

Supporting MST224 students with bridging material during their transition from level one mathematics.

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Executive Summary

Using funding from eSTEEeM, we have created an interactive website and series of online tutorials under the umbrella of *Revise and Refresh* (R&R) for MST224: Mathematical methods. These provide support to students prior to module start, enabling them to be fully prepared when they return to study mathematics, hence increasing retention and the students' academic attachment to other students and to the University. Traditionally students on MST224 do not major in mathematics, and these students are seen as a priority for needing additional support.

Revise and refresh is designed to help to bridge the study gap between prior mathematical study and MST224 and allow students to "hit the ground running" at the start of MST224 having already revised prerequisite material and interacted with other students.

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Aims and scope of your project

What were the main aims of the project?

We aimed to create a 'Revise and Refresh' website for students registered on MST224: Mathematical Methods; the materials would be focused upon key areas of the prerequisite module MST124 (Essential Mathematics 1) that are essential for success in MST224 and beyond. A team of tutors would, furthermore, provide support to the students using forums, online tutorials and practice quizzes.

What were the more specific goals?

To provide mathematical support targeted on six key areas vital for success in MST224: *Algebra, Functions & Graphs, Trigonometry and Complex Numbers, Vectors and Matrices, Differentiation and Integration*. We employed three tutors with expertise across both MST124 and MST224; they knew the specific skills needed for success in MST224, and furthermore knew the areas in which the students tend to struggle the most. By creating *revise and refresh* materials which contain a gradation from straight forward to more challenging exercises, we aimed to engage the students during the leading months from July to September ahead of the October start for MST224. The *revise and refresh* website serves as between module support.

Activities

What was the overall approach?

Following the techniques described in *Designing for student retention* [1] and *Designing online courses to promote student retention* [2] we designed a program that supported the development of study habits and provided a gradual knowledge and skills gradient, helping students develop a growth mind-set [3]

The program is split into two key areas:

1. A *revise and refresh* website, which is self-led by the student. It contains an environment in which students can explore the areas of the prerequisite module that they need to review and receive guidance from tutors.
2. A series of *tutor-led* tutorials which were run just before the start of the module; an academic-led series of online revision tutorials.

The timings of the project were as follows:

- Early 2017: Successful eSTEEeM Bid;
- April-July 2017: Preparation of website;
- July 2017: initial contact to point students to the resources;
- July 2017— September 2017: students engage with the website: student-led part of the resource;
- September 2017: students engage with the tutorials: tutor-led part of the resource;
- October 2017: the module begins;
- June 2018: the module finishes.

Using our eSTEEeM funding, we employed three tutors, Linda Brown, Anne Rhodes, Paul Twine, to prepare the material for the website. They harvested existing examples, exercises and videos from the pre-requisite modules (mostly MST124, but occasionally legacy modules such as MS221). Tutors are our subject matter experts, and one of the single most valuable resources to which we have access at The Open University. It was important to use existing materials for a few reasons:

- It is important for the *revision* part of the process for the students to have seen the examples and exercises before so as to re-engage their familiarity with the materials;
- From a work-load perspective, the Document Processing Unit (DPU) needed to be able to access the materials easily and readily without having to re-key too much new material;
- Using existing material that has already been through significant editing and quality assurance lead to a reduction in necessity of checking and proof reading.

The website provides mathematical support targeted on six key areas vital for success in MST224:

1. *Algebra*

2. *Functions & Graphs*
3. *Trigonometry & Complex Numbers*
4. *Vectors & Matrices*
5. *Differentiation*
6. *Integration*

The key areas were identified via consultation with module tutors to establish where students struggle and which topics from the prerequisite modules were most important. To prepare the material, the 6 areas were split between the 3 tutors; they submitted their work sequentially to Sue and Chris, who proof read it, worked through the exercises, and sent it on to DPU for typesetting.

Furthermore, we had generous support from Tim Lowe who graciously created online practice quizzes using existing STACK questions from MST124. These questions allow the students to receive interactive feedback from intelligently graded computer assignments.

In the September before the start of MST224, a series of six online tutorials are given in the virtual classroom associated with the *revise and refresh* website; each one concentrates on one of the six key topics. They are run by two of the tutors that collated the resource material for the website; one tutor presents the tutorial and the other tutor is there to assist by answering any questions that arise in the chat box and taking over presenting if the initial tutor has any technological issues.

What were the planned activities of the project?

