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Implementation Process of an Approach for Teaching Mathematics in Elementary School

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Abstract

In 1987 a teacher that work in special school in Ticino (the Italian speaking part of Switzerland) to teach his students mathematics build an approach; it has been disseminated for 20 year in most of the Ticino primary schools.

The aim of this study is to explore the implementation procedures and describe the process. The diffusion and opposition to the approach, seem to be connected mainly to the communication and less to an evaluation of the costs & benefits ratio. The strong promoter personal involvement had driven other subjects to overlap promoters and innovation itself (with positive and negative connection).

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1. Introduction

The issue of change is frequently addressed in scientific literature. One of the problems encountered in schools, in terms of processes of change, lies in the existence of numerous projects that are disconnected, episodic, fragmentary and chaotic. Citing Bryk, Sebring, Easton and Luppescu (1998), the author calls to mind the “problem of the Christmas tree”: schools are often decorated by an immensity of “small projects” (like Christmas tree decorations), which too often are difficult to understand. Innovations are forced on schools in an uncoordinated manner, and institutions rarely have the opportunity, or the capacity, to really select which of these to adopt. The great challenge for scholastic institutions is therefore to move from an approach of superficial and fragmentary change, to programmes that are coherent and meaningful. The task is therefore to adopt reform processes that can be clearly recognised and understood by all the actors involved.

When applied, change in effect usually triggers off anxiety, resistance and insecurity, rather than enthusiasm (Schein, 1998). These dimensions must not be underestimated, although they should not necessarily be considered as negative since they are natural, and the underlying reasons should be investigated. The concept of resistance to

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change, often utilized in a superficial manner, must therefore be employed carefully because it contemplates a Taylorist-type division of the organisation, identifying those who think and those who do as two figures that are organisationally different. The scientific literature considers this way of considering organisational life as out-dated and ineffective (Sorrentino, 2006). It is preferable to see change development process as integrated into the culture of an organisation, and as part of the mechanisms of belonging to this organisation (Wenger, 2005).

For teachers, change clashes with the pressures to which they are subjected in their daily lives, and which may be traced back to what Huberman (cited in Fullan, 2001) calls the “pressures of the classroom”: pressure for immediacy and concreteness; pressure for multi-dimensionality and simultaneousness; pressure for adaptation to constantly changing conditions, or unpredictability; pressure for personal involvement with the pupils. These phenomena lead to teachers focussing on their daily work, tending to cut themselves off from other adults, particularly colleagues, and using up their energy that could be used for more in-depth reflection on the processes of change that are taking place.

Moreover, the institutional strategies providing support to reform processes are often organised superficially (for example, by means of continuing education courses), and require a major investment of time, while rarely tackling the issue of the culture and important matters. However, Fullan (2001) maintains that culture is precisely the area that most requires work.

This must all be considered while also fully appreciating that it is in any case unthinkable that some general “rational” strategies can be more effective than others, because since they are general they do not consider local cultures. However, one tenet is that any change is destined to be unsuccessful unless thought is given to the development of a structure that is appropriate for fully involving teachers in the process, by giving them a deep understanding of the meaning of this change.

Finally, in order to be able to talk about a change that is truly satisfactory and long-term oriented, there must be awareness that this is a multi-dimensional phenomenon which, in addition to involving the culture, also engages the didactic approaches and materials, and that these two dimensions must be involved in the process.

