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Professional development of mathematics academics

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Abstract It is almost 30 years since Morris Kline published his wide-ranging critique of undergraduate education in his book, "Why The Professor can't Teach" [1]. In 1999, Steve Krantz, in his book, "How to Teach Mathematics" [2] reported that academics were paying much more attention to their teaching duties than before. Both of these books were largely about the situation in the USA. This paper explores ideas around the early in-service and continuing professional development of academics and uses examples from several countries.

1 Introduction

Professional development is the increase of knowledge or skill through study, travel, research, workshops or courses, sabbaticals, internships, apprenticeships, residencies or work with a mentor or master. It is often seen as individual and focussed on a particular facet of a person, such as their career, or even a part of their career, such as teaching. It is often focussed at the start of one's career or as you move to a new position.

In this paper we look at the professional development of university mathematics academics and we take a wide view of developing teaching, research and the person as a whole. We also move beyond the development of the individual to the development of teams of researchers and teachers. We believe strongly that professional development has to be seen in a wide frame: if we just try to develop teaching in isolation those who do not see themselves as teachers will not go far. But if professional development overall becomes regarded as usual practice for professionals, and this includes development of research, teaching, and a wider general development (eg learning a new language) then we think there is a chance of a favourable reception from academics.

One consideration when talking about "professional development" or "learning in the workplace" suggests that having an identity as a learner may not be compatible with being regarded as competent (Boud & Solomon [3]). Boud and Solomon further discuss the notion of learning as being put forward using different terms, for example, they point out that in the conceptual work of Lave and Wenger [4] the term "learning" is almost absent and other terms such as mutual engagement and participation are used. Further, various working practices, such as organisational processes, can also be understood as learning practices (Boud & Middleton [5]; Boud & Solomon [3]). We believe that this is also true of academics; as they have done their learning (very successfully with many degrees to show it) and do not want to be placed in the context of being a student again. Perhaps this explains some of the negative reaction to formal teacher training that we report in section 4.

In terms of professional development for teaching, several countries (UK, Sweden and France [6]) have well-developed one-year courses in higher education teaching which are on offer to those new to lecturing. For example, in the UK, titles such as a *Postgraduate Certificate in*

Higher Education Practice (PGCHEP) are used. Most UK universities would offer a course, and these would all be accredited by the UK Higher Education Academy as meeting set standards. The content of a PGCHEP is largely generic, dealing with pedagogical issues common to all subjects. Subject specific learning is normally mediated through a mentor in the new lecturer's department. The Mathematics, Statistics and Operational Research subject centre of the UK Higher Education Academy also offers a subject specific short course to new lecturers on mathematics teaching at university level. Universities offer a staff induction session for new academics to acquaint them with services at their university. Formal provision for continuing professional education for teaching for experience colleagues is not usual.

In the next section we discuss initiatives to increase research output.

2 Research

Academics go through a strong apprenticeship in research. They complete an honours degree (or equivalent) then a PhD and perhaps several post doctoral fellowships. They generally have strong publication records by the time they are appointed as an academic. There are often prizes at conferences for the best student presentation so research students are encouraged to refine their presentation techniques.

There is considerable pressure to publish and continue to publish throughout an academic career. Nevertheless, at different points in people's careers they need assistance with research and research writing. As pointed out by Burton [7], research mathematicians do not receive training in writing and the expectations of writing are not clear. McGrail et al ([8]: p. 24) make a similar point.

Even though the ability to write for publication is a key skill for an academic staff member to possess, most staff will not at any stage of their career, whether as a student or as a staff member, be directly taught how to write for publication in refereed literature. In most cases, it is expected that they will have already attained a medium level of written communication, and will be able to learn on-the-job the more specific academic writing skills needed. However, this is not always the case and some universities have introduced writing courses, believing that their staff will benefit by attending these.

Several ideas have been suggested to increase the quality and quantity of academic writing. McGrail et al [8] published a review of interventions to increase academic publication rates. The dominant model was that of writing support groups. These consisted of peers regularly meeting together to provide a combination of encouragement, discussion, feedback on manuscripts and/or writing time. Regular meetings seemed to be the key feature as it kept the participants more goal oriented and motivated. The second most frequently reported intervention was the provision of a course in writing for publication. Experts, usually senior academics or professional editors led the writing courses. Participants were provided with didactic and written information about the writing and publication process. Most required development of a draft manuscript during the course. A couple of universities provided professional writing coach for staff to assist with one-to-one development of writing. For all of these interventions, increases in publication rates were noted.

An interesting development in Australia has come out of the Research Quality Framework exercise where academic staff are encouraged to be part of a research team rather than working individually (DEST [9]). The Federal Government appears to be favouring research teams rather than individuals. This appears to be similar for teaching grants from the Carrick Institute in Australia where consortia of universities and groups are favoured.

As part of the professional development program for the mathematics department at the University of Auckland, NZ, the Head of Department (HoD), Bill Barton is running a trial of research writing pairs (using Boise's ideas to increase research writing output [10]). At the University of Technology, Sydney (UTS), new academics are encouraged to form writing pairs and UTS are experimenting with a more formal use of a mentor and formal workplans to assist new and continuing academics to set their goals.

