Different profiles of 'negative attitude toward mathematics'[1]

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1. INTRODUCTION

In this communication some reflections about 'negative attitude toward mathematics' are proposed, which link theoretical issues with problems emerging from both teachers' practice and students' experiences.

After a brief theoretical introduction, in which some issues from research about attitude toward mathematics are summarized, a study from an Italian National Project about negative attitude toward mathematics is presented, aimed at investigating teachers' use of the construct in their practice. Then a second study from the Project is discussed, based on students' narratives about their own stories with mathematics. From this study a characterization of attitude emerges, that strictly links theoretical issues with students' experience. Implications for research and teachers' practice are then discussed.

2. THEORETICAL ISSUES ABOUT *ATTITUDE*

Research on attitude has a long history in mathematics education. The construct was borrowed from the field of social psychology (Allport, 1935), where attitude is viewed as the predisposition to respond to a certain object either in a positive or in a non positive way. The early studies in mathematics education aimed at investigating the relationship between attitude towards maths and achievement. This kind of studies led to often ambiguous or even contradictory results, as highlighted by the meta analysis carried out by Ma and Kishor (1997).

Research about attitude in ME more recently developed in the field of affect. In the classification of Mc Leod (1992) attitude is considered together with emotions and beliefs as one of the constructs that constitute the affective domain (De Bellis & Goldin, 1999, propose values as a fourth construct).

With the development of the field, the need also grows for a theoretical framework for affect in ME (Zan et al., 2006).

This claim for theory also involved the construct of 'attitude to mathematics', and led to identify some critical issues in research:

i) Need for theoretical clarity about the definition of attitude and of positive / negative attitude (Leder, 1985; Ruffell, Mason & Allen, 1998; Daskalogianni & Simpson, 2000; Di Martino & Zan, 2001, 2002, 2003).

Most studies about attitude do not provide a clear definition of the construct itself. Attitude tends rather to be defined implicitly and a posteriori through the instruments used to measure it (Leder, 1985; Daskalogianni & Simpson, 2000).

When a definition is explicitly given, or can be inferred, it mainly refers to one of the two following types:

- A 'simple' definition, that describes attitude as the positive or negative degree of affect associated with a certain subject (McLeod, 1992; Haladyna, Shaughnessy J. & Shaughnessy M., 1983).
- A multidimensional definition, which generally recognizes three components in attitude: emotional response, beliefs regarding the subject, behaviour related to the subject (Hart, 1989).

If in the case of the simple definition the characterization of positive / negative attitude seems *natural* (identified with positive / negative emotional disposition toward mathematics), in the case of multidimensional definitions it requires several choices that need to be made explicit (what do 'positive' or 'negative' refer to? To each dimension individually? What does 'positive' belief mean?)

ii) Need for instruments consistent with the research problem and with the chosen definition of attitude, and capable of capturing the deep interaction between affect and cognition. In particular several scholars question the possibility of 'measuring' attitude through questionnaires (Ruffell et al., 1998).

iii) Need for overcoming the limits of a normative approach. Most studies try to point out a general cause / effect relationship between attitude and behaviour, but this approach does not seem compatible with the fact that the interaction affect / cognition depends on the individual. In particular, the same belief can elicit different emotions in different individuals: for example some individuals associate the belief 'In mathematics there is always a reason for everything' with a positive emotion, others with a negative one (Di Martino & Zan, 2002).

3. AN ITALIAN NATIONAL PROJECT ABOUT ATTITUDE

The points made above about the need for a theoretical framework for affect, together with the importance given to linking theory and practice, have been fundamental issues of an Italian Project about attitude, named 'Negative attitude towards mathematics: analysis of an alarming phenomenon for culture in the new millennium'.

One of the first studies carried out within the Project was an investigation aimed to recognize how teachers actually use the construct 'negative attitude' in their practice (Polo & Zan, 2006).

With this aim a questionnaire with 6 multiple choice questions and 6 open ended questions has been designed and administered to 146 teachers from various school levels.

The study highlighted that the diagnosis "This student has a negative attitude toward mathematics" is frequently given by most teachers. Furthermore it emerges that to describe 'negative attitude' teachers do not refer to a simple negative emotional disposition toward mathematics: their answers regard students' beliefs about maths, students' beliefs about self, students' emotions, students' behaviour.