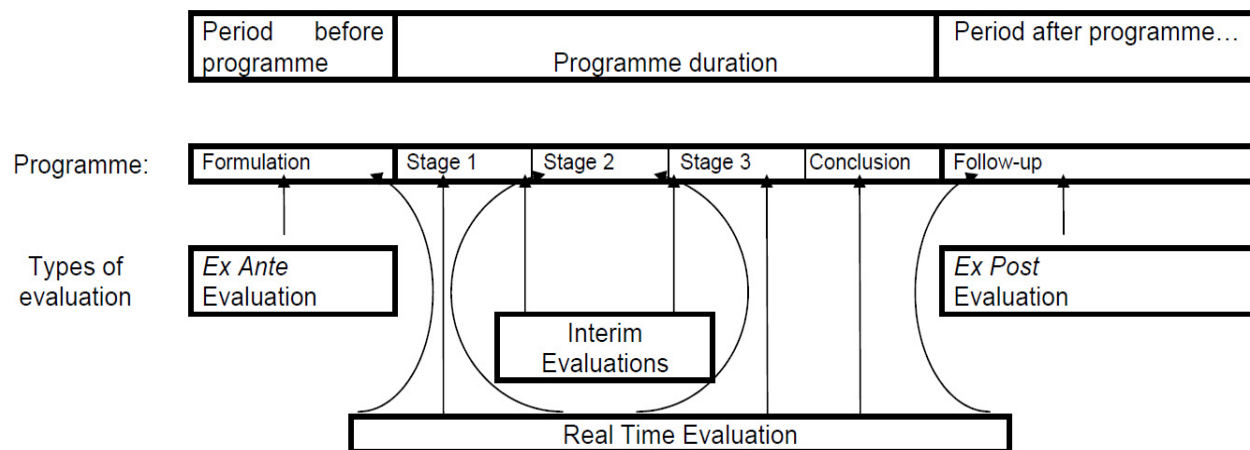
Many researchers have generally identified three major phases of the change process (inter alia Lewin, 1951, Schein, 1999 and Kotter, 1996). First of all there is a moment when the innovation begins, when it is adopted by a system or by an organisation. This also includes the process of the decision to initiate a certain innovation, and also the decision to adhere to existing reforms (for example, in the case of an institution). The second vital moment is that of implementation, which refers to the period in which an attempt is made to translate an idea or a reform into practice. Then comes a phase called “institutionalisation” (or “generalisation”), when the changes introduced should become part of the daily routine of schools. All this should then generate results, that can be interpreted in terms of pupils’ learning outcomes, changes to teacher practices and results at the organizational level (Fullan, 2001).

When evaluating a process it is first of all important to consider the temporal dimension, since coordination with activities conducted simultaneously may permit adjustments to be made while the process is under way. Intervention during evaluation also questions the possibility of obtaining an evaluation of what might have happened if the evaluation was not provided. In all these evaluation processes of reforms/innovations it is therefore necessary to negotiate between what would be scientifically valid and what would be functional for the adjustment of the system (information arriving too late might not in effect be very useful for the system). Four evaluation typologies have traditionally been identified in this sense, and they lie in time frames other than the that of the change process itself: ex-ante evaluations; intermediate evaluations; real time evaluations; ex-post evaluations (Bezzi, 2010).

Each of these typologies offers advantages and disadvantages at various levels, not least that of participation in the evaluation process by the organisation in which the process takes place, the objective of the evaluation itself. In fact, it is impossible for a structure to be evaluated if it does not collaborate in the evaluation process itself.

In a recent study (Louis Lengrand & Associés, PREST, ANRT & Reidev Ltd, 2006) the relationship between the evaluation process and the development of an innovation programme has been depicted as shown in Figure 1. However, when innovations involve an entire system (a scholastic system, for example) it is difficult to state when an innovation process can be said to be concluded. A superficial interpretation alone may in fact lead to the conviction that generalisation is the conclusion of a process, since it requires a form of stabilization that can only be fully evaluated at a later date. Complex systems are effectively marked by their long-term projection, and their learning outcomes must also be viewed from this aspect.

Figure 1 – Phases of the assessment of an innovation (Louis Lengrand & Associés, PREST, ANRT & Reidev Ltd, 2006)



1.1. Presentation of the approach

At the beginning of the 1990s a differentiated approach to mathematics learning began to spread through the elementary school system in Ticino. This approach, which gradually took on the name DIMAT (*Differenziare in MATematica* – Differentiate in MAThematics) (Dellagana and Losa, 1999), led to the development of an innovative teaching method that has been adopted by many teachers working in the second part of the elementary school cycle.

Throughout this period, the approach promoters focussed mainly on creating materials, implementing the approach and training teachers. No study has yet been conducted on the evaluation of the process that led to its introduction.

There are at least two reasons why DIMAT constitutes an extremely interesting case study in the field of implementation evaluation. Firstly, since it was initiated 20 years ago, DIMAT is a reform that has had time to become consolidated, and can be considered as apparently institutionalised (as will be seen, the first internal report to the Office of Primary Education “UIP” dates back to July 1992 and refers to an experience that took place in 1990-1991). Most of its phases can therefore be analysed. Secondly, from many aspects DIMAT can be defined as a bottom-up type of reform. In fact, the creation and introduction phases were not planned by the Department of Education and introduced subsequently, but came “from below”, experimented by a teacher working in schools for children with special needs, and then promoted by a group of Elementary School teachers.

