and schools. Activities 1, 2, 3 and 4.

5. What assumptions have you made in determining your outcomes?

Participants are willing to engage and schools are willing to allow participating teachers time to take part and for individual mentoring visits. We have allowed for some teacher drop out in our planning.

6. What is your evaluation plan?

Outcomes A and B: Teacher knowledge and understanding: We will examine directly whether participating teachers make gains in their own knowledge and understanding of Further Mathematics. We will collect pre- and post-intervention data of teacher knowledge and understanding. We will design a test ourselves based on selected Further Mathematics A-level questions. Teachers will be asked to answer the questions fully, to identify potential misconceptions and difficulties that students will encounter and to describe ways in which they would teach the underlying mathematics ideas. We will design this test ourselves and will validate it during the first year of the project.

Outcome B: Teacher beliefs and understanding of a connectionist approach to teaching: We will use a previously validated questionnaire that taps teachers' beliefs about connectionist / dialogic approaches to teaching, which we will adapt slightly for Further Mathematics: http://www.transmaths.org/teachers/.

Outcomes A and B: We will compare the results to the general Transmaths results for AS teachers. We will collect baseline pre-test data [Teacher knowledge and understanding] in January 2014 for the first group of teachers and collect post-intervention data in Autumn 2014 and in Summer 2015. We will collect baseline pre-test data [Teacher knowledge and understanding] in July 2014 for the second group of teachers and collect post-intervention data in Summer 2015.

Outcome C: We will collect data on take-up and retention of students to Further Mathematics from the participants' schools and compare these to similar schools and trend data from previous years in the participating schools. We will collect pre-intervention and trend take-up and retention of Further Mathematics at A-level in January 2014 and post-intervention data in September 2014 and September 2015. Note that we expect this to be a secondary outcome of the project and that there will be a time lag in achieving this outcome.

Outcome D: We will collect data in Yr2 on attendance at the two network meetings and the number and range of schools represented. In addition, we will identify at least three

teachers from the first year's project who will have contributed to the central sessions and in-school mentoring taking place during the second year. We will collect evidence of their contribution in Yr2.

Professor Jeremy Hodgen will lead on the evaluation of the project in close collaboration with Dan Abramson, the overall project lead. The data will be collected and analysed by a post-doctoral fellow at King's College London (under supervision by Jeremy Hodgen and Dan Abramson). We expect to have results at the end of the project at the beginning of the Autumn term 2015.

7. Supporting evidence

- *Evaluation plan / framework*

Appendix 2

London Schools Excellence Fund: Self-Evaluation Toolkit – FINAL

	Outcomes	**Indicators**	**Baseline data collection**	**Impact data collection**
Teacher outcomes **Sub Groups** As part of establishing the baseline, the characteristics of the eligible cohort should be analysed across the following sub groups: ☐ NQTs ☐ 3 years + These should be expressed as a % of the whole group. **Churn** Throughout the programme thorough records of any "churn" of teachers leaving or joining the intervention group must be kept. In order to do this records must be kept of: ☐ Unique teacher identifier ☐ Engagement date ☐ Disengagement date and reason	☐ Increased subject knowledge and greater awareness of subject specific teaching methods ☐ Improved understanding of, and expertise in, the pedagogy of advanced school mathematics, by having increased understanding of (i) how students learn advanced school mathematics, and (ii) the extent and quality of their repertoire of rich tasks	☐ Increased teacher scores in subject knowledge/ student learning / teaching approach tests of Further / Advanced Mathematics Tests will be taken by all teachers involved in the intervention. We will use Yr1 of the intervention for which there is a smaller cohort of teachers as a pilot and validation exercise for Yr2 (and larger cohort of teachers)	☐ Scores collected for individual teachers from pre intervention subject knowledge/ student learning / teaching approach tests of Further / Advanced Mathematics. Date of collection Yr 1: January 2014; Yr 2 July 2014	☐ Scores collected for individual teachers from tests after Yr1 and Yr2 of intervention Date of collection Yr 1: Autumn 2014 & Summer 2015; Yr 2 Summer 2014
	☐ Improved understanding of, and expertise in, the pedagogy of advanced school mathematics, by having increased understanding of (iii) developed their ability to use dialogic and connectionist approaches to teaching	☐ Increased teacher scores in beliefs survey	☐ Scores collected for individual teachers from pre intervention beliefs survey Date of collection Yr 1: January 2014; Yr 2 July 2014	☐ Scores collected for individual teachers from post intervention beliefs surveys after Yr1 and Yr2 of intervention Date of collection Yr 1: Autumn 2014 & Summer 2015; Yr 2 Summer 2014

	Outcomes	**Indicators**	**Baseline data collection**	**Impact data collection**
Pupil outcomes **Sub Groups** The characteristics of the eligible cohort should be analysed across the following sub groups: ☐ LAC continuously for 6 months+ ☐ FSM ☐ FSM at any time during last 6 years* ☐ Disadvantaged pupils ☐ EAL ☐ Gender ☐ Ethnicity ☐ Statement of SEN or supported at School Action Plus ☐ Started respective Key Stage below expected level, at expected level, above expected level	☐ Increased take up, retention and attitudes of students in Further Mathematics A-level NOTE: This is a secondary outcome of the project and that there will be a time lag in achieving this outcome.	☐ Increased numbers of pupils taking up Further Mathematics subjects at A Level and at H/FE against trend data from previous years in the participating schools and against general patterns in take-up of Further Mathematics A-level	☐ Trend data: numbers of pupils taking up Further Mathematics at A Level and STEM subjects at H/FE for 3 years prior to intervention ☐ Intervention group: pre intervention data on take-up and retention of Further Mathematics at A-level ☐ General patterns in take-up: Data on Further Mathematics at A-level for 3 years prior to the intervention ☐ Date of collection for all baseline data: January 2014	☐ Intervention group: numbers of pupils taking relevant subjects GCSEs and A Levels after 12 and 24 months of intervention (analysed by cohort profile) ☐ Intervention group: post-intervention data on take-up and retention of Further Mathematics at A Level ☐ General patterns in take-up: Data on Further Mathematics at A-level post-intervention ☐ Date of collection: September 2014 and September 2015

	Outcomes	Indicators	Baseline data collection	Impact data collection
School system outcomes	☐ Establish a network of Further Mathematics teachers and schools centred around King's College London Mathematics School	☐ Attendance at the two network meetings in final 6 months of the project and the number and range of schools represented ☐ Three teachers from the first year's project will have contributed to the central sessions and in-school mentoring taking place during the second year	NOTE: This is a new network so no baseline data is available. Moreover we are targeting schools and teachers that do not currently have sufficient expertise to contribute to mentoring.	☐ Number of teachers attending each network meeting, and number and range of schools represented. Date of collection: Spring and Summer 2015 ☐ Numbers and profile of teachers who have contributed to leading central sessions and in-school mentoring taking place during the second year. Date of collection: Spring and Summer 2015