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Joy of Maths

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For many mature students, mathematics can be a threshold concept which becomes a barrier to their opportunities. To tackle this, for the past two years the Lifelong Learning Centre at the University of Leeds has trialed an outreach programme for mature learners called 'Joy of Maths'. Joy of Maths aims to illustrate the beauty and fun of maths whilst imparting practical skills. Many of the mature learners who have attended Joy of Maths sessions have a deep-seated fear of maths due to previous bad experiences. In the sessions we demystify concepts and hence their negative beliefs and build confidence to illustrate the possibilities for their further learning journey. We will show that as a consequence several of the learners have chosen to return to education either by returning to FE or by successfully applying to courses at the University of Leeds.

Introduction

The Lifelong Learning Centre at the University of Leeds prides itself on being a department that widens participation through a variety of different programmes, courses and outreach activities. One aspect of this work on widening participation is to provide opportunities for mature students to realise their potential and as a consequence consider opportunities to begin a learning journey in higher education.

When a mature applicant applies to the University of Leeds, if they do not currently possess the required GCSE qualifications or if their GCSE qualifications are more than 10 years old, the University requires the applicants to participate in an Alternative Entry Matriculation scheme. This scheme consists of a Maths and English assessment that ensures the applicant has the required skills equivalent to the respective GCSE. On average 118 mature learners per year who lack current mathematical qualifications want to enrol on University of Leeds courses. As such, many mature applicants struggle to enter the University without any support to improve their maths to the appropriate level.

For the past six years the Lifelong Learning Centre has run a free programme called JumpStart to help mature learners realise their potential, whilst also tackling the issue of any skills shortage that may impact their chances on the English portion of the Alternative Entry Matriculation scheme. JumpStart is a 10-week programme that consists of multiple aspects taught in an informal way to put learners at ease.

> JumpStart gives its participants a taste of different subject areas which can be studied at university and helps them gain the knowledge to make choices about possible future careers. The course is designed to take the fear out of academic study by developing essential study skills such as critical thinking and analysis. [1]

Over the years JumpStart has been highly successful in developing the skills required for mature learners to embrace opportunities previously not considered. However, for mature learners maths and the ability to evidence their mathematical ability was still elusive. From learner feedback and through the pedagogy, we acknowledged that maths had become a "troublesome threshold concept" for mature learners. [2, 3] Over time we considered ways to incorporate maths into JumpStart but with reflection we realized that this would detract from the successful course already established. Therefore, we embarked on creating a new course, which would run in parallel to JumpStart, that focused solely on mathematical skills and provided support for students taking the maths portion of the Alternative Entry Matriculation scheme. This became the Joy of Maths programme.

Joy of Maths Concept

Joy of Maths is a free programme that consists of an hourly session which runs once a week for ten weeks. The first of these programmes ran in October 2016 and since then it has run twice a year, once starting in October and once starting in February. The aim of the sessions is to build confidence, demystify mathematical processes that are perceived as complex, and inspire participants to consider returning to education. As a consequence, we believe mature applicants will also be better equipped to successfully take the Alternative Entry Matriculation maths scheme or pursue mathematical qualifications in FE. As noted by Dodd *et al.*, "Adult students bring with them knowledge and experience which can adversely affect their learning of mathematics", [4] and by Rycroft-Smith and Macey, "over time, even initial enthusiasm for maths wanes and can eventually become outright hostility". [5] Therefore, the key aspect of Joy of Maths was to reduce fear and examine preconceived ideas.

A student-centred approach was taken to the session design in order to counter the palpable obstacles of fear, anxiety and general hatred of maths. [6, 7] The first session primarily focuses on discussion, especially verbalizing any fears or obstacles previously encountered. At the beginning of the first session the group draws up a "hate list" of topics that had previously caused distress. This list is then put to the side to revisit in future weeks when confidence has grown. The remainder of the first session focuses on "fun facts", showing, for example, how the golden ratio and Fibonacci sequence occur in everyday life and also showing the students how much general maths they use every day. Very little calculation or maths is attempted during the first meeting as trust and confidence with each other and with me as the tutor needs to be built. [8] The next two sessions are then primarily tutor-led and focus on the building blocks of maths, such as operator order of precedence BIDMAS, arithmetic, dealing with negative numbers, fractions and decimal numbers. By having these first sessions tutor-led we can ensure a solid foundation upon which to build.

