Factors affecting the implementation of reforms in secondary school mathematics

<u>Naomi Chissick</u>, Head of Mathematical Studies, ORT Israel

Abstract

The last 25 years have seen a growing reform movement in mathematics education in many parts of the world. However, implementation has been slow and difficult. The study described here aimed at:

·   examining the factors affecting the implementation of reforms in secondary mathematics education;
·   grading these factors in order of importance;
·   studying mathematics teachers' self-esteem and its impact on implementation of reforms.

The study combined socio-cultural and psychological perspectives with educational perspectives. All three fields involve intricate relations between people; thus the hermeneutic approach has been adopted. The study was inductive, naturalistic, and relied on fieldwork for data. It followed cycles of data collection, interpretation, theory building, and more data collection, to verify the theories and uncover more information, in line with grounded theory approach. A variety of methods were used for analysis, mostly qualitative. Case studies were undertaken in two secondary schools, and vignettes from seven other schools were analyzed.

The study offers new insights into the roles that different factors play in implementation processes, and discovers their relative importance. The evidence suggests that strong, united and supportive school teams, and a Head of Department with leadership qualities, are essential starting points for the effective implementation of reforms. Contrary to expectation, it turned out that teachers' self-esteem played only a minor role in the process. External and contextual factors may hinder reforms, but were found to be low in the emerging hierarchy of reform implementation factors.

Further research is needed to determine how to sustain the process of professional development initiated in such reform projects.

Background: Changes in mathematics teaching

During my work with mathematics teachers in the last 17 years, I have come to appreciate the intricacy of their work on the one hand, and its importance and impact on the other. The research described here stems from my experience as a teacher, HoD, supervisor and teacher-educator in secondary mathematics education in Israel. The research studied teachers – the factors that affect them in relation to reforms and innovations, and the hierarchy of these factors in their view.

The Israeli School System is facing the challenges of reform in various ways. The Ministry for Education and Science and the Departments for Science and Mathematics Education in the Universities and Colleges have been working for years on developing new teaching materials and training new teachers and in-service teachers in new teaching methods. However, the new approaches have penetrated into very few schools, and many teachers

continue to teach the way they always did (Chissick, 2000). Thus, a study of the factors that affect the implementation of reforms seemed necessary.

At the same time the study can be perceived fundamentally as an enquiry into adult learning paradigms. Knowles (1990) developed a theory for adult learning, or *Andragogy*, that differs from other forms of learning in the following aspects:

- adults are self-directed and expect to share the responsibility for decisions (this is in line with Wenger's (1998) *negotiated mutual engagement)*;
- adults want to know why they need to learn;
- adults want professional learning to be based on experience and be relevant to their immediate needs and practice;
- adults want their professional learning to be collaborative and centered on peers;
- adults want their learning to be problem-centered and not necessarily content-centered.

In the study, I have looked at teachers' learning as a professional development process in a social setting. A project for implementation of reforms in the didactics of mathematics teaching (PIRM) was examined through the eyes of the teachers involved.

PIRM

Fullan (2001) differentiates between *restructuring*, which can be done by authorization, and *reculturing*, which deals with how teachers come to question and change their beliefs, and as a consequence, their practices. He claims that *reculturing* is what is needed these days, and that it proves to be much more difficult than anticipated (p.34).

In PIRM, a project that I ran for ORT (a network of Colleges and Schools for Advanced Technologies and Sciences in Israel) with the aim of implementing reforms by creating a culture of teamwork, collaboration and continual professional development, we tried to promote *reculturing* with as little restructuring as possible.

The project was designed to answer the needs of mathematics teachers in times of reforms and changes. It was conducted at a period when the mathematics curriculum was on the national agenda, and mathematics teaching in Israel suffered severe blows.

The project aims were:
- to develop a culture of long-lasting professional learning and growth of mathematics teachers and mathematics teams;

- to encourage teachers and teams to try out new concepts and methods in mathematics education;
- to enhance constant reflection on teaching and assessment practices;
- to create communities of teachers (from different schools) that will take part in professional discussions, and will share materials and experiences for the benefit of all.

We tried to create a culture that will enable teachers to make lasting changes in their professional behavior - including processes of continuous learning and growth. The core of the project was the guidance and support given to the teachers to build a framework for collaboration and teamwork, to strengthen the status of the HoD and to reconsider their teaching methods. PIRM was based on:

- constructivism as the leading knowledge paradigm;
- Planning –Action – Reflection (Schon, 1983) in teaching and in teachers' learning;
- teamwork in the school and between schools;
- in-school support for the teachers and HoD by facilitators, once a week, for three years (Chissick, 2002:3).

It was assumed that professional development of teachers, both personal and as a team, should lead to improvement in students' mathematical thinking, learning schemas and achievements. The suggested instructional approach for PIRM was derived from social constructivism (Vygotski, Jaworski 1996) and the Social Practice Theory (SPT) of Lave and Wenger (1991).

