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THE PUPIL'S VIEW OF MATHEMATICS LEARNING

ABSTRACT. This article reports an exploratory study which set out to examine how 14-year-old pupils perceive good and bad learning experiences in school. In particular, it describes the significant features in learning experiences which were associated with mathematics. Eighty-four pupils were asked, in semi-structured interviews, to tell stories about times when they had felt particularly good or particularly bad when learning. A story consisted of a 'critical' event actually experienced by the pupil and what the pupil had felt at the time. The structure of the interview used and the means by which the qualitative data were analysed are discussed, as well as the main findings of the research.

1. BACKGROUND

Learning . . . is a puzzling mixture of good and bad; of spontaneous enthusiasm on the one hand and of being forcibly done good to on the other (Bliss and Ogborn, 1977).

A great many people have written about the motivation to learn and any review of the literature reveals considerable differences in emphasis and theoretical stance (see, for example, Cofer and Appelby, 1964). There is, however, some agreement that the way an individual perceives the nature of the motivating influence may, in fact, affect his or her motivation and involvement in the task at hand; the critical distinction being whether the influence is seen to be internal or external (see Deci *et al.*, 1975). This distinction in the designation of the motivating influence as internal or external has also been found to result in qualitative differences in learning (see, for example, Fransson, 1977, 1978). These ideas have been further elaborated within attribution theory particularly in the context of achievement-related behaviour, based on the assumption that causal perceptions of success and failure mediate between the antecedents of causal perception and achievement performance. In his latest work, Weiner (1980) further maintained that attributions must be analysed in relation to the three causal dimensions of locus (internal v external), stability and controllability and also the central role of emotions within attribution theory must be recognised.

As far as the specific field of mathematics learning is concerned, much of the work relating to motivation has focussed on attitude to the subject, the different dimensions of attitude, the influences attitude may have on achievement and the factors which appear to affect attitude. Mathematics anxiety has also been the subject of attention. Explanations of an anxiety particularly related to mathematics appear to divide into three areas:

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(i) explanations derived from the nature of the subject mathematics (Biggs, 1959; Williams, 1963; Nimier, 1976);
(ii) Explanations based on the influence of past experience in mathematics and the self concept of ability in the subject (Szetela, 1973; Buxton, 1979, 1980; Tobias and Weissbrod, 1980); and
(iii) explanations concerned with how mathematics is taught and learned in school (Biggs 1962; Mellin-Olsen, 1979).

The research described here did not aim to test any particular theory of motivation or confirm any particular experimental result. It was originally conceived as an extension of the Higher Education Learning Project (Physics), HELP (P) (Bliss and Ogborn (1977)) and, as such, hoped to explore ways of gaining insight into 'the puzzling mixture' referred to earlier as it occurred in a secondary school population (Hoyles, 1980, 1981).

2. COLLECTION OF THE STORIES

The research set out to examine how 14-year-old pupils perceived good and bad experiences associated with their learning in school, how and why they judged specific learning situations as good or bad and what they perceived to influence these judgments. An attempt was made to 'capture' these perceptions by asking the pupils to tell stories about times during which they had felt particularly good or particularly bad when learning. The research also aimed to discover how frequently stories about mathematics, good or bad, might be told and to find out if these mathematics stories had any distinctive features in a comparison with stories about other areas.

The rationale for the collection of descriptions of actual events experienced by the pupils, events which they considered had been particularly significant in their learning, came from HELP (P).

> A question like 'what makes you work hard?' is difficult to answer, but a question like 'tell me about a time when you found yourself really working hard' makes more sense (Bliss and Ogborn, 1977, p. 2).

An approach based on the description of real situations rather than the collection of generalities or opinions was thus felt to be more meaningful to the pupils concerned. This approach also allowed an analysis of learning situations from the pupils' point of view, that is from their internal frame of reference. It was therefore concerned with the pupils' subjective descriptions and interpretations, the importance of which has been recognised by, for example, Bar Tal (1978), Kelley (1973) and Weiner (1980).

