TEACHING & LEARNING
RESEARCH INITIATIVE
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Mathematics Enhancement Project: Professional development research

This Teaching and Learning Initiative (TLRI) project on professional development was conducted within the context of the Mathematics Enhancement Project. The Mathematics Enhancement Project involves the Mathematics Education Unit of the Department of Mathematics, University of Auckland, working with senior mathematics teachers in low-decile secondary schools in the Manukau region. The intention is to create a mode of professional development for these schools that can be used elsewhere in New Zealand, that is realistic in terms of cost and resource input, and that will increase the participation of students in tertiary education courses with mathematical requirements.

This TLRI project was situated in the teacher development component of the Mathematics Enhancement Project during the years 2004–2005. Our preliminary research had confirmed other studies that professional development of teachers requires their active participation in investigating aspects of their practice in ways that take account of the systemic problems of their particular environment (in this case, low-decile schools). The project, therefore, set out to establish whether and how teacher research could form part of effective professional development.

The project involved 27 teacher–researchers and six university–researchers in an ongoing research community that produced quality research on the mathematics learning of their classes. De facto, the 17 research group meetings held during the course of the project, were professional development sites where best mathematics teaching practice was discussed and support given for classroom changes. In the first year, participating teachers were grouped into six predetermined research studies as research partners. In the second year, teachers could choose to be involved in their own classroom-based studies, and a further study was added to the six original ones. The teachers were inducted into critical research processes and thus gained insights into their practice as part of a professional community that included research as part of professional practice. The whole process was researched for its effectiveness as professional development.

Project aim and objectives

The specific aim of this research was to investigate the effectiveness of research activity as a professional development strategy for senior mathematics teachers in low-decile schools. The objectives were to:

- involve all project teachers in secondary research projects as active participants;
- research the barriers and effective motivators for these teachers' involvement; and
- research the effect of involvement on the teaching practices of each teacher, and on the community of practice of the project teachers as a whole.

Research questions

The main research question was:

1. Does involvement in classroom research lead to positive changes in teacher behaviour and classroom practice for senior mathematics teachers in low-decile schools?

Research questions for each of the seven studies that eventually comprised the active research component were:

2a. Will participation in new mathematics learning cause teachers to reflect upon their own classroom practice and lead to changed teaching behaviour?

2b. How can peer mentoring be established between teachers in participating schools, and how will any mentoring established affect their practice?

2c. How do students come to see themselves as effective mathematics learners, and how do teachers come to see themselves as effective mathematics teachers.

2d. What agreements are formed between teachers and students regarding mathematics learning in the classroom, and how are these established?

2e. What are students' conceptions of calculus at senior school level, and how do these compare with their conceptions at university?

2f. What use is made of Tongan and Samoan language in the classroom amongst speakers of those languages, and can an understandable mathematical discourse be established?

2g. What characterises whole-class discussion in senior mathematics classes, and what are its effects on student learning?

In addition to these explicit questions, some teachers developed their own smaller classroom studies. In general, these were not formalised, nor did they get to the stage of formal reporting beyond verbal accounts of their investigations to the teacher meetings. The questions investigated all fall under the same umbrella question:

3. What aspect of my classroom mathematical practice might I change in order to improve student learning, and how could I achieve this change?

The participants

The participants in this project were the teacher–researchers themselves. All were teachers of Year 12 or Year 13 mathematics with statistics or mathematics with calculus classes in decile 1 or 2 schools in the Manukau region. Of the 27 teachers who became involved at one stage or another: 20 were educated, trained, and/or had taught outside New Zealand (10 were recent immigrants); 12 had a language other than English as their first language; 12 had mathematics majors in their degree while 4 had no university mathematics background; and 14 moved to the project school or away from it in the two-year-period of the study.

In summary, the group was varied in cultural background, language background, and mathematical training. It was transient, and represented the full age range from first-year teachers to those with 30 or more years' experience, with two teachers having remained in their same positions for more than 10 years.

Methodology

The primary and secondary research studies used mainly qualitative methods, predominantly classroom observations, interviews, and written feedback from the teachers and research leaders. A second emphasis running through all studies was that of triangulation. This was achieved by the sharing of results from different parts of the studies. At the university–researcher meetings, results obtained that were relevant to each others' studies were discussed and hard data shared if appropriate.

Each of the projects operated separately under its own methodology, as outlined in the reports of the individual studies in the appendices to the full report of our research.

The classroom studies undertaken by the teachers themselves can be characterised as action research-like methodology, but they did not reach any formal stage.

The project was fortunate to have the involvement of a number of overseas researchers who visited the University of Auckland during the period of the project. Their advice, comments, and critiques were most valuable to the research team.