The strategy was under constant review in order to improve the implementation methods, find ways to cope with resistance and promote renewal and regeneration of new ways in mathematics education.

The project was run for three years (1999-2002) in seven schools in the first year, and 13 schools in the third one.

Research design and methodology

"The biases of our careers, our personalities, and our situations constitute essential starting places for our research attention" (Wolcott, 1994:408).

The research and the research questions evolved from my deliberations while planning PIRM, and from discussions with colleagues of the difficulties encountered during its operation.

The primary research question (**P**) was:

What are the factors affecting the implementation of contemporary mathematics teaching practices in secondary schools in Israel?

The secondary research questions (**S1; S2**) were:

What is the hierarchy of the factors affecting the implementation of reforms in secondary school mathematics in Israel?

What is the place of the mathematics teacher's self-esteem in the hierarchy of factors affecting the implementation of educational innovations?

All three questions attend to gaps in knowledge that need to be studied in order to improve and rejuvenate projects like PIRM.

The research combined socio-cultural perspectives and psychological perspectives of teacher change. This approach of co-ordination between perspectives was chosen because it seemed to be most suited to the problem at hand. The combined approach lies within the field of educational research and allows penetration into the area of change processes in organizations.

The conceptual framework of the study emerged from the research questions, my basic philosophical stance and extensive reading on the different research paradigms. It combines socio-cultural aspects, psychological aspects and theories of change in educational setting.

The research was designed around the following theoretical and philosophical theories: hermeneutic as a leading philosophy and the constructivist learning paradigm as a leading construct, combined with naturalistic and inductive approaches and grounded theory. The interpretive and the constructivist approaches that were used have roots in hermeneutics: they both aim at understanding human experience through the eyes of people connected to it.

The research followed cycles of data collection, interpretation, theory building, and more data collection - to verify the theories and uncover more information, in line with grounded theory approach (Glaser and Strauss, 1967). Data was accumulated from facilitators' reports and other project documents as well as interviews, observations and questionnaires. A variety of methods were used for analysis, mostly qualitative.

Case studies were done on two secondary schools, and vignettes from seven other schools were investigated.

Findings and discussion

The factors affecting implementation of reforms in secondary school mathematics education are many and varied. They include field conditions (time, administration's support, teamwork and peer support, external intervention, external exams) and psychological conditions (teacher's self-esteem, belief system and recognition of the needs for change).

The study offers a new insight into the roles that the different factors play in implementation processes, and discovers their <u>relative importance</u>. This is a theme that has not been studied before to the best of my knowledge.

The hierarchy of factors was drawn from the coded data, the observations, questionnaires, interviews and written reports, combined with the grading of factors that teachers were asked to do at the end of PIRM, in a questionnaire distributed to all the teachers. The questionnaires were anonymous, but teachers had the option to fill in their names if they so wished. Out of 85 teachers, 64 (75%) responded. The grading was between 1 (high) and 10 (low), and are presented below:

Factor	Rank (Ave. grading)	Comments
Teamwork	1st (3.22)	In school A (an Arab school) the rating was significantly lower (6.125). The reasons seem to be cultural.
The HoD	2nd (4.64)	Schools A, M and AE rated much lower (6.5; 6.43; 7.5). In School AE the HoD was younger and less experienced than the other teachers. School M will be discussed in the Chapter 11.
The facilitator	3rd (4.72)	There is a significant difference between groups here. Schools NH, AE and A rated 7.8, 8.5 and 6.125. All three were only two years in the project and have very mature teams. On the other hand, AH and NE had the same facilitator, very mature and knowledgeable, and their rating was high (1.33, 3).
Teacher development sessions (teamwork sessions)	4th (5.17)	Here School F, a vocational school, rated the sessions much higher than the others (2.33). This may be due to their unsatisfactory level of mathematical knowledge and agrees with their rating there.
The ORT supervisor and head of PIRM	5th (5.58)	School AE (new at ORT) gave a relatively very low rating.
Time	6th (5.82)	
Teachers' mathematical knowledge	7th (6.21)	See comment in 4th place.
The school's administration	8th (6.90)	
Shortage of suitable textbooks	9th (7.08)	

Factor	Rank (Ave. grading)	Comments
External examinations	10th (7.40)	Teachers realise that external examinations bring changes in content only, not in teaching practices.
Pupil's opposition	11th (8.13)	
Staff-room atmosphere	12th (8.67)	
Co-operation with teams from other schools	13th (9.33)	In PIRM, only the facilitators and HoDs had contacts with other schools.

Factors 4 and 11 may be particular to ORT as a network.

The data strongly suggests that the major factor that supports reforms' implementation is the community-of-practice that surrounds the teacher, supports him/her and shares the responsibility.