What the study mostly suggests is that the diagnosis "This student has a negative attitude toward mathematics" is not an accurate interpretation of the student's behavior, capable of steering the teacher's future action. Rather, it is a generic causal attribution of the student's failure, that the teacher perceives as global and uncontrollable and gives as the final step of a series of unsuccessfull didactical actions.

To make the 'negative attitude' construct turn into a useful instrument for both practitioners and researchers, it is necessary to clarify it from a theoretical viewpoint, while keeping in touch with the practice that motivates its use.

4. AN INVESTIGATION BASED ON STUDENTS' NARRATIVES ABOUT THEIR OWN STORIES WITH MATHEMATICS

With this aim a second study was carried out with students. We meant to get over the normative approach that characterises most research on attitude, and that we consider one of the reasons underlying both the lack of theoretical clarity and the

difficulties encountered in getting significant results. Therefore we adopted an interpretive approach, aimed at studying attitude in its natural context.
The need for studying affect in its natural context is particularly stressed in the field of affect, and it is the basis for the use of non-traditional methods, such as narratives (da Ponte et al., 1998; Ruffell, Mason & Allen, 1998; Hannula, 2004).

In our study we collected and analysed students' narratives about their own story with mathematics (hence autobiographical writing, according to the classification of Connelly and Clandinin, 1990), investigating students' relationship with mathematics 'from the bottom' and trying to spot in their descriptions the dimensions involved.

In order to stimulate students' narration of their story, they were proposed the essay "Me and mathematics: my relationship with maths up to now".

In choosing autobiographical essays we are interested in what the student thinks he/she has done, the reasons underlying these actions, the type of situations he/she believed to be into and so on: it is not important whether the story told is actually «contradictory» or «likely» (Bruner, 1990).

In the end, our hypothesis is that the narrative and autobiographic data collected allow us to identify the dimensions students use to describe their relationship to mathematics and therefore may suggest a characterisation of attitude towards mathematics (in particular of negative attitude) that strictly links to practice.

We collected 1656 essays ranging from grade 1 to grade 13: 867 from primary school (grade 1-5), 369 from middle school (grade 6-8), 420 from high school (grade 9-13).

The essays were anonymous, assigned and collected in the class not by the class mathematics teacher.

As already mentioned, we adopted an interpretive approach, trying to understand how students interpret their own experiences with mathematics, rather than to explain their mathematical path in terms of cause / effect.

Final outcome of this analytical process is expected to be the construction of a set of categories, properties, relationships: what Glaser and Strauss (1967) call a *grounded theory*, i.e. a theory based on collected data, the construction of which requires a continuous back and forth between the different research phases.

In our case the essays were read in the light of both pre-existing categories (for instance liking and disliking mathematics) and in a free way, trying to identify meaningful categories a posteriori.

As regard the analysis, we refer to Lieblich et al. (1998), who, looking at different possibilities for analyzing life stories and other narrative materials, identify two main independent dimensions:

(a) Holistic versus Categorical approaches
(b) Content versus Form

Combining these dimensions results in four modes of reading a narrative:

(1) Holistic – Content mode of analysis
(2) Holistic – Form – based mode
(3) Categorical – Content mode ("content analysis")
(4) Categorical – Form mode

Each of the four modes of analysis is related to certain types of research questions. Both quality and quantity of collected data and the aims of our research led us to use all these four types in our analysis.

Here we will only present some results about:

- the 'dimensions' used by the students to describe their own relationship with mathematics
- some particularly meaningful types of stories, and precisely stories characterized by changes in the quality of the relationship with mathematics, and stories characterized by difficulties and unease.

5. THE 'DIMENSIONS' USED BY THE STUDENTS TO DESCRIBE THEIR OWN RELATIONSHIP WITH MATHEMATICS

From a repeated reading of the essays, supported by a quantitative analysis carried out through the software T-LAB (consisting of linguistic and statistical tools to analyse texts), we identified three main expressions: the most frequent is 'I like / dislike mathematics' (in the different forms: I like / I don't like / I used to like …), followed by 'I can do it / I can't do it', and then 'mathematics is...'.

Therefore we identified three core themes:

- the emotional disposition towards mathematics, concisely expressed with 'I like / dislike mathematics'
- the perception of being /not being able to succeed in mathematics, what often is called *perceived competence* (concisely expressed with: 'I can do it / I can't do it')
- the vision of mathematics, concisely expressed with 'mathematics is...'.