3 Teaching

Research can be funded selectively on the basis of excellence - but the country can't afford not to fund teaching to be excellent everywhere. I believe passionately that every student, wherever and however they are taught, has the right to be taught excellently.

Professor Janet Finch, Vice-Chancellor of Keele University, UK [11]

Is mathematics substantially different to other disciplines? Should it be taught in a different way? This appears to be the crux of the debate about courses to develop the teaching of university mathematics academics. At the University of Auckland, the university professional development unit (CPD) is moving from generic to subject specific modes, the HoD there believes that the answer lies in taking this into our own hands rather than relying on generic university responses.

In UK (here we quote the Education Secretary of the London Mathematical Society)

... we {the LMS} undertook a survey of Heads of Departments of Mathematics. We received detailed responses from over twenty universities, including the majority of research-intensive single-subject programme providers. These showed a remarkable degree of consensus, both on the problem and on the right way to solve it. All of our respondents believed that the HE sector needs high-quality, fit-for-purpose courses for new teachers, but very few felt that the current system provides this.

The main criticism of the current courses is of their reliance on generic methods and learning theory which are felt to be largely inapplicable, and far-removed from the practicalities of teaching, in mathematics. Learning in mathematics requires a complex interaction between the acquisition of demanding technical skills and the development of new ways of thinking which are at once rigorous and intuitive. The generic courses cannot realistically begin to engage with this, and to do so requires a course supported by those, both in the Subject Centre and in departments, who have grappled with these problems themselves.

The negative and even combative tone of many of the responses we received was largely, it seemed to us, due to the lack of such engagement. ...The outcome is the alienation of new lecturers, and the perception of the courses as unhelpful and burdensome. [Circular e-mail to HoDs, 14 Mar 04]

4 Comments from participants

We have been conducting a survey of heads of mathematics departments about professional development in their departments (<http://surveys.uts.edu.au/index.cfm?surveyid=1230>) and report here on some preliminary results. These are qualitative and give a flavour of responses to questions of professional development. A similar survey has been conducted by the LMS in UK and we will discuss the findings in our conclusion.

The tension between research and teaching (indeed between research and anything else) is clear in many comments.

4.1 New staff: induction

Heads of department made the following comments about usefulness of the induction programs for their new staff. Some Heads stated that it had been a long time since they had had any new staff: a reflection on the state of mathematics departments. When we consider the variation in responses, we observe that some programs are working better than others, at least from the perception of the Head of Department. It is worthwhile noting that induction programs are not all the same and that it would be wise to investigate programs that are successful rather than condemn all programs as useless.

1. The training is generic and reports from staff say it does not correspond very closely to the practical requirements of a new lecturer in maths. It absorbs a LOT of time which puts them under even more pressure at a critical point in their career. We are a research led University.
2. The course is highly generic and staff are frequently demotivated by it. There is often very little relevance as far as they can see.
3. There are too many unspecific components. Staff find it a heavy drain on their time for relatively little benefit.
4. It is useful for a new member of staff to find out about the ways of the institution, since different universities can have quite different cultures, assumptions, procedures, etc. It has to be said that the two days are, of course, overloaded with information, so the real learning takes place on the job, but the icebreaker is valuable as a chance to talk about uncertainties and (important) meet other people in the same position.
5. First, the evaluation by the new lecturers is very positive. Second, and most importantly, it enables them to produce high quality teaching materials (the materials being open to scrutiny by the wider world).

4.2 New staff: formal teacher training

The majority of the comments below are from UK universities where the PGCHEP has been running for some years. The main deficiencies (again from the HoDs point of view) are the lack of subject-specificity in the offerings.

1. Career progression for staff is based primarily on research performance. Deficiencies in teaching performance as perceived by students (the main determinants of teaching success) relate to problems which are not addressed by such bits of paper, e.g. inability to speak English sufficiently well or motivation to help particularly weak students unwilling to help themselves.
2. Too generic. Doesn't reflect the full job of an academic
3. This needs to be tailored more to the needs of the individual lecturer and less to some notion of qualification so that boxes can be ticked to say training has happened. The MSOR network training appears to be more useful.
4. Many of our new staff have attained the PG CERT HE and have benefited from this, but it is still lacking in a subject specific component to give it top marks.

4.3 Continuing staff: teaching development

Continuing staff were encouraged to improve their teaching in a variety of ways, such as peer review, teaching awards and encouragement to compete for a National Teaching Fellowship. The following quote gives the flavour of many respondents:

We support people who go to courses but do not put pressure on them (Research is top priority provided the students are not rioting).

We also asked *Are there ways in which teaching staff are hindered in their teaching?* and received a long list of difficulties including; not enough time, too much administration, large classes and a shortage of academic staff. Several respondents focussed on the culture of the university and the pressure to do research. In some cases student evaluations were not shown to the teaching staff but kept by the university administration. This was seen as a hindrance to teaching. Two comments below sum up the difficulties that mathematics lecturers face.