Revise and refresh website

The front page of the website has the following structure:

- A self-diagnostic quiz: this assists the student in assessing their knowledge and ability to start the module.
- A table containing the six topic headings with an indication of how long it takes to review each topic (measured in weeks) and the date of the associated tutorial. The table is used as the portal for accessing the individual topics.
- Finally, a link to the tutor support forum which is also linked from every topic page. At all stages the students are encouraged to post messages and questions on the tutor-moderated forum. At key points throughout the three months the tutors post extension questions and practical situations that relate to the mathematics studied, inviting the students to comment on the posts, thus increasing their participation. The forum moderators and students also have the use of a virtual classroom if they wish to discuss any issues.

Each of the six topic areas are presented using the same structure, as illustrated below for Integration.

Integration

*Restricted: Not available unless: The activity **Integration** is available (hidden otherwise)*

Try this quiz first



Integration quiz

Revise and refresh Integration

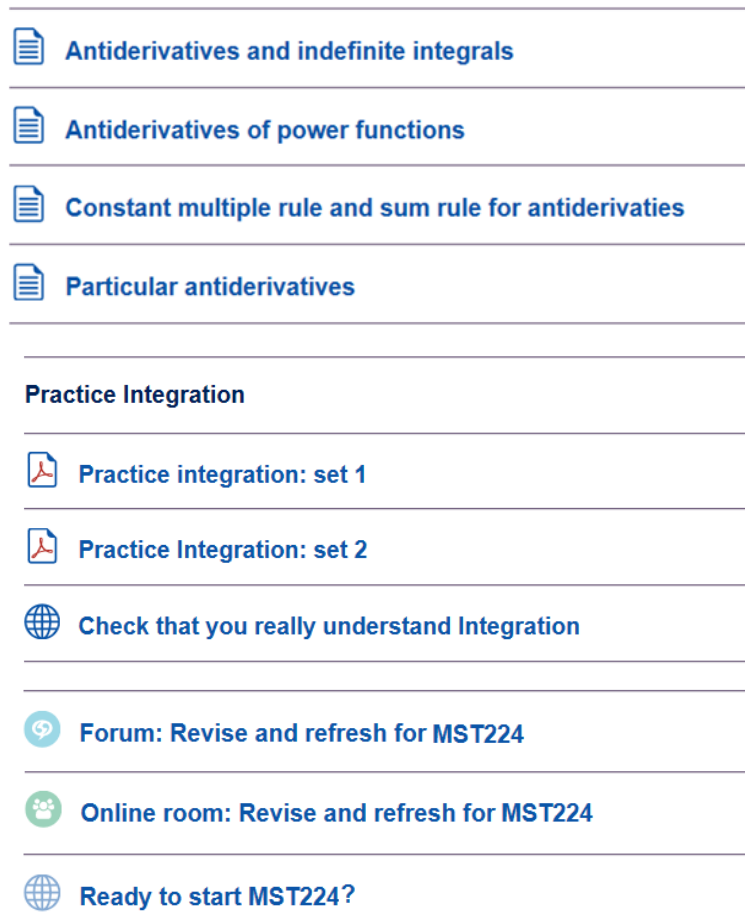


Figure 1: Structure for each of the topics within the website.

At the top of each page, the online interactive quiz helps a student establish if they need to spend time revising that topic as they are given feedback on how well they have done. The students can then choose, given the outcome of their quiz results, whether they need to study a subtopic.

Each subtopic gives an overview of the subject, which is enough for a brief *refresher* and then a reference to the material in the prerequisite module if the student wishes to *revise* it in more depth, together with relevant screencasts and similar videos.

Once the student has *revised* and *refreshed* all the subtopics, they can download a series of questions, with full solutions, to attempt in a traditional ‘pencil and paper’ style; they can then link back to the online quiz to see if they can improve their score. Links to the tutor-moderated forum are provided throughout.

Online tutorials

Before the start of the module, a series of six online tutorials are given by two tutors at a time, in the virtual classroom associated with the R&R website; each one focussing on one of the six key topics.

The tutorials are designed to challenge the learner, using effective questioning to achieve deeper understanding. They are run in a relaxed and friendly manner, promoting discussion, with students encouraged to post questions into the text chat, as described by Linda Brown, one of the associate lecturers involved in running the MST224 tutorials:

Enthusiastic chat and responses to questions during the online sessions showed students were fully engaged, learning and having fun. Students own words reveal the benefits they experienced "Thanks now I know what to practice" and "educative as always".