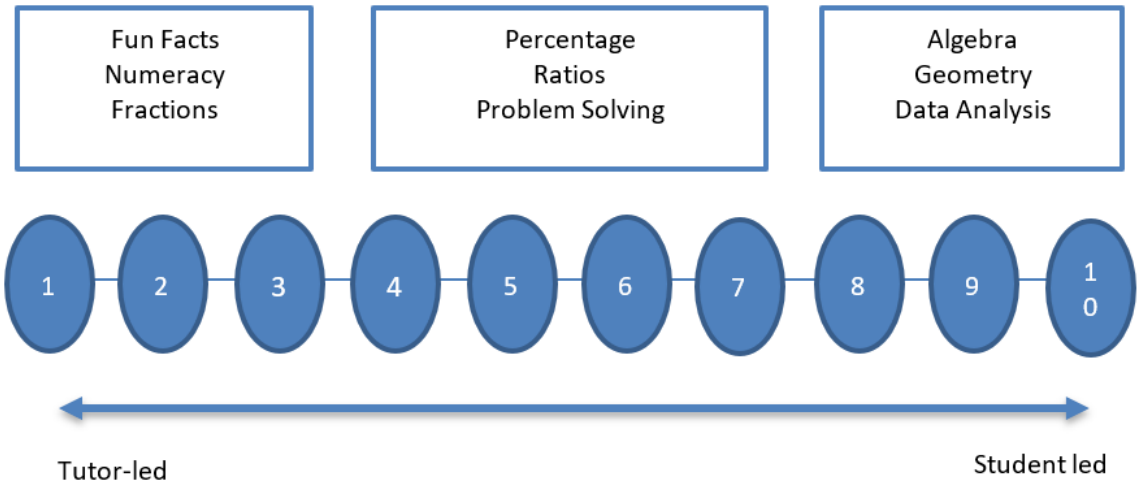

Figure 1. Diagram illustrating a typical 10-week Joy of Maths schedule.

As noted by O'Carroll et al., "Mature learners benefit from more flexibility in terms of delivery of material" [9] and Cullity states, "organising a fit between academic culture and mature learner requirements is fundamental in increasing mature learner success rates". [10] Over the remaining seven weeks a less directive approach is taken in order to allow the students to dictate pace and content. The design of the programme as a whole and typical content of sessions can be seen in Figure 1. At the end of each session, follow up material and practice exercises are provided but it is not expected that a participant must complete them. It is, however, wonderful to see that most choose to attempt some of it. Activities are varied within the sessions to allow collaboration and mutual support within the group as "a cooperative learning approach increases positive attitudes toward mathematics". [11] As we progress to the end of the course, the choice of topic we examine and discuss is solely chosen by the group. This has the potential to cause logistical concerns for arranging supporting materials for the sessions but on the whole the student groups tend to be drawn to the "hate list" they previously feared and it helps distinguish my role as "facilitator" rather than teacher. [6] In the last session I get the students to reflect on the journey they have taken and how their perceptions of maths and themselves as learners have changed.

We bring the learners onto campus and run the sessions in a regular university teaching room. We do this as mature and widening participation learners from disadvantaged backgrounds can feel intimidated by an elite university [12, 13] and as a by-product of the programme we hope to foster a sense of "belonging" in any learning environment.

Throughout the time on the course and for the following year we give the students access to MyMaths. [14] MyMaths is a subscription only on-line service that provides resources and assessment to guide students through content from primary school level to A-Level. Access to this interactive online tool allows the students to take ownership of their learning and to continue practising the maths they are investigating.

Cohort	Male	Female
Oct 2016	3	7
Feb 2017	5	7
Oct 2017	6	10
Feb 2018	7	10

Figure 2. Attendees of five or more sessions per cohort of Joy of Maths

Outcomes and Analysis

Joy of Maths sessions are not mandatory and students can attend as many or few of the ten sessions as they choose. Also, as the programme is free, voluntary and aimed at mature learners, the timing plays a crucial role as it can affect work, childcare or other caring responsibilities the learners may have. Due to the logistics of tutor and room allocation, the sessions have always run on a Wednesday afternoon on the University campus which has not been ideal for participant numbers. That being said, attendance has been extremely positive as there have been, in total, 55 regular attendees to date, as shown in Figure 2. Regular attendees are students who have attended five or more sessions. The number of distinct attendees per cohort is higher but some have been unable to attend regularly due to the constraints mentioned earlier. To date, in total, there have been 71 distinct attendees on Joy of Maths. It should also be noted that some learners choose to return and join in with later cohorts due to the enjoyment experienced, but for the sake of the data these students have not been counted again. I guarantee that all content and resources are shared with every participant regardless of attendance as we do not want to restrict the learning potential.

