What role does Skill Centre based consultancy serve in mathematics and statistics teaching communities of practice?

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Abstract

Mathematics and Statistics Teaching (MAST) is a staff facing service set up by the University of Bath Mathematics Resource Centre in September 2021. The service was created to collaborate with academics involved in mathematics and statistics teaching in their academic departments. In September 2023, MAST ended its pilot phase and entered a new growth phase fine-tuning existing structures and practices. During the pilot phase, MAST worked with academics consulting on enriching their programme of study and/or teaching practices. Specifically, the key principle that guides MAST is engaging in long-term sustainable collaborations with academic departments. As a means to address the key principle, we explore the potential of building communities of practice and supporting a wider network across the range of disciplines who encounter similar objectives. Facilitating a wider community of practice could be challenging, especially considering the tight schedule of the academics involved. We discuss our plans to cultivate communities of practice within departments and how we are working towards meeting our goal of establishing best practice and collecting evidence to support a wider community.

1. Introduction of the landscape

In 2007, the Mathematics Resources Centre (MRC) at The University of Bath was established. In 2008, the primary service Mathematics and Statistics Help (MASH) expanded and the Statistics Advisory Service (SAS) was initiated. In the years since, MASH and SAS interacted with students with mathematical or statistical questions often in the regular, on campus, drop in. Sometimes 'floods' occurred, where a large number of students came with the same questions within one cohort. The MRC would evaluate the significance of the issue in terms of whether it was likely to affect the learning experience of the specific cohort at large. If the issue was deemed significant, the MRC staff would approach the academic department in question to discuss the difficulty.

MASH and SAS – as primarily student-facing services – could provide limited support to academic departments. Historically, academic departments asked MRC staff to teach some mathematics or statistics content for their department (i.e., service teaching), as a solution to the issue. However, limited capacity meant that the MRC staff could not offer service teaching to all departments. During this operational phase, despite some historical MRC service teaching being present across the university, the University Executive Board confirmed that service teaching was not in the MRC mandate. Subsequently, the MRC did not enter into any new service teaching arrangements and all prior arrangements were phased out. The future for the MRC would involve the support of teaching collaborations, rather than teaching the units themselves.

In 2021, The Mathematics and Statistics Teaching (MAST) service was set up to take on a consultative role for academics (i.e., teaching/research staff within academic departments). MAST was developed

as a staff facing support to academics at The University of Bath who deliver mathematical and statistical content to students within their departments. MAST was established to work alongside the complementary services in the MRC.

The aims of the service are for the MAST team to work with academics and departments to support or enrich existing practice, research and develop new teaching methods within a current module or course, support the creation of new units, and to develop contextualised teaching and learning resources.

During the pilot phase, the MAST offer was based on the team's personal skills and expertise and was not structured in a way that could be sustainable if a team member with a particular expertise left or if the team diverged. The initial services were instigated to enable quick wins that could be delivered in a timely way by the small two-person team. The two people in the team are both trained teachers and are employed as teaching fellows by the MRC on part time contracts. The first author and team member is a lecturer in the maths department in addition to their role in the MRC and has a breadth of experience teaching mathematics in secondary schools in England and abroad. The second author and team member has a PhD in Mathematics Education and pedagogic research expertise. The team's initial objectives were to be supportive to academics while building a series of case studies. The case studies could be used to explore what works and identify a network of potential MAST collaborators with the intention of building a sustainable model.

The growth of the MAST service, in this second phase, focuses on how we aim to operationalise our key principle to engage in long-term sustainable collaboration with academic departments. This growth is underpinned by the idea of utilising and developing communities of practice (CoPs). To take you through our reasoning for this claim, we are first going to briefly highlight the main aspects of CoPs from a theoretical perspective in the following section.

2. Communities of Practice

CoPs are "*groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis*" (Wenger, McDermott and Snyder, 2002, p.4). The main idea behind the conceptualisation of CoPs is that learning is a matter of belonging as well as intellectual processes (Lave and Wenger, 1991; Wenger, 1998; Wenger, McDermott and Snyder, 2002). CoPs emerge in organisations as social learning systems (Lave and Wenger, 1991; Wenger, 1998; Wenger, McDermott and Snyder, 2002). In Higher Education, CoPs has been operationalised as a model for engaging staff and organising professional development opportunities (Hunter-Jones et al., 2009; Moore, Elfving-Hwang and Garnett, 2009; Kilpert et al., 2022).

According to Wenger, McDermott and Snyder (2002), the structure of CoPs can be thought of in terms of three key elements: community, domain and practice. The element of community is considered key for learning in this context. Communities can provide a sense of belonging and trust, encourage interactions and willingness to share and challenge ideas, ask questions, and listen to others. The boundaries of the topic and what activities are considered relevant for a CoP are determined by the subject of shared interest or what is called the domain. The domain creates a shared understanding and an identity for the members of the CoP and it can be the source of inspiration for the members. Finally, the third element of CoPs is their practice. Practice is the set of shared knowledge, ideas and information; shared stories and a common language along with the tools and resources that guides the community's engagement with its domain. When these three elements function well together make a social structure – a CoP – that can develop and share knowledge, thus facilitating learning (Wenger, McDermott and Snyder, 2002).