In each session tutors solve questions in real time, which can help to remove some of the student's "fear of failure" as they may observe tutors and other students making small slips, and can see that making mistakes is a natural process and a learning opportunity rather than as something to avoid. Time at the start and end of each session is given to more general chat, thus creating a community of practice. A Staff Tutor also attends some of the tutorials to answer any procedural questions that arise, and to offer pastoral care and study planning advice in a private breakout room.

What changes did you have to make to your plan (aims, project activities, etc.) and why (e.g. technical problems, difficulties in involving users/stakeholders, etc)?

The main difficulties we had were in the production of the static documents. There was a bottle neck in workload with DPU, a team of two people; the majority of the production happened from July—September 2017, during which a lot of the time only one of the team members from DPU was available due to holiday and/or because of other work-load commitments.

What data and evidence did you gather and how did you gather it (e.g. survey, interviews, focus groups, user studies, cultural probes)?

We gathered 'engagement' data on each of: the interactive practice quizzes, the tutor-moderated forums, the series of tutor-led online tutorials.

We determined those that had *actively* engaged doing any of the following:

- answering an online quiz;
- posting or reading a message on the forum;
- attending an online tutorial.

Students who *passively* engaged by:

- viewing the website;
- downloading practice questions;
- watching a recording of an online tutorial.

Unfortunately we only have methods of recording the participation of those users who *actively* engaged with the Revise and Refresh website; we are hopeful that there will have been more *passive* users who have benefited from the resources.

Findings

What are your main findings?

At the start of MST224 in October 2017 (the 17J presentation) there were 455 students registered to study the module. Our main finding is that for the students in this 17J cohort, they had a higher percentage of assignment submission and the highest percentage exam sitting since the module began in 2013.

Table 1 TMA submission rates and exam sitting rates for MST224

| | 2013 | 2014 | 2015 | 2016 | 2017 |
|---------------------|------|------|------|------|------|
| Assignment 1 | 87% | 88% | 86% | 88% | 89% |
| Assignment 2 | 84% | 85% | 84% | 83% | 85% |
| Assignment 3 | 77% | 79% | 76% | 78% | 78% |
| Assignment 4 | 63% | 61% | 61% | 62% | 65% |

| | | | | | |
|-------------|-----|-----|-----|-----|------------|
| Exam | 69% | 71% | 69% | 70% | 72% |
|-------------|-----|-----|-----|-----|------------|

Furthermore, as detailed in Figure 2, pass rates have increased by over 3% on the previous year and are more than 1% higher than the previous highest pass rate.

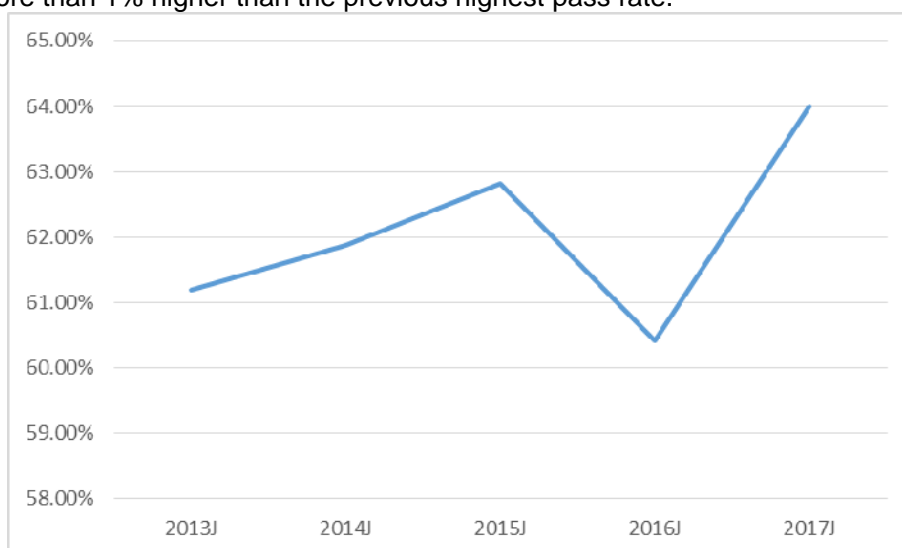


Figure 2 Pass rates on MST224 by presentation year

While it is not possible to attribute either of these statistics explicitly to the Revise and Refresh program, we will detail the data covering the engagement of students within the program.