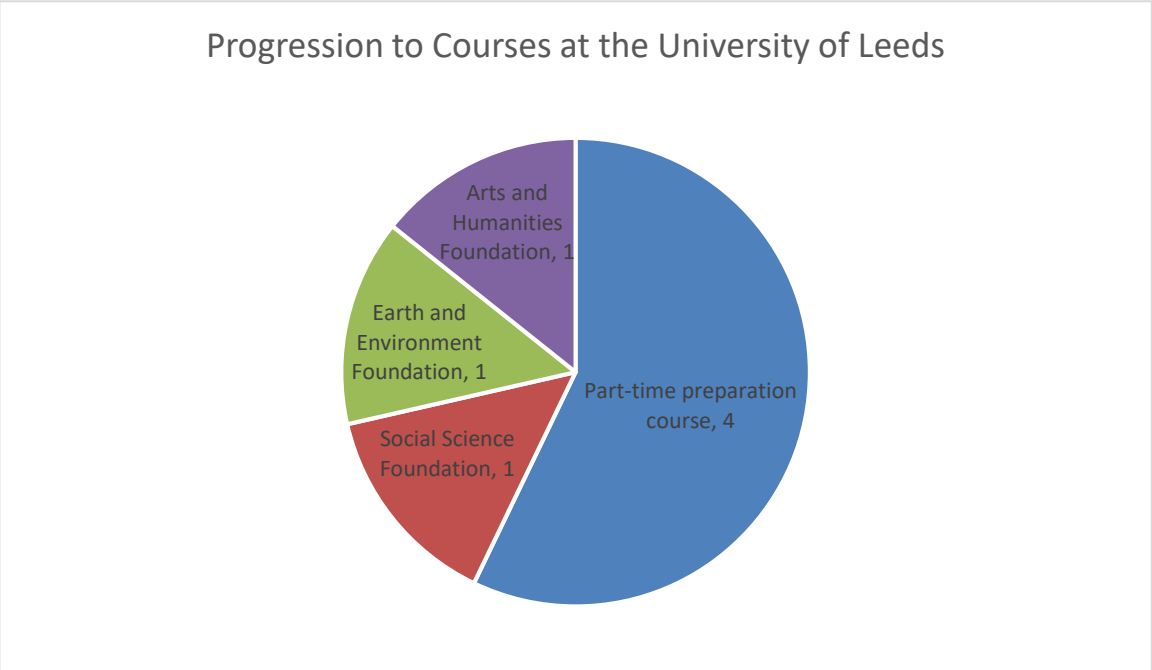

Figure 3. Students successfully applying to a variety of programmes at the University of Leeds from the 2016/17 cohorts.