Thirdly, the HELP (P) approach enabled all the factors perceived by the

pupils as important to be brought into the analysis. The usefulness of such an holistic approach to educational research has been argued by writers such as Shulman (1970), Hamilton (1973), Cronbach (1975), Hunt (1975), Walker (1976) and Elliott (1977) and within the context of mathematical education by Bauersfeld (1978). The significance of affective factors in learning has also been widely documented (see, for example, Preston (1972), Weiner (1980), Morgan (1977), Hoyles (1975) and Kyles (1976)) and one of the particular strengths of an holistic approach is that it does allow a consideration of these affective influences as and when they occur.

A systematic means of collecting the pupils' descriptions was developed for this research study. Descriptions were to be obtained by interview (as in the HELP (P) study) since an interview (although presenting its own problems) would allow an understanding to be reached of the pupil responses in the context in which they were made. A semi-structured interview was devised which was based on the critical incident technique used by Herzberg *et al.* (1967) in his studies of motivation to work[1]. During the development stage of this interview, different techniques and procedures were tried out and a course in interview training and evaluation undertaken.

A pilot study, in which a total of 24 14-year-old pupils were interviewed, was undertaken in Spring 1976 in three London Comprehensive Schools. Fifty-one stories were obtained and shown to a group of researchers who agreed that they were vivid, highly personal and detailed and appeared to describe genuine, vital and significant experiences. No pupil failed to recall a story and pupils in general seemed at ease, willing, indeed eager, to describe their experiences. The pupils were allowed to describe any incident in their secondary school experience which spontaneously came to mind. In the pilot study 18 of the stories collected were concerned with mathematics which seemed to indicate something worthy of further investigation.

After the pilot study the final version of the interview structure was drawn up.

A fixed schedule of questions was not appropriate in this interview since the pupil was free to describe any event, or sequence of events, but a systematic approach was adopted. Six stages of the interview were distinguished:

- the informal introduction aimed at setting the pupil at ease and where the research is described in a chatty manner;
- the collection of pupil data;
- the formal introduction where the request for a 'story' of a critical incident is made;
- the elicitation of the concrete details of the event described;
- the elicitation of how the pupil had felt at the time of the event;
- the request for a further story.

Pupils were asked to describe two events, one good and one bad, but were also allowed, if they wished, to tell further stories if more came to mind. Each interview was about 20 minutes in length although there were considerable individual variations.

The nature of the interview, with its probing style and reiteration of detail, was structured to make it difficult for a pupil to make up a story and not betray this through inconsistencies or contradictions. The interview was also specifically designed so as to put the pupil at ease and encourage him or her, in a non-directive and neutral manner, to talk openly.

The main study was carried out in three London comprehensive schools, two mixed and one single sex. The researcher was introduced to the school through the head teacher and care was taken that no indication was given of her particular interest in mathematics. Eighty-four pupils were chosen by random means from the total population of 14-year-old pupils in the three schools. All the pupils followed a similar common core curriculum, although there was some variation in a few options followed.

It was hypothesised that the good and bad stories collected in the research would be characterised by different patterns of relative importance between types of factors concerned with the pupil's feelings and with the pupil's perception of:

(a) the extrinsic rewards associated with the pupil's work;
(b) the nature of the pupil's work and the extent of his/her involvement, competence and self-determination in relation to the work;
(c) the quality of teaching;
(d) inter-personal relationships and the environmental context of the pupil's work.

It was anticipated that the stories which concerned mathematics would share the general features of all good stories and all bad stories. However, it was also felt that mathematics was a subject provoking strong and often adverse reactions. It was therefore expected that:

(a) there would be a disproportionate number of stories about mathematics;
(b) bad stories about mathematics would predominate;
(c) the patterns in the types of factors described above which were found to characterise stories about mathematics would have some distinctive features.

It can be seen that the hypotheses of the research were made up of predictive statements of a rather general nature. It was, however, anticipated that the method of analysis developed in the research would enable a detailed

examination of both the patterns of factors perceived by pupils to influence good and bad learning experiences and the distinguishing features these patterns might exhibit when stories concerned mathematics learning.

3. ANALYSIS OF STORIES

After the collection of the stories, procedures of analysis were developed which aimed to be both flexible enough to catch the essence of the stories yet rigorous enough to allow comparisons to be made between stories. The taped protocol of each interview was transcribed verbatim and checked.

In order for a description to be accepted as a story for coding and analysis, the following three components had to be identifiable:

(1) The context or situation in which the story took place, called the *situation*;
(2) The feeling expressed, called the *feeling*;
(3) The factors which appeared to be associated with the feeling, called the *reasons*.