2. Methods

Methodologies adopted

As mentioned above, the information for this study were assembled on a conceptual framework built up on the basis of an analysis of the literature. In the qualitative research field, numerous authors qualified as pure “inductivists” maintain that it is not necessary, or that it may even be dangerous, to go “into the field” with pre-conceived ideas, and that it is instead preferable to gather a maximum amount of material on the basis of which then theories might be constructed (Glaser & Strauss, 1965), while other authors, particularly those of a quantitative nature (but not only those), state that it is possible to gather data only after having constructed a solid conceptual framework, research questions and hypotheses, therefore following a deductive approach (Miles & Huberman, 2003). In this study the authors put themselves in a dialectic position, in accordance with the methodological indications also found in Silvermann (2009)

This research was structured according to the main stream of mixed methodologies (Tashakkori & Teddlie, 2003 and 2009). Referring to the literature, the authors also place themselves in the middle, in terms of epistemological approach. In fact, they feel that it is both more practical and more economical to begin gathering data after an initial in-depth exploration of the theories related to the subject being studied, and then to continue on

the basis of a clear conceptual framework, which therefore constitutes a sort of “guidelines” that can and must be debated continuously. Very briefly, if we wish to refer to the literature, the epistemological approach adopted in this research can be defined as “pragmatic” (Johnson & Onwuegbuzie, 2004).

The evaluation instrument adopted includes methodologies that differ in terms of the phases and areas of study. Both quantitative (Muijs, 2004) and qualitative (Miles & Huberman, 1994) methods were used, and at times these two methods were integrated in accordance with the epistemological indications of the “mixed methodology” (Tashakkori & Teddlie, 1998, 2005, 2010).

The research was structured into three main phases.

First phase: analysis of the literature, construction of the research design and of the conceptual frame work.

This phase involved an in-depth examination of the literature and group discussion for the construction of the conceptual model.

Second phase: analysis of the official documentation and interviews with the various stakeholders who were directly involved. All the documents written between 1991 and 2010 were analysed, 5 classroom observations and 29 interviews were conducted. (The following groups of subjects were contacted: teachers, parents, expert subjects, creators of the approach, school directors and former pupils).

In this phase information were collected, the official documentation was read, and semi-structured interviews were conducted with some key players in the reform process.

The procedure adopted to analyse the documentation and the interviews was inspired by grounded theory (Tarozzi, 2008) for the main principles, and a specific software (AtlasTi) has been used in order to construct a common analysis space (Crescentini and Mainardi, 2009 and Crescentini and Cian, 2010). The aim was to describe the reference situation and, where possible, to identify the causal links between the various factors in play. Based on the research questions and conceptual framework, a coded grid was then constructed, and used to classify the documents and the texts of the interview scripts. This made it possible to write the summarising texts and draw up new conceptual and causal frameworks based on the material analysed.

Third phase: quantitative analysis with questionnaire.

The quantitative investigation, by on-line questionnaire, was conducted in this phase. The questionnaire was also based on the research questions and on the conceptual framework, taking into consideration the results of the previous two phases. It was therefore possible both to test some important issues already emerged in the qualitative phase, by means of triangulation (Berger, Crescentini, Galeandro and Mainardi, 2010), and also to analyse other dimensions, such as the level of institutionalisation.

3. Results

The theoretical framework will be followed in order to illustrate the conclusions, dividing them up into individual parts and then presenting a comprehensive summary.

Start

The context in which this innovation developed was very favourable for its implementation. In the early 1990s the Ticino primary school system was wondering which instruments to use in order to implement the principles of differentiation. In this sense, the objectives and the vision underlying the approach converge with the institutional objectives and vision. The approach also explicitly identified itself, and still does, as an extension to the Primary School programmes.

Moreover, those who had proposed the approach had direct access to the contextual information, since one was a teacher in Schools for Children with Special Needs and the other was a Primary School teacher trainer. They were therefore able to note any deficiencies, and at the same time, any perceived needs or pressure related to the fact that something of this type was being developed.

These conditions allowed the then director of the Office for Primary teaching to identify and activate the financial resources required in order to develop the approach. As emerged from the interview with the Director, this made it possible to provide support to an innovation that had been created in the local area, and, although without making it the official choice of the Office, to provide the approval required for it to be present in classroom.

Implementation

The innovation was evaluated (also on the basis of the first reports written by Losa, 1992) as being high quality and in line with the changes recommended by the Office of Primary School Teaching. Moreover, as mentioned above, the contents met a need that were previously identified. The stated objectives were agreed on by the decision makers, and a line of communications was therefore established, with the inspectors at the centre. These inspectors had a number of tasks to perform: coordinate those enrolled on the training courses for the use of DIMAT; evaluate the use of the approach; promote teacher enrolments on the courses.

The members of the group focussing on the development and diffusion of DIMAT ensured that the communications channels with the UIP, and a system for recording teacher satisfaction, were always kept open, in order to be able to face any problems that might arise.