In a meeting held with one of the team nearing the end of the project, teachers said:

I have learnt a lot from my colleagues. how to deal with the syllabus, what is important.

I know what each of my colleagues is teaching.

To this day I use 'tricks' that Mira and Ayala taught me.

Here I learn…

This is a warm group. I feel fantastic. I am not ashamed to ask…

Everybody helped me. I arrived, a new immigrant, not knowing what to do.

A strong team was formed. This is stable, there will be no retreat.

We have discovered the strength and the possibilities in collaboration.

The Head of Department and the external facilitator also play a major role as leaders of the team.

Hargreaves (1994) enlarges on this phenomenon. He argues that some of the elements that make teamwork so important in reform situations are moral support, increased efficiency, reduced overload, reduction of uncertainty, increased capacity for reflection, opportunities to learn and professional development. However, teacher educators should be aware that collaboration or controlled teamwork might cause complacency and encourage teachers to rely on others and relieve themselves from responsibility.

Psychological literature rates self-esteem as the most important element that rules our lives and guides our behavior. However, mathematics teachers' self-esteem was found, in this study, to be no different than other teachers', and its effect on implementation - irrelevant. However, one may assume that a strong team strengthens its members' self esteem.

Contextual factors were found to play a minor role in the process. High workload, no set time or place for team sessions, and lack of suitable teaching materials prevent the team culture from developing and changes in teaching practices from being tried. Evidence also shows that external, top-down changes lead to changes in curriculum, but not in teaching practices.

Thus, the findings suggest that a strong, united and supportive school team, with a HoD who has leadership qualities, is an essential starting point for an effective change process.

To conclude:
1. The socio-cultural factors are the major force in the change process.
2. Contextual factors are important in enabling or hindering change processes.
3. Psychological factors were found to be not as important as psychologists assume.

I would like to stress that the factors affecting implementation of reform cannot be separated into distinct categories. Therefore, I refer mainly to the factors themselves and not to their domains. However, I would like to present the findings as they inform two groups: the teachers and the education authorities.

Teachers tend to work in isolation. They are alone in their classes and usually have to take full responsibility for their pupils' achievements or failures. In addition, professional burdens and personal circumstances prevent many of them from joining professional courses. Thus, the process of continual learning and professional development is not an integral part of their agenda. Teamwork, as described here, supplies the opportunities for learning both content and didactics on the one hand, and the umbrella of collaboration and shared responsibility on the other. Teachers should allow this to happen, by allowing the time and opening their minds and hearts to learning and sharing.

Most of the findings inform authorities and administrators (principals, teacher educators and supervisors in particular) too. In line with the principles of Andragogy mentioned earlier, teachers should be allowed to be active participants in the design and planning of their professional development processes. In addition, field conditions should enable and enhance these processes.

However, further study is needed on the *effectiveness and preservation of reform implementation* in education in general and mathematics education in particular. Implementation of reforms take a long time, and the results tend to fade with as time goes by.

The results of this study strengthened me in my belief that professional development strategies for mathematics teachers should follow the principles of the *social practice theory*.

The acquisition of knowledge in the traditional sense that used to be done through courses and seminars should become part and parcel of the community-of-practice activities, in the teachers' natural setting: the school.

References

Chissick, N. (2000) *'In-Service Teacher-Training: Implementation of New Teaching Practices in High-schools'*. Paper presented at the 9th International Congress on Mathematical Education (ICME), WGA7, Makuhari, Japan.

Chissick, N. (2002) 'Factors affecting the implementation of reforms in school mathematics'. In Cockburn, A.D. and Nardi, E. (Eds.) *Proceedings of the PME 26th Conference,* Norwich, UK. Vol. 2, pp. 249-256.

Chissick, N. (2005) *Factors affecting the implementation of reforms in secondary school mathematic*. A PhD thesis, Chelmsford, UK: Anglia Polytechnic University.

Fullan, M.G. (2001) *The New Meaning of Educational Change.* New York: Teachers College Press.

Hargreaves, A. (1994) *Changing Teachers, Changing Times: Teachers' Work and Culture in the Postmodern Age (Professional Development and Practice).* New York: Teachers College Press.

Jaworski, B. (1996) *Constructivism and Teaching - The socio-cultural context.* At http://www.grout.demon.co.uk/Barbara/chreods.htm

Knowles, M. (1990) *The Adult Learner: a neglected species.* (4th edition) Houston, Gulf Publishing.

Lave, J. and Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation.* Cambridge: Cambridge University Press.

Schon, D.A. (1983) *The Reflective Practitioner. How Professionals Think in Action.* USA: Basic Books, Inc.

Wolcott, H.F. (1994) *Transforming Qualitative Data. Description, Analysis and Interpretation.* Thousand Oaks: Sage Publications.