What evidence supports these findings?

We will detail the engagement data in the following three categories: online quizzes, forum posts, and tutorial attendance.

Online quizzes

Of the 455 students registered onto MST224 in 17J:

- 142 tried at least one of the 6 online quizzes (one for each of the 6 topics);
- 43 students attempting at least 4 quizzes;
- 20 students attempting all 6 quizzes.

We have detailed the student engagement in each of the 6 quizzes in Figure 3. We note, in particular, that:

- In general the progression of the students through the online quizzes roughly follows the suggested timetable for studying the revise and refresh website, however there is a large influx of students doing the quizzes on all topics during the first few weeks in September; this coincides with the time at which most students register on MST224 and the series of online tutorials.
- A small number of quizzes are attempted even after the module had started on the 7th October. The revise and refresh website are accessible to all students registered with the Open University and it is interesting to note that 45 students also attempted some of the quizzes even though they did not go on to study MST224 that year.

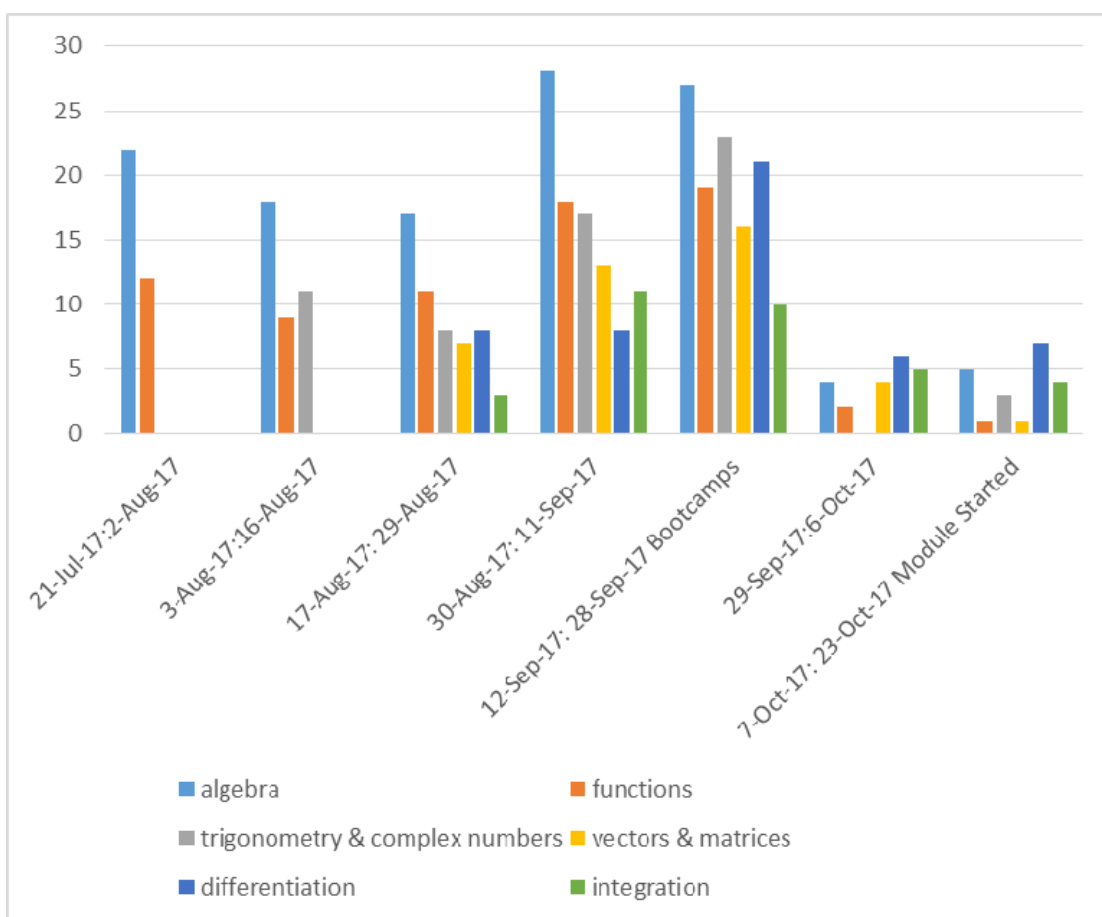


Figure 3 student interaction with the computer-marked quizzes, by topic and date

Forum posts

The students were encouraged to engage with the forums to ask questions of their support tutors, and to answer 'challenge' questions from the tutors. We summarise the forum engagement in Table 2.