Often the blackboards are broken. You have to bring your own chalk and duster. The OHP is occasionally absent, occasionally broken; screens for it are non-existent. Rarely, the lecture room's lights are broken. Students often cannot afford to buy the prescribed textbook. Photocopying lecture notes for students is a difficult procedure.

There is always insufficient time to do everything that is required of an academic. Classroom equipment should be updated more often. At present there are still some classrooms without a data projector. No classrooms have electronic whiteboards as yet. Classroom space is at a premium and hence it is difficult to experiment with different teaching room layouts.

4.4 Sessional staff: induction and teacher training

About one third of the departments who replied to our survey conducted orientation programs for sessional or short-term staff (generally tutors). One said that they were assisted in their teaching *informally, by old hands, as do the permanent staff appointees*. Other departments have comprehensive training for sessional staff, often run by the teaching and learning unit of the university. Some departments run their own training for tutors, for example; the University of Auckland and the University of Technology, Sydney. This was not seen as a priority.

4.5 Teams

When addressing student and teacher learning, the context of a team approach can enrich the professional learning of the team members and create a context that supports change (Balach & Szymanski [12]; Drew & Vaughan [13]). This came out clearly in a few of our respondents, for example:

The course team process is a major source of on-going staff development. As well as periodic discussions stimulated within the university and university, e.g. on extending the use of elearning and ICT, the university's Institute of Educational Technology undertakes research and organises courses and seminars on effective teaching at a distance. In addition, the university offers internal teaching fellowships to fund research on teaching and, most recently, the university has been awarded 4 CETLs, one devoted to the teaching of maths and physics which has funded substantial buy-outs for fulltime staff and for Associate Lecturers to research maths teaching methods. I should add that the faculty has always supported proposals to develop one's teaching, if funds permit.

Again, Bill Barton at the University of Auckland, is trialling:

- direct input into the development of teaching teams;
- peer support of teaching pairs (involving mutual observations and meetings).

This is a promising way of working to improve the teaching of all staff.

4.6 Research into teaching and learning mathematics

One of our survey questions asked whether research into teaching and learning mathematics was encouraged and heads of department were asked to explain their answer. Here we note some of the explanations. The answers point to very different cultures in universities. A comment made similarly by two HoDs was:

We have found that the most effective teachers are those who are the best mathematicians; so we encourage lecturers to do research into pure or applied Mathematics, to form research groups (e.g. the Graph Theory and Cosmology groups collaborate more fruitfully and joyfully than our maths educationists). For several years the most positive student assessments have been earned by one of the most highly rated researchers in the department.

We could think of several counter-examples to that statement! However it points to a link between research and teaching that furthers our conviction that professional development should encompass teaching, research and the whole person. An academic who is achieving in one area of their career and life will also feel more confident about tackling new and exciting developments in other areas.

Question: *Are new staff actively encouraged and supported to conduct and publish research into the teaching and learning of mathematics?*

For those who answered no:

- Research into teaching and learning maths is seen as an easy option, not ‘real’ maths, and derided.
- There is more than enough hard mathematical research to be done
- This is a mathematics department, not a mathematics education department.
- Nobody cares about such things

For those who answered yes:

- Yes, funding is also available for research and to attend Conferences on Teaching & Learning Math
- The University's career structure for the “teacher”, as opposed to the “researcher”, encourages staff to publish pedagogical scholarly activity.
- Teaching is left to the individual lecturer.
- Yes, staff are encouraged by me as HOD to conduct and publish research in LTA in mathematics, although a different HOD might not be so encouraging as they might have different priorities. There is some possibility to join in generic faculty level development projects, and to bid for development money for projects with a more specifically mathematical aspect. Research per se is only given a time allowance if explicitly supported by external grant funding. There are those without external funding who just do the research in their “own” time - i.e. they do not get an allowance on their workplans for it. Carrying forward the Mathematics LTA agenda means walking a path under the influence of various forces. Corporate pressures tell us to spend less time on Learning and Teaching, and this can distort which research and development projects are accepted. Corporate pressures also seem at my institution to be leading to generic projects relating

to corporate aims. Disciplines can join in with these and interpret in their context. However it is also still possible for projects to be instigated within a discipline area, and this does indeed happen - financial support for this can come from the Teaching Quality Enhancement Fund, or from funding for widening participation, as mathematical skill level is recognised as a key issue for many students across a whole range of disciplines.

5 Conclusion

In UK, in particular, there is a call for early career teaching development that is subject specific. In other countries it is not so clear and it may depend on the quality of the generic programs and the links made within those programs to the subject areas. There is significant benefit in stepping outside one's discipline and observing what others take for granted. Are we being a little too precious about mathematics?

In terms of our survey, all universities valued research. There was a divide between the cultures of universities which valued teaching as well and where academics could take a route of teaching as a career and so become a researcher in mathematics education. New staff received some training in teaching and induction to the university. This was not common for sessional teaching staff. Professional development for experienced staff was neither encouraged nor discouraged but left up to the individual, with some encouragement with teaching awards, conferences and grants available in some institutions. Most saw developing and spending time on teaching and learning as taking time away from research.

Several universities are investigating ways of increasing research output by developing the writing of their staff. This includes writing grant proposals.

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