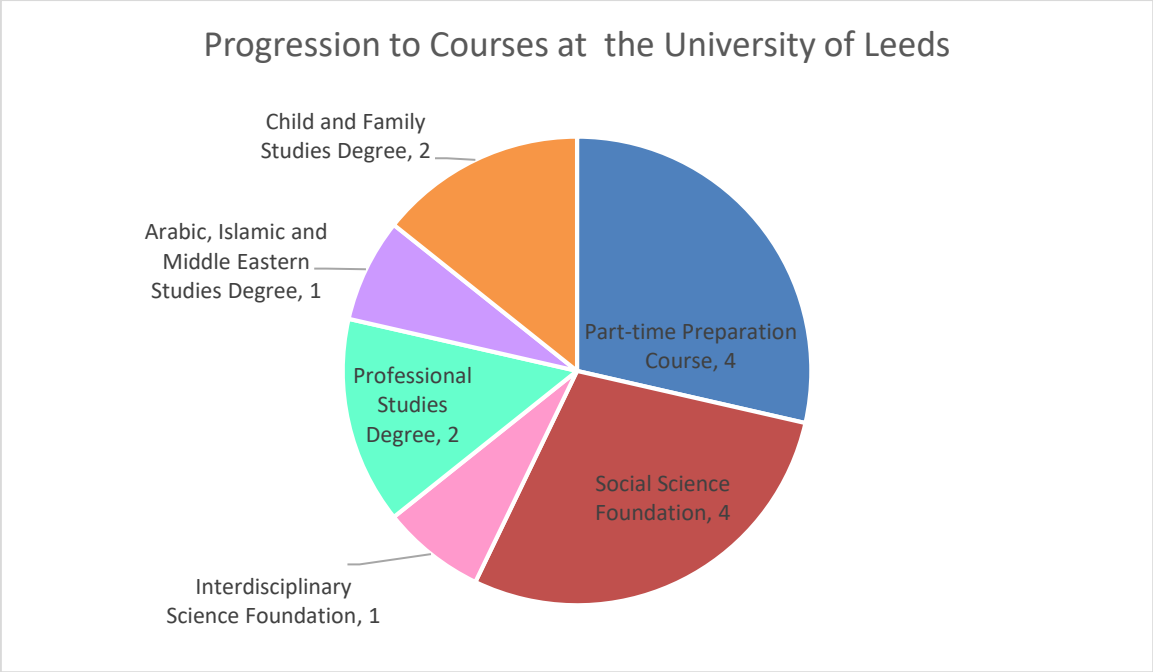

Figure 4. Students successfully applying to a variety of programmes at the University of Leeds from the 2017/18 cohorts.

Aspirations are raised by the Joy of Maths and JumpStart programmes. Therefore, during the programmes, the participants have the option of a guidance appointment to consider their future options. As a consequence, several of the learners have chosen to return to education. In 2017 two of the participants returned to FE to gain GCSE qualifications and seven chose and successfully applied to University of Leeds foundation year and preparatory programmes as can be seen in Figure 3. These seven students have now progressed onto University of Leeds courses and are successful students.

In 2018 three of the participants returned to FE to gain GCSE qualifications and 14 chose and successfully applied to University of Leeds foundation year, preparatory and degree programmes as can be seen in Figure 4. It should be noted that this number may increase as the admissions cycle is not yet complete because admissions for mature applicants remain open.

As mentioned earlier, to successfully apply to the University of Leeds mature applicants must pass the alternative entry assessment. As can be seen in Figures 3 and 4, although maths is not part of all the chosen progression pathways within the University, it is a vital part of gaining a firm place on a University of Leeds course.

The True Success - Feedback from Participants

Feedback was obtained from each cohort at the end of the 10-week programme. Snapshots of the outcomes from all groups follow.

When asked, “How did you feel about maths before starting Joy of Maths?”, 16% of participants said that they felt they definitely did not want to do maths ever again. The follow-up question then asked, “After Joy of Maths, how do you now feel about mathematics?”; 100% of