An extract from one of the interviews is given below to illustrate these components. The story is also chosen as being typical in terms of length and complexity. [The introductory part of the interview is omitted here. (I = interviewer, P = pupil.)]

1. I: Well, can you think of anything to tell me?
2. P: Yes, once, in the second year and we had this teacher, she was a really good teacher, maths it was, and I've never been any good at maths. She never pushed you or nothing but let me get on with it at my own pace.
3. I: What do you mean exactly when you say she never pushed you?
4. P: Well, she was nice. I had tried and she realised it and didn't keep picking on me. I used to really try hard in her lessons and just get on with it. As soon as she left it changed and I went off and went back to my usual way.
5. I: Hang on a minute and let's hear more about this good time. Supposing I was to make this film of your story. What was happening? I can't quite see it?
6. P: During this term with this teacher I was just working away. She took time over every person . . . not just 'this is what you have to do and now go ahead and do it'. She explained it over and over to me. She really cared if I could do it.
7. I: She cared, you say?
8. P: Yes, well I thought she did. She didn't just rattle on with lots more maths up there in the front and leave me all behind.
9. I: Can you tell me how you felt during her lessons? What did you feel inside?
10. P: Well really good, it was really nice to be there.
11. I: What exactly does that mean, I'm not sure? What sort of expression must I have if I was sitting in your place in that class, do you think? What sort of things might I say about it all to the others?
12. P: I suppose really I just felt I was getting somewhere for a change. I'm not much good at maths but I was plodding along well and, well, getting stuck into it. It just

made a difference that she knew where I was and I was keeping up; struggling along. It didn't seem such a hopeless task as usual.

13. I: That was really interesting, thank you. It is nice to hear about when you were getting on well. Can you perhaps now think back and tell me about a time which was particularly bad; you were learning something and you felt really bad about it all?

Situation: The story took place in mathematics lessons over a period of time. No particular topic in mathematics is mentioned.

Feeling: The feeling is expressed in paragraph 12, "I suppose really I just felt I was getting somewhere for a change".

Reasons: There are several factors described in the story which are significant:

(a) The teacher did not put pressure on the pupil. did not leave her behind and did not pick on her (paragraphs 2, 4 and 8).
(b) The teacher took a lot of time over her explanations and cared whether the pupil had understood (paragraph 6).
(c) The pupil was not confident in her ability in mathematics (paragraphs 2 and 4).
(d) The pupil tried hard in these lessons (paragraph 4).

It should be stressed that these factors did not necessarily describe what had actually occurred but only how the pupil had perceived the situation.

Two different types of reason were distinguished. Firstly, there were reasons describing things which were actually going on in the event which had a direct influence on the pupil (such as (a), (b) and (d) above). Secondly, there were reasons which were included by the pupil by way of contrast; that is they served to highlight the significance of the story by contrasting what happened in the event with something else. For example, (c) above was a contrasting reason, since it was mentioned by the pupil to highlight the fact that she was doing well with this one teacher. Put in another way, the pupil's low expectation of progress in mathematics contrasted with the feeling expressed in this particular story of 'getting on well'.

Any pupil descriptions which did not contain all of the three components above were discarded, after which process a total of 281 stories were available for analysis. These stories were then coded, that is summarised into a series of descriptive statements and fitted into a standard outline structure as follows:

The first line of the story described the situation after the standard introduction: STORY CONCERNS . . . .

The second line of the story described the feeling expressed in the story, after the words: WHEN (I FELT . . . .).

Reasons were then listed after the words BECAUSE or ALSO BECAUSE (abbreviated to ALSO).

Contrasting reasons were listed after the words: EVEN THOUGH.

Any consequences were listed after the word: SO. Thus, every coded story had the following structure[2]:

STORY CONCERNS . . . Classification of situation
WHEN (I FELT . . . statement of feeling)
BECAUSE (. . . statement of reason)
ALSO (statement of reason)
EVEN THOUGH (statement of contrasting reason)
SO (statement of consequence).

The statements describing the feeling or reasons were initially taken almost directly from the interview transcript.