3. The rationale that led to the current structure of the service

Initially MAST did not have CoPs in mind as a way forward for the development of the service. However, as the collaborations developed, elements of CoPs emerged. The idea of developing CoPs as a means to achieve long term sustainable collaborations with academics and their departments was the product of reflection and self-study during the pilot phase. Self-study is a well-conceptualized methodology grounded in theory and justified by moral, ethical, and political values, making it a trustworthy approach to improving practice (LaBoskey, 2004). Schön (1983) highlights the dynamic nature of practical professional knowledge and emphasises that "*reflection-in-action*" holds transformative value in professional development. In this case, the professional development needed is the knowledge of how to develop a course of action for the MAST service in a way that does not depend on individual goals, skills and priorities. Studying our actions during the pilot phase of the service, we aim to abstract the features that would make the service sustainable. To do so, we use documentation such as our initial action plan, meeting notes, and feedback from collaborators. This methodology allows us to proceed with integrity and confidence, leading to an improvement of the service. Sharing our reflections with the CETL-MSOR community acts as a guard against self-justification.

Reflecting on our activities as a consulting service, we have identified the three elements of CoPs – community, domain and practice – in MAST collaborations. In the following sections we present our reflective accounts through examples from collaborative activities during the pilot phase and challenges we encountered. In Section 3.1, we highlight the three elements in our activity of facilitating workshops for student teaching staff. In Section 3.2, we outline how the three elements emerge in collaborations to review the delivery of mathematical and statistical content in various academic departments. In Section 3.3, we reflect on challenges we encountered along the way which inform our future actions.

3.1 A reflective account of workshops

The MRC had experience of delivering workshops on teaching mathematics and statistics to groups of new student teaching staff who deliver mathematics or statistical-based tutorials and seminars in a department delivering substantial quantities of such tutorials and seminars. These staff will hereafter be referred to as 'tutors'. MAST was approached to expand this offer to provide ongoing support to tutors as they became more experienced. Thematic areas such as interaction and engagement during tutorials or marking and feedback were selected in collaboration with the tutors and the academic coordinator.

We began by consulting with tutors, gathering their opinion on their preferred areas for development to support them in transforming their aspirations into teaching practices. We developed the theme's centred around our own ideas and the tutor responses, identifying an overlapping domain of shared interest and key issues.

We designed the workshops to provide a protected, safe, structured opportunity to share good practice, exchange ideas and learn from each other. The aspect of community emerged as a central pillar to build mutual trust and engagement. The role of the MAST staff was as facilitators, to help tutors set realistic goals to enrich their teaching by providing starting points and concrete activities to develop shared practice. This involved engaging in the conversations and sharing our teaching experiences, introducing tutors to ideas, tools, and resources that they could adopt and build their shared repertoire.

At the time of the pilot, we did not have a framework in mind guiding our collaborations. Thus, the three elements we identified are not necessarily fine-tuned to encourage the development of a CoP In the meantime, our collaboration grew beyond just offering workshops and we established a virtual area on

Microsoft Teams where tutors could communicate and share. We hope this could be a step towards forming an online CoP and provide the opportunity for tutors to continue their development together after this initial input from MAST. This potential online CoP has some prepared resources (curated by the MAST team) that tutors can use directly or as stimuli to create or adapt their own, before sharing back to the community.

Our role is central in the initial stages of this type of collaboration. Reflecting on the emergence of a CoP, we note the requirement of a consultancy, such as MAST, to step back at an appropriate time. This allows the participants, in this case the tutors, ownership over the CoP's future direction. We would still hope to continue as active members of the CoP by sharing news, events, ideas, new tools. However, the tutor's agency will be enhanced when adding their own resources and through their participation and discussion.

3.2 A reflective account of supporting the development of new materials and courses

Other pilot phase activities included reviewing and developing the delivery of mathematical and statistical content with academic departments. Our aim was to collaborate with departmental staff and together identify good practice, priorities, and areas for improvement (e.g., potential knowledge gaps or diverse needs of students) to be addressed.

Products of these activities are the collaboratively designed contextualised resources (e.g., Numbas questions, lecture notes) to aid students transition to mathematics within their discipline of study. First, the idea of developing contextualised Numbas questions as tools for supporting students learning was proposed during our initial collaboration to develop a unit for non-specialists in a department of the Faculty of Humanities and Social Sciences. MASH had an established, positive history, trialling and using Numbas questions (Southwood, McGovern and Hand, 2022) before the MAST service was created. Up until that point in time, MASH was leading the development and use of Numbas resources across the university. However, during this first collaboration the development of Numbas questions became a shared *practice* beyond the MRC and is a corner stone for our collaborations with academic departments. The collective engagement with the development of the questions means that we share expertise, responsibility and knowledge throughout the creative process.