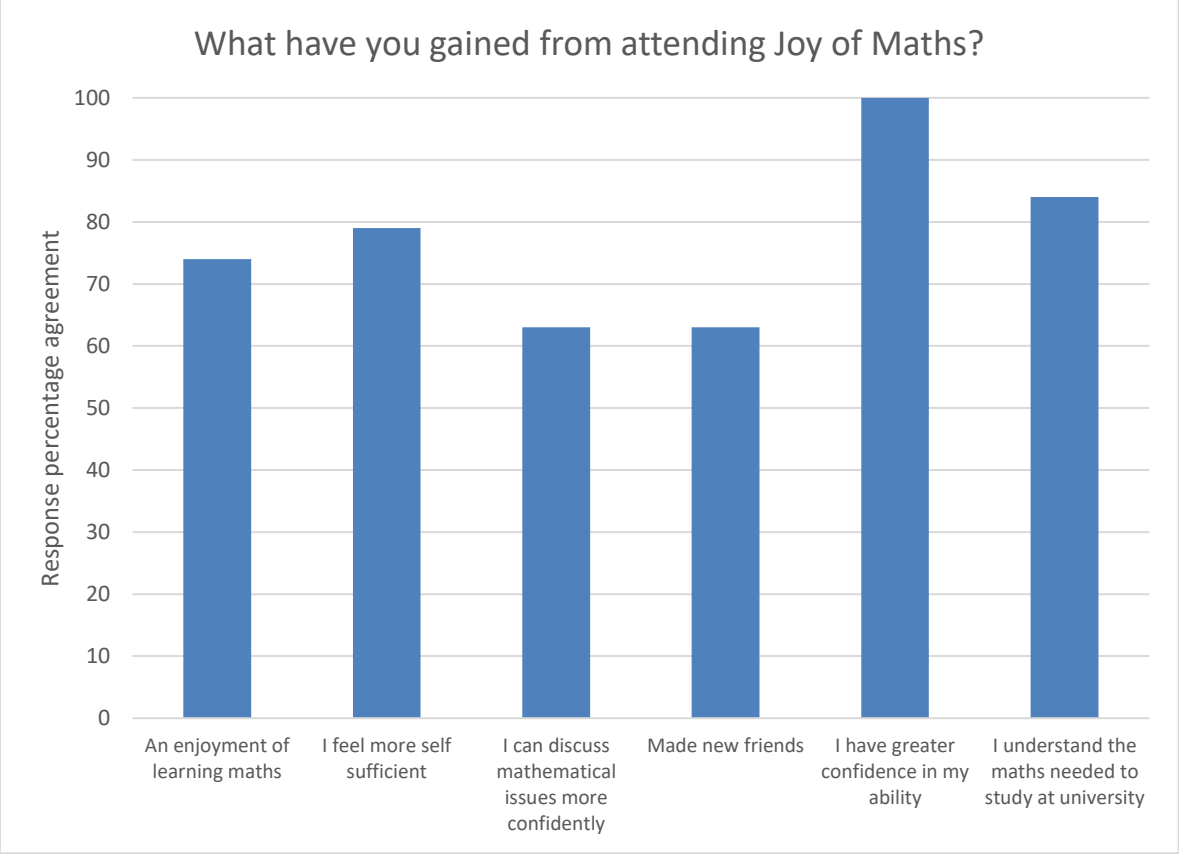

Figure 5. Participant Responses from all cohorts.

participants stated that they were interested or definitely wanted to know more. This shows the transformation from the negative mindset often associated with maths. [4, 5]

When asked, "Do you feel that your view of yourself as a learner has changed in any way throughout Joy of Maths?", a student responded,

> Yes. I felt that if there was a problem that I couldn't solve, I could bring it to class and find the solutions with help.

This shows that where previously they may have got anxious and become disenfranchised, they are beginning to be resilient, problem-solve the situation and seek guidance. Another responded,

> Yes. I always felt stupid and unworthy, embarrassed and fragile without the knowledge I've gained through this course. Now I am confident and interested in what is happening in the world – a door has opened and I know I can learn.

Together these comments show the true transformative nature the programme can have and the variety of impacts from the subject specific to personal transformation.

When asked, "How did you feel about your mathematical ability and knowledge **before** Joy of Maths?", 74% of all participants felt either somewhat negative or extremely negative about their ability. When asked, "How did you feel about your mathematical ability and knowledge **after** Joy of Maths?", only 5% of participants were feeling slightly negative about their ability. The remainder were all positive or had extremely positive feelings. This improvement in confidence is also quantified in the feedback. I also posed to them a series of statements

that they could tick if they felt they agreed with them. In Figure 5 we can see the percentage of participants who agreed with each of the statements. The resounding success of Joy of Maths can be seen in the fact that 100% agreed that they had greater confidence in their ability. Also the fact that 79% felt more self-sufficient is promising in that this new skill set can hopefully be transferred to their future studies.

The design and my role as facilitator are also key factors in the success of the course. As noted by Cornelius-White, the goal of working with mature learners is to "foster development of students and their desire for the topic" by building "authentic relationships where they are spoken to with honesty, warmth and encouragement". [8] It was warming and reassuring that these teaching methodologies were praised in the feedback, with comments such as:

> The tutor has a passion for maths which is shown in her sessions. I felt this has rubbed off on me and my attitude towards maths and learning.
>
> The teaching style and methods made things much simpler to understand.
>
> The ability of the tutor to place herself on the different levels of us students in order to engage us, her ability to find pertinent ways to explain, and her patience. Her enjoyment of teaching was infectious, it was such a good positive learning experience.