Sometimes an essay develops around one of these three themes. More often, it makes reference to all the themes, although it is centred on one of them, which therefore we called the 'core theme' of the essay.

The three themes are explicitly and deeply interconnected: the most frequent connection is associated with the word 'because'.

Starting from the most recurrent theme, i.e. the emotional disposition (expressed with 'I like / dislike') it is a motivation ('I like / dislike *because* …') that leads to the other two themes.

The motivation 'because' may link the *emotional disposition* to the *vision of mathematics*:

> I never liked to learn things by heart (except for some formulae) and this subject, together with Physics, gives me a chance to think and discuss. I like it, because it is a subject which needs reasoning. [3H.16[2]]

> I don't like it because there are many rules to make a tiny little operation you must divide one number by the other one, take away the number you had before and so on. Moreover, if you forget a rule you run into troubles! [1M.16]

From these essays, two different visions of mathematics emerge, that Skemp (1976) respectively calls *instrumental* and *relational*: on the one hand 'rules without reasons', leading to the need of remembering / memorizing; on the

[2] The first number refers to the class level, the letter refers to the school level (Primary / Middle / High), the last number indicates the progressive numbering of the essay within the category.

other hand 'knowing both what to do and why', thus stressing the role of reasoning.

Combining emotional disposition ('I like/I dislike maths') and instrumental/relational vision of mathematics, we have, in theory,four possible combinations: I like / relational, I don't like / instrumental (excerpts 3H.16 and 1M.16 reported above), I like / instrumental, I don't like / relational.

Interestingly enough, we did not find the combination I don't like / relational in any of the 1656 essays.

Getting back to the link between emotional disposition and the other themes pointed out by the causal conjunction 'because', we also found a strong connection between emotional disposition (expressed with 'I like') and perceived competence (expressed with 'I can / can't do it').

This connection comes out so strong from the essays, that sometimes the expressions "I like" ("I dislike") and "I can do it" ("I can't do it") are used as synonyms:

> Since primary school, I remember when the teacher asked us to number by 2, 3, 6, 9 up to 800, 900 … I used to hate it.Then I changed school and I started to hate it even more because of the expressions. Let's not talk about middle school I changed 4 teachers in the 3 school years and therefore if I didn't understand anything before, now I really understand zero. [1H.3]

One of the most interesting outcome of the reading of the essays is that 'success' in mathematics has many deeply different meanings.

In some essays 'succeeding' is identified with school success, i.e. with getting good marks, and thus it is up to the teacher to acknowledge one's success.

In some other cases, 'succeeding' is identified with 'understanding' (and therefore it is the student that acknowledges his/her own success): sometimes 'understanding' is used with an instrumental meaning and it is identified with knowing the rules and being able to apply them correctly, in other cases a relational-type 'understanding' appears, referring to one's awareness of why the rules work and how they are linked to one another.

As a consequence, the themes 'perceived competence' and 'vision of mathematics' turn out to be deeply intertwined within the beliefs the student has about success in mathematics.

6. STORIES

Although the title asked students to write their own 'story' with mathematics (also stressed by the expression 'up to now'), not all the essays are 'stories', since a story involves a sequence of events in time (a beginning state, a middle action, a final state): what is called a plot.

The development of the plot over time has been analyzed by Lieblich et al. (1998), who identified three basic formats:

- in a 'progressive narrative', the story advances steadily
- in a 'regressive narrative' there is a course of deterioration or decline
- in the 'stable narrative', the plot is steady, and the graph does not change.

These three basic formats can be combined to construct more complex plots. In our sample the most frequent plot is characterized by jumps.
Actually our stories always tell a 'change', i.e. we did not find 'stable' narratives.

The moments in which this change occurred, what Bruner (1990) calls the turning points, are described by the writer in great detail, thus giving more information about the possible causes.

We are particularly interested in those stories in which change involves an inversion in the quality of the relationship with maths, since - due to our goals - we are interested in the possibility of change from 'negative' to 'positive', and in understanding the reasons of a change from 'positive' to 'negative'.