Findings and limitations

In this summary, only the findings of the main research question are reported.

The project was designed with the intention of a team of university mathematics education researchers leading groups of teacher–researchers working on substantive research topics. Although these research projects were more or less successful in themselves, they were not effective in involving teachers in a substantive way in critical evaluation of mathematics education issues in their classroom. This was largely due to a lack of appreciation of the difference between a researcher's research question and a teacher's research question.

The approach used in the second year was more successful, although substantive research was not forthcoming. It is possible that formal research of an action-research style might be forthcoming if more than one year was available, but we feel that this is unlikely. The style of research practicable for these teachers in this context is more like a guided study than formal research. However, the involvement of teachers, and the development of a critical perspective on their practice, did emerge.

In the first year, the university-based researchers unwittingly made themselves indispensable to the classroom-based research. They undertook to visit teachers in their classrooms, and most of the research activities took place through their lesson observations and subsequent discussions. In the second year, our visits to classrooms were much less frequent. Time was spent in each meeting discussing the research activities that were taking place, and in these the role of the university-based researchers was predominantly to take notes and re-focus discussion. Participation in a discussion of other people's research was valuable for these teachers.

The development of a community of practice also seems to have had a bearing on the greater success in the second year. The success of the model adopted in the second year occurred at the same time as the community of practice developed. Where any causal relationship lies cannot be determined, but we believe both that the research activity could not have been successful without the developing community, and that the research activity contributed strongly to this development.

The teachers' changing approach to research was a measure of their growing confidence in themselves. Although they rejected the pre-organised model of the first year, and turned to individual critical reflections through the second year, at the final meeting they requested that any continued research focus be done in clusters of teachers working together on the same idea. That is, they appeared happy to return to the first-year model, with the difference that they would do the predetermination. They had the confidence that they could choose suitable topics and conduct research in equal collaboration with university–researchers.

The project enabled some theorising of this situation. It was possible to identify two features of teachers' engagement that made reflexive practice more difficult. (Reflexive practice means activities that bend back on to the subject; that is, practice that then affects the practitioner.) One feature came to be called "the dragon": This was a fear of being exposed as inadequate as a teacher. The difficulties of these schools made teachers feel close to the edge of failure, and thus any change was a danger. The second feature was that of teacher identity. All teachers construct themselves in such a way that they have means of coping when things go wrong, and they are deeply emotionally connected to these constructions. In order to engage in reflexive practice, such mechanisms need to be put aside so critical self-examination can take place. We theorise that herein lies the mechanism of the community of practice. Successful participation in the community is a necessary and sufficient condition for these two features to be put aside.

The two main findings are that:

- Research can be an effective strategy for professional development, but the nature of this research will only be effective if it is:
  - undertaken from the point of view of the teacher; and
  - undertaken at a formality that is commensurate with the experience and intentions of the teacher.
- Involving teachers in any sort of research leading to critical activity is interrelated with the development of a fully functioning community of practice.

Another way of saying this is that the role of research in professional development is that it can enable teachers to be engaged in a different way in the classroom. Formal research is probably only possible if the teacher steps out of that environment (for example, to do further studies). Research has the benefit of empowering teachers to tap into their own interest and enthusiasm.

There is also evidence that the input of external researchers is necessary, but as organisers and research guides, rather than as research leaders.

Furthermore, we now believe that the role of research in professional development is not what we expected. While we still believe that critical classroom activity is a worthwhile objective, we now view the major aim of professional development as the formation of a community of reflexive practice. Indeed, such a community is probably a prerequisite for teachers being critical practitioners and transforming their classroom behaviour. Thus, our finding should be reinterpreted as that research activity is an effective contributor to the development of a community of practice.

Recommendations

1. It is recommended that professional development initiatives of all kinds be designed to maximise their contribution to a sustained community of reflexive practice, that is, a community that functions on a wider scale than the particular initiative being considered.

2. Involving teachers-in-practice in classroom-based research must take account of their point of view towards research and their practical situations. This may involve a re-thinking of what constitutes research.
3. Research by teachers is primarily to be seen as a vehicle for engaging in a different (critical) way with their classroom practice, and can be used to tap into their enthusiasm and interest.
4. Professional development for teachers needs to be sensitive to their emotional needs, which may include defensive strategies that are initially counterproductive to change.
5. For senior mathematics teachers, the subject of mathematics itself can be used as part of effective professional development, and for some teachers is effective for tapping into enthusiasms.

In conclusion, we are sure that this has been a positive involvement for the teacher–researchers, and compares extremely favourably with other professional development experiences.

The full reports of all TLRI projects are published on the TLRI website (www.tlri.org.nz).

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