People from various levels of primary school organisation were involved in the implementation process. In fact, directors were asked to attend specific courses on the use of DIMAT, in order to gain an understanding of the implications of the approach in the teaching environment.

Working conditions suitable for the development of the approach were ensured mainly by the members of the work group. One observation that should be made is that, over the years, it has been noted that teacher contributions to the new material creation process were very limited, and that this is seen in relation to the lack of time (resources) for this specific activity. However, this observation does not apply to the initial phase, when this aspect was one of the drivers to the development of the approach.

This approach was generally received positively in the Primary School environment. Criticisms came mainly from the subsequent school cycles. However, a number of reservations were expressed, recurrently, also by other actors, and related to the potential impact of the approach on the less able pupils.

Institutionalisation

Although the history of DIMAT is not brief, it is effectively difficult to fully discuss the issue of institutionalisation, since it has never become the main approach of the scholastic system for teaching mathematics.

Although the data gathered by means of the questionnaire show a diffusion rate of more than 60% (adding together teachers who use it and those who do not due to contingent reasons, but who attended the course and who plan to use it), it cannot be ignored that some resistance to the approach can be identified in terms of how materials are used in ways other than those imagined by the designers and that are more coherent with a traditional teaching method.

As mentioned above, many of the conditions identified in literature as optimal for proceeding with institutionalisation have been implemented: principally, training, supervision and support. Tools for making teacher experiences available on line have also been envisaged, in order to create a learning community. However, for the reasons specified above, material production has remained basically delegated to the DIMAT group, and teachers have assumed a mainly passive role.

Results

The auto-evaluations of the teachers often report a change in teaching method, not only for mathematics but also for other subject matters. These changes are reported as modifications to their professional practice as a whole. Compared with most innovations, it must be remembered that this does not make an impact on the programme, but instead is an extension to it. In fact, various parties noted that some parts of the programme were ignored by teachers due to the lack of specific materials, but those promoting the approach point out explicitly that the programme does not supply everything and that the teacher should create the missing material in a proactive dialectic with the material already available.

However, the evaluation of the results lacks one fundamental part: the impact on the pupils. The only evaluation currently available was developed in Italy in 2005 (Petracchi, 2005).

4. Conclusions

The origins of the DIMAT approach lie in a class of a school for children with special needs. Following an initial experience in this environment, it was extended to a primary first class. This experiment made it possible to create the material required for the project to be presented to a director of the former Office of Primary School Teaching. The Primary School system needed to identify teaching methods differentiated by subject, as required in the study

programmes, but at the same time it had only recently encountered many problems when introducing subject didactic innovations.

The conditions existed for the two forces, personal for the author and institutional for the UIP, to meet and provide each other with mutual support. The UIP was therefore ready for initial experimentation, the aim of which was not to evaluate the functioning of the approach in relation to the teaching of mathematics, but rather to evaluate the adequacy in terms of the pedagogic principles and to further develop it, so that it could subsequently be extended to the rest of the Canton. The necessary resources were then made available for the approach to be experimented and implemented, accompanying it with a psycho-pedagogic evaluation. This experiment made it possible to structure an approach, in order to be able to present and extend it to a greater number of teachers, also identifying the essential teaching requirements to which the approach could be applied. Teachers of the first experimental group were selected on the basis of their interest in and enthusiasm for the issue of differentiation. These conditions put the group in a position that was clearly exceptional in comparison with a standard teaching practice situation.

Strictly speaking, the institutionalisation phase cannot be considered as having been implemented since the system has not declared ownership of it in a formal, structured and complete manner. However, it can be considered as having been implemented in relation to the diffusion of the innovation, which is generally widespread in schools, to the fact that the innovation has now become established in the Ticino school system, and to the organisational conditions achieved (financing for training programmes, structured agreements for the production of material and the institutional promotion of the training programmes).

A comparative evaluation has not yet been conducted on the results, or on whether DIMAT will improve or worsen the learning of a subject. An evaluation of this type has been conducted in Italy and shows no relevant differences. On the other hand, there are no negative evaluations, and during the formal discussions in meetings with Middle School mathematics experts, the learning outcomes of pupils who had followed the DIMAT approach were not seen to be evaluated at lower levels than those achieved by pupils had not followed the approach.

An evaluation must still be made on how the psycho-pedagogic dimensions of the approach affect the subsequent careers of pupils. It is worthwhile bearing in mind that the promoters themselves believe that the main focus of the approach is not mathematics, but specifically the psycho-pedagogic structure.

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