Actually we found examples of these kinds of inversion, but most frequently we found ups and downs:

> The first time I met mathematics was in the first year of primary school, and then my hatred for mathematics started because of the times tables. (…)

And then I went to lower secondary school and there I most hated mathematics, as a matter of fact I didn't understand anything, mathematics was Arabic to me. We were not made to be together, but then, who knows why, in grade 8 there was a Boom, I was like a sort of mathematician, I was so good that equations and problems and theorems seemed to be brothers of mine, I

almost appeared as a genius in mathematics. But, as it happens in dreams, good things never last for long and actually my achievement dropped in grade 9, but nothing serious: my relationship to mathematics depends on the moment. [1H.42]

As we said earlier, turning points are described in great detail, thus giving information about the factors that caused the change.

Among these factors we sometimes found specific episodes, topics / activities (mainly algebra, equations, sets ...), moves from one school to another one.

But, above all, the teacher emerges as the most important factor:

> My relationship with mathematics did not start well, because my primary school teacher only looked after the best pupils and this was not fair to me. My relationship with mathematics at lower secondary school got betterm because I had a teacher who looked after me; whereas my relationship at higher secondary school is rather good, maybe because the teacher is looking after me enough. [1H.27S]

Another interesting point related to the stories is that in most essays that tell a story of difficulty or unease, a recurrent pattern emerges. This pattern is characterized:

- by an instrumental vision of mathematics, which implies the need of memorizing many products perceived as unconnected;
- by a low perceived competence, also witnessed by causal attributions of failure (see Weiner, 1974) to causes often external and stable, but mainly perceived by the student as uncontrollable: for example the teacher, mathematics itself, some characteristics of the student himself.

7. CONCLUSIONS

The study highlights that to describe their own relationship with mathematics students use the three main following expressions, deeply interconnected in the essays mainly through the word 'because':

- I like/dislike maths
- Mathematics is…
- I can / I cannot succeed in mathematics.

This result suggests – as a first implication for research - that attitude toward mathematics may be described through the three corresponding dimensions:

- Emotional disposition
- Vision of mathematics
- Perceived competence.

In this way a multidimensional description of attitude emerges, based on emotions, beliefs about mathematics, beliefs about self.

This multidimensionality, together with the richness of the students' narratives, underlines the inadequacy of the positive / negative dichotomy, and rather suggests the opportunity of considering *profiles* of negative attitude, depending on the dimension that we can define as 'negative'.

In particular, and oversimplifying, we can reduce the complexity of each of the three dimensions to a dichotomy:

- Emotional disposition: like / dislike
- Vision of mathematics: relational / instrumental
- Perceived competence: high / low.

In this way we obtain eight different profiles, out of which, seven are 'negative' in some sense.

Interestingly, the profile 'I dislike / relational vision / high self-efficacy' did not emerge from any essay.

A second implication for research is that the essays underline the deep interaction among the three dimensions (in particular between the vision of mathematics and the emotional disposition toward maths) and the subjectivity of this interaction. More generally, the essays confirm the role of affect in learning mathematics.

This study also suggests some implications for practice.

Drawing on the study on teachers' use of the construct 'attitude' we observed that the diagnosis "This student has a negative attitude toward mathematics" is

not an accurate interpretation of the student's behavior, capable of steering the teacher's future action: it rather is a generic causal attribution of the student's failure, that the teacher perceives as global and uncontrollable and gives as the final step of a series of unsuccessfull didactical actions.

The three dimensions that emerge from students' narratives about their own story with mathematics suggest that different and targeted diagnoses of negative attitude are possible, through the identification of one or more negative components. This diagnosis in turn, would suggest a teaching intervention aimed at changing those components .

Particularly interesting profiles that emerge from the study are those characterized by an instrumental vision of mathematics and by a low perceived competence.

Both these two kinds of profiles lead the student to the perception of not being capable to have *control* over mathematics, a sort of 'fatalism', that can result in giving up thinking, and therefore in a failing behaviour, such as avoiding answering, or answering randomly.

This interpretation suggests a didactical action aimed at overcoming low perceived competence and the instrumental view of mathematics: an activity centred on mathematical processes rather than on products – such as problem solving – may be a valuable strategy to either prevent or overcome both these negative profiles.

The study also emphasizes the teacher's role in the vision of mathematics constructed by pupils, in the idea of 'success' they develop, in their perceived competence.

But most of all, by highlighting teachers' role in stories of change, the study suggests that it is never too late to change one's own relationship to mathematics.

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