During our collaborations, new Numbas questions are created, and old ones are adapted and shared across different departments with similar needs. The repertoire of shared resources and tools expands to encompass the priorities and ideas developed in each collaboration, as well as new technologies and tools acquired by the university (e.g., Notable for statistics assessments). The role of the academics is crucial, as experts of their subject they provide insight into ways of knowing in their discipline, applications of mathematics and specialists' vocabulary. MAST provides expertise related to students' mathematics education backgrounds, teaching, and learning approaches as well as technical support with teaching tools. In that sense, the development of contextualised resources, such as Numbas questions, can be thought as part of a shared practice during the collaborations.

The modus operandi of the collaborations calls for regular meetings, clear objectives and expectations. During the meetings we exchange ideas, plan, develop and assess our progress. This practice is common across our collaborations and works well with mutual engagement from all parties. For example, one of our collaborations was centred around the development and delivery of the mathematical content in a first-year skills unit for an academic department within the Science Faculty. This collaboration was operationalised under the clear boundaries of a *domain*. The objectives of our collaboration were established during the initial meeting based on the needs, as communicated by the department, and the expertise of MAST staff. The process of reviewing the current content and developing new teaching and assessment materials was a group effort that required mutual engagement of staff in various positions (e.g., the Director of Teaching, the academic who convenes

the unit and administrative staff supporting the delivery) creating a small group with a shared interest of improving the delivery of the unit. During our meetings and email correspondence, the group members would share their ideas, concerns and insight associated with their respective role and the group would carefully listen and discuss them, indicating that the group shared qualities of a small *community*.

The above account covers a number of examples that illustrate how the elements of CoPs arose when reflecting on our varied activities during the pilot phase. However, the identified elements of *community, practice* and *domain* do not provide sufficient evidence to suggest the emergence of well-functioning CoPs.

3.3 Reflecting on the challenges

Despite the overall positive uptake of the service, we have often faced challenges when trying to approach new collaborators. These challenges should be acknowledged and addressed to develop a sustainable course of action, fostering the growth of mathematics teaching practices and developing CoPs.

During the pilot, varying levels of academic involvement and interest have impacted how the MAST service functioned. For example, the development of workshops for student teaching staff would not have been possible without the interest of the academic with responsibility for tutoring. Their promotion and enthusiasm for the development of the tutors was crucial for steering the development of the *community* and identifying its *domain*. In this case we had positive outcomes but in other potential collaboration the schedules, workload and responsibilities of the link academic has impeded, and in some cases halted, the progress of a collaboration. Another challenge is related to the staffing for mathematics teaching which is transient across academic departments and impacting the stability of the potential *community*. Often those who have been allocated to teach the mathematics and statistics sections of courses in a discipline are new or only allocated the teaching for a year. On the other hand, we have also had discussions with staff members who have taught the mathematics and statistics for a long time but sharing their practice with others was not a priority for them at the time. Finally, the MAST service currently operates with two members of staff in part-time roles. Therefore, MAST collaborations required clear distribution of responsibilities within a specific timeframe.

4. Discussion of the developed structure

The reflective accounts presented in the previous section highlight elements of community, domain, and practice that emerged in MAST collaborations during the pilot phase. Abstracting these three elements of our collaborations helps in refining the structure of the service and developing a practice-based and theory-informed course of action. When liaising with academic departments, we realised that there are already various *communities* which could encourage the development of mathematics and statistics teaching and our consultancy has a role in refining the structure and facilitate the *domain* of those communities. In our interactions with academics, we have worked to bring colleagues with shared issues closer together, take part in discussion and use our expert knowledge and skills when needed, to develop shared knowledge and a *shared practice*.

This means we have all three elements: *community*, *domain* and *practice* required to develop CoPs. When the three elements function well together, the CoP is a construct that encourages individuals to form alliances which facilitate learning through the development and sharing of knowledge (Wenger, McDermott and Snyder, 2002). In earlier collaborations, the elements were not necessarily fine-tuned to encourage the development of CoPs. However, we are working on establishing strategies that would allow the elements' co-function grounded on the practice-based literature.

CoP structures emerge in organisations to achieve specific aims and phase out when their aims are achieved or otherwise mitigated (Wenger, 1998). Using this 'ecological' metaphor, the scope of MAST collaborations could be to facilitate professional growth within a CoP when and as the need arises. In relation to the key principle of engaging in sustainable collaborations, framing the MAST collaborations around the idea of building CoPs could help us set boundaries and clear responsibilities for the parties involved. Whilst the timeframe of the collaboration depends on the specific aims and engagement.

Finally, comparing the domains across our engagement with different departments, we have identified that a common area of interest across different departments is to address the mathematical and statistical needs of uneven cohorts due to the various admissions roots. Thus, it might be possible to bring small communities from different departments together and work on common issues. Cultivating a wider community of practice can be challenging, especially, considering the tight schedule of the academics involved. To alleviate the challenge, we are currently working towards building and maintaining communities of practice within departments, branching out to multiple departments whenever possible.

5. Conclusion

In the initial stages of an alliance with a new academic or department we have learned to factor in academic time commitments to ensure we understand the potential scope of the partnership. In the 2-year extension of the service, the MAST team will concentrate on developing mechanisms to support the functions of existing and new CoPs. To this aim, we are reviewing the practice-based literature on CoPs for reports on how to systematically overcome the identified challenges. We are testing different recommendations and approaches, and collecting evidence for evaluation.

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