Table 2 forum interaction

| Number of forum posts | # students who read this many | # students who posted this many |
|-----------------------|-------------------------------|---------------------------------|
| 0–5 | 70 | 22 |
| 6–10 | 18 | |
| 11–15 | 11 | 1 |
| 16–20 | 4 | |
| 21–25 | 4 | |
| 26–30 | 2 | |
| 31–35 | 5 | |
| 36–40 | 3 | 1 |

Online tutorials

A reminder communication was sent to students registered on the module at the start of September 2017 about the revise and refresh website, and to invite them to attend the tutorials.

We have the following summary of attendance:

- In total 62 students attended at least one tutorial, 43 of these students had also completed some of the online quizzes, with 19 students only attending the tutorials and not actively participating with the revise and refresh website.
 - As with the online quizzes, participation in the online tutorials decreased as the series progressed with only 20 students attending the final tutorial on integration.
 - We recorded that 34 students attended over half of the tutorials, and 10 students attending all 6.
- We recorded 99 students that participated in the online quizzes but didn't attend any tutorials
- Therefore, in total 161 students, 35% of the total body registered participated in the revise and refresh program for MST224.

These attendance records do not account for the number of students that will watch the recording after the event. Data on those that watch the recording could not be captured from the system used in 2017, however it should be possible to do so for 2018.

Do you have you any particular successes to report?

One of the reasons for creating the revise and refresh program was the low pass rates of students that had not studied the prerequisite module in over a year.

We separated the students into the following four groups, based on how many engagement events with which they engaged (minimum of 0 events, and maximum of 12 events for the 6 online quizzes, and 6 tutorials)

- group 1: those that have had *no* engagement;
- group 2: those that have had *low* engagement (1-3 events);
- group 3: those that have had *moderate* engagement (4-8 events);
- group 4: those that have had *high* engagement (9-12 events).

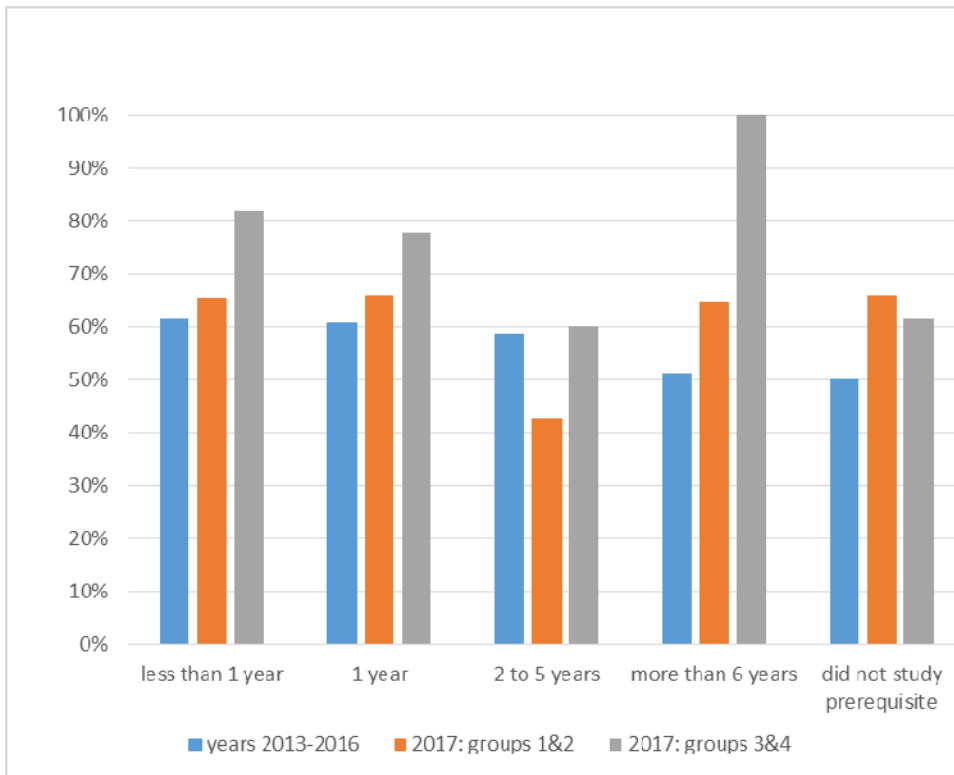


Figure 4 percentage of students passing MST224 based on length of time since studying one of the prerequisite maths modules

Figure 4 shows the results from 2017, alongside the results from prior years we can see that generally this year, regardless of engagement with the revise and refresh program, all students have done better than in previous years.