As mentioned previously, access to MyMaths is given to the learners at the beginning of Joy of Maths and for the following year. At the end of the Joy of Maths programme the average proportion of learners using MyMaths is 41%, unfortunately after one year this has dropped to 14%. The reason for this drop is not quantified, but after talking informally to former participants, we believe it is because of either life constraints or that the progression in further learning does not need a rigorous mathematical understanding.

Conclusions

The literature shows that maths is a divisive topic for mature learners. We believe we have shown that with patience and enthusiasm we can build confidence and inspire mature learners to progress on their own learning journey. As the content discussed and considered varies for each cohort, the efficacy of Joy of Maths is in the confidence, belonging and self-sufficiency it generates in the learners that partly transcends topic specificity. In the future I would like to trial a taster version of the sessions in the community to allow for better flexibility and to gain further buy-in from community groups that may feel intimidated by and unsure about the University. [15] Also, with the funding provided by the University of Leeds University Student Education Fellowship (USEF), I hope to produce online resources tailored for mature learners to support them further and to reach a wider audience.

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References

[1] JumpStart, http://www.llc.leeds.ac.uk/community-outreach/Jumpstart [accessed 23rd July 2018].
[2] Meyer J. H. F. and Land R. (2005) Threshold Concepts and Troublesome Knowledge (2): Epistemological Considerations and a Conceptual Framework for Teaching and Learning, Higher Education, 49:3, 373-388.
[3] Perkins D. (1999) The Many Faces of Constructivism, Educational Leadership 57: 6-11.
[4] Dodd M., Mathias J. and Nolan S. J. (2016) Teaching Mathematics to Adults: Integrating New and Old Knowledge. In: Marshall C., Nolan S., and Newton D. (eds) Widening Participation, Higher Education and Non-Traditional Students. Palgrave Macmillan, London.
[5] Rycroft-Smith L. and Macey D. (2018) 'Can We Get Every Student to Love Maths?'. TES, www.tes.com/news/can-we-get-every-student-love-maths.
[6] McCabe A. and O'Connor U. (2014) Student-centred Learning: The Role and Responsibility of the Lecturer, Teaching in Higher Education, 19:4, 350-359, DOI: 10.1080/13562517.2013.860111.
[7] Berry J. and Sharp J. (1999) Developing Student-centred Learning in Mathematics Through Co-operation, Reflection and Discussion, Teaching in Higher Education, 4:1, 27-41, DOI: 10.1080/1356251990040102.
[8] Cornelius-White J. (2007) Learner-Centered Teacher-Student Relationships Are Effective: A Meta-Analysis, Review of Educational Research, 77:1, 113-143, DOI: 10.3102/003465430298563.
[9] O'Carroll J., Ennis C., Loscher K., Ryan D. and Dixon N. (2017) Strategies for Enhancing the Mature Student Experience in Higher Education. Dublin Institute of Technology.
[10] Cullity M. (2006) Challenges in Understanding and Assisting Mature-Age Students Who Participate in Alternative Entry Programs, *Australian Journal of Adult Learning*, 46:2, 175-201.
[11] Zakaria E., Chin L. C. and Daud M. Y. (2010) The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude Towards Mathematics, Journal of Social Sciences, 6:2, 272-275.
[12] Reay D., Crozier G. and Clayton J. (2009) 'Strangers in Paradise'?: Working-class Students in Elite Universities, Sociology, 43:6, 1103-1121.
[13] Read B., Archer L. and Leathwood C. (2003) Challenging Cultures? Student Conceptions of 'Belonging' and 'Isolation' at a Post-1992 University, Studies in Higher Education, 28:3, 261-277, DOI: 10.1080/03075070309290.
[14] MyMaths, https://www.mymaths.co.uk/ [accessed 23rd July 2018].
[15] Christie H., Tett L., Cree V. E., Hounsell J. and McCune V. (2008) 'A Real Rollercoaster of Confidence and Emotions': Learning to be a University Student, Studies in Higher Education, 33:5, 567-581, DOI: 10.1080/03075070802373040.

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Katy has a first class (hons) MMATH degree, a PhD in Theoretical Computer Science and a Fellowship of the Higher Education Academy. Since 2003 she has been employed by the University of Leeds as a mathematical specialist working in conjunction with multiple departments to improve mathematical teaching. She has been based in the Lifelong Learning Centre since 2013, teaching and facilitating mathematics and coding on Science foundation programmes and as part of outreach and engagement work with widening participation students.
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