The coded version of the story given previously was:

STORY CONCERNS LESSONS TYPICAL/MATHEMATICS/2nd YEAR
WHEN (I FELT I WAS GETTING ON)
EVEN THOUGH (I'VE NEVER BEEN ANY GOOD AT MATHEMATICS)
BECAUSE (TEACHER DID NOT PUSH ME)
ALSO (TEACHER DID NOT KEEP PICKING ON ME)
ALSO (TEACHER DID NOT RATTLE ON AND LEAVE ME BEHIND)
ALSO (TEACHER CARED IF I COULD DO IT)
ALSO (I TRIED REALLY HARD IN HER LESSONS).

As can be seen from the above, the coded story could be read fairly naturally, despite its rather disjointed nature, and its meaning could, therefore, be quite easily compared with that of the original transcript.

After all the stories had been coded some standardisation of the coded statements was undertaken.

The following points were also noted about a story:

- the subject it was about (if mentioned)
- the topic it was about (if mentioned)
- the school year in which the event described had taken place
- whether the coding had been checked or not and by whom
- any features of the story which were thought to be of particular interest.

Finally, two categorial schemes, one for feelings and one for reasons, were inductively developed for the statements in the coded stories. An a posteriori approach to content analysis was used. After the categories had been defined and clarified, it was possible to see how they could be grouped into larger, superordinate categories, called main categories. This grouping provided three main categories of feelings and four main categories of reasons. A description and rationale for each of these main categories was then formulated. Because of constraints of space, full details of the categorial schemes are not quoted here.

They are, however, available in Hoyles (1980) or may be obtained from the author.

In order that the results reported later in this article may be meaningful, the main categories are described below in such a way as to summarise their constituent categories and sub-categories.

4. MAIN CATEGORIES OF FEELINGS

Feelings Within Self (Within Self)

This main category grouped together all the things the pupil felt within himself or herself. It was concerned with feelings of happiness, fun or well-being and their negatives. These feelings were either rather general expressions of satisfaction or focussed on the pleasure of success or a series of successes without, however, the suggestion that the pupil felt particularly proud of himself or herself.

Feelings Towards the Outside World (Outside World)

This main category grouped together all the feelings expressed by the pupils towards other people and other things. Four categories were distinguished:

- Feelings about the work at hand,
- Feelings towards the teacher,
- Feelings towards peers,
- Feelings about the school in general.

Feelings About Self (About Self)

This main category grouped together all the things the pupil felt about himself or herself as a person and as a pupil in various learning situations.

Within this main category were classified expressions of pride in oneself, self-esteem, confidence in oneself and one's position in class and confidence in one's ability and an expectation of success. Negative feelings described wounded pride, shame, anxiety, self-doubt, hopelessness and an expectation of failure.

5. MAIN CATEGORIES OF REASONS

Characteristics of the Work (Work)

This main category grouped together all the things the pupil said about his or her work and the way he/she had to do the work. It was concerned with the

perceived interest, usefulness and level of difficulty of the work, how the work compared to other subjects and how it lived up to expectations. It was also concerned with the activities carried out in the learning process, the choice and variety available and the amount of group work involved.

Factors in the Context of Learning (Context)

This main category grouped together all the things the pupil said about the context of learning over which he/she seemed to perceive he/she had little control. It is concerned with everything that was going on around the pupil, that is what the teacher was doing and what the rest of the class were doing. It is also concerned with the physical surroundings of learning and the more general school practices which were felt to affect learning. All the things that the pupil said about the teacher were in fact differentiated into five sub-categories. These related to the pupil's view of:

- the affective relation of the teacher with him/her individually or with the class,
- the teacher's ability to teach, explain or communicate,
- the pace or pressure of work imposed by the teacher,
- the teacher's overall class control,
- the teacher's disciplinary or managerial behaviour towards the individual pupil.

Characteristics of the Pupil Himself in Relation to His Work (Self)

This main category grouped together all the things the pupil said about himself or herself and what he/she had done or tried to do in his or her work. It included statements of how he/she had carried out a task, organised the work, made decisions, and descriptions of how much effort had been made and what was finally achieved.

Factors Concerned with the Recognition or Assessment of the Pupil's Work (Recognition)

This main category grouped together all the things the pupil said about how his or her work was assessed or his or her efforts recognised. It was concerned with the formal evaluation of work through marks, grades, promotion or class position. It was also concerned with the more informal means of assessment such as praise and criticism.

Extensive discussion, checks, modifications and refinements took place at each stage of the analysis of the stories before the categorial schemes were finally derived. In particular, all the transcripts were checked from tapes; 25 stories were independently coded from their interview transcripts and the codes compared and discussed; and 25 coded stories were independently classified and the resulting sets of categories compared and discussed.

Finally a further 70 stories were taken for a complete reliability check. They were coded and classified quite independently of the researcher; 44 by one other experienced researcher and 26 by a panel of experts consisting of researchers all involved in the analysis of qualitative data.

There were some differences in the coded stories produced by the different coders but only in a total of five cases (7%) did these differences result in a different set of categories for a story; that is in almost all cases slightly different statements in a coded story were, in fact, assigned to the same category. These five cases were discussed and changes, such as the addition or subtraction of one line of code or the inclusion of a different standardised form of coded statement, were made so that, ultimately, complete agreement was reached.

After this period of extensive checking, the relevant data for each story – that is the background data of the story concerned with the pupil, and school, and the list of categories which had been derived for the story – were recorded on a coding sheet. This coding sheet was designed so that the information given in it could be punched onto computer cards for computer analysis. Each computer card consisted of 68 variables; 7 variables were taken up by pupil and school data; 10 variables were taken up by background descriptive data concerning the type (that is good or bad), year, subject and situation of the story and whether checking had been undertaken at any stage. The remaining 51 variables were taken up with the classification of the feeling, reasons and consequences of the story. The cards were punched and verified. The analysis of the data was carried out with the aid of the Statistical Package for the Social Sciences (SPSS).

6. DISCUSSION OF RESULTS

Out of the total of the 281 stories collected in this research a significant proportion (116 stories, approximately 40%) was concerned with mathematics and this proportion did not merely reflect the time and emphasis given to the subject in the school corriculum. Nearly one-third of all good stories (42 out of the 135 stories) and one-half of all bad stories (72 out of the 146 stories) were, in fact, about mathematics learning. Out of the total of 114 mathematics stories, a significant proportion (over 63% $\chi^2 = 9.64$, $p < 0.01$) was bad.

In all the other areas taken together the proportion of bad stories was less than half (44.3%). It would be reasonable to assume that the frequency of recall of stories about mathematics is, to a certain extent, a reflection of the strength of reaction to learning experiences in the subject; that is pupils would be more likely to recall experiences to which they had reacted strongly than those which had a lesser effect on them. These findings, therefore, suggest that mathematics tends to provoke both strong and adverse reactions in 14-year-old pupils.

Further findings relate to the distribution of the main categories of reasons (Table I).

TABLE I

Distribution of the main categories of reasons in good and bad stories

Main categories of reasons	Good stories		Bad stories	
	No.	%	No.	%
Work	96	34.2	34	13.5
Context	42	14.9	130	51.8
Self	69	24.6	60	23.9
Recognition	74	26.3	27	10.8
Total	281	100.0	251	100.0

The table above shows that there is a considerable difference in the distribution of the main categories of reasons between good and bad stories.

Factors related to work (34.2%), recognition (26.3%) and self (24.6%) predominate in good stories. These three main categories have a common feature in that they are concerned with the learning activity itself, its characteristics, how it has been carried out and the success or recognition achieved. They can, therefore, be grouped together to form 'content factors' in order to compare their influence with that of the context factors which are concerned with the context in which the learning takes place rather than the actual learning itself. The proportion (85.1%) of these content factors in good stories is very significantly greater than this proportion (48.2%) in bad stories ($\chi^2 = 83.0, p \ll 0.01$, d.f. $= 2$).

In bad stories, the proportion (51.8%) of context reasons is considerably greater than the proportion of any of the other main categories.

The main category reasons do not, however, divide neatly into a set tending to be described in good stories and another set in bad stories, since self-factors are described in approximately similar proportions in good and bad stories (24.6% and 23.9% respectively). The data do nevertheless suggest that content factors as defined within the main categories of Work, Self and Recognition,

are more powerful determinants of pupil satisfaction than context factors and these context factors have a much greater influence in bad stories than good.

In a comparison of mathematics stories with stories about other