Referencing Table 3 we see that students who engaged with the *revise and refresh* program in groups 3 and 4 had a lower proportion of *Withdrawn or failed* than those in groups 1 and 2. Students in groups 3 and 4 had the highest proportion of gaining a distinction.

Table 3 percentage of students passing MST224 based on their engagement with the revise and refresh material

| | Distinction | grade 2 | grade 3 | grade 4 | Withdrawn or failed |
|---------|-------------|---------|---------|---------|---------------------|
| group 1 | 26% | 16% | 12% | 8% | 38% |
| group 2 | 27% | 16% | 11% | 9% | 36% |
| group 3 | 36% | 20% | 9% | 7% | 29% |
| group 4 | 63% | 13% | 13% | 13% | 0% |

Impact

Student experience

The *revise and refresh* program uses a two layer approach: a website and a series of online tutorials.

The website is student led, they must take ownership and accountability for their own progression through the material, it can be studied at their own pace and in their own time.

We are emphasising the student's own ability to conduct independent learning. The students will need to be honest with themselves about their own ability; they will need to reflect upon their skills, and seek guidance and support to fill in any gaps. Students take ownership, accountability and responsibility for their own success in this part.

Whilst using the website, participants have an opportunity to develop and/or practice key IT skills that would help them progress with their degree pathway, such as inputting mathematical notation into interactive quizzes (used in our continuous assessment), and using online tutorials and forums.

This is complimented by the online tutorial series which is a tutor led; the tutor ensures that all material required is covered and provides a real time opportunity to ask questions about the material.

The tutorials are designed to challenge the learner, using effective questioning to achieve a deeper understanding. They are run in a relaxed and friendly manner, promoting discussion, with students encouraged to post as many questions as they wish into the chat box with time at the start and end of each session given over to more general chat creating a community of practice [5]. Each session is live with tutors actively solving questions in real time, which can help to remove some of the student's "fear of failure" [4] as they see tutors and other students making mistakes and can welcome errors as a learning opportunity rather than something to avoid. A senior academic and member of the MST224 module team also attends some of the tutorials to answer any procedural questions that arise and offer pastoral care and qualification guidance in a private breakout room.

The two parts of the program are interlinked with the *revise and refresh* website raising issues that can be addressed in the tutorials and the tutorials exposing areas where the student needs to look at the material on

For the October 2017 presentation of MST224, 35% of students actively participated in the R&R programme. As can be seen from the table below, those students that interacted with the R&R website had a 17% higher proportion of success compared with those that did not interact with the website.

Table 4 percentage pass rate based on interaction with R&R

| | pass | withdrawn or failed |
|--------------------------------|------|---------------------|
| Actively interacted with R&R | 79% | 21% |
| No active interaction with R&R | 62% | 38% |

At the end of the October 2017 presentation 72% of students took the examination which is the highest percentage since the module began, and the number of students passing the module increased by over 3% percentage points to 64% compared to the previous year.

Teaching

The team has disseminated this project's outputs at the Horizons in Stem conference in July 2018. We have also had a paper accepted to New Directions in the Teaching of Physical Sciences.

Strategic change and learning design

The *revise and refresh* for MST224 site has now been augmented to cover revision for students preparing to study MST125: *Essential mathematics 2* and M248: *Analysing data*.

We are currently liaising with two teams within the School of Mathematics and Statistics who are creating further R&R sites, one for level 3 mathematics and statistics modules, and another for MST210: *Mathematical methods, models and modelling* and M208: *Pure mathematics*, which will both be launched in 2019. Along with *revise and refresh* for MST124, this suite of resources will then cover the majority of the modules for the mathematics and statistics undergraduate qualifications as well as modules taught as part of degrees within other schools such as engineering and science.

The team are in the early stages of discussions for disseminating the information to the Sigma (mathematics support centre) Network steering group who are interested in our distance learning support techniques to further

List of deliverables

Revise and refresh for MST224 Website:

<https://learn2.open.ac.uk/course/view.php?id=206217&cmid=1180957>

Figures and tables

List of tables and figures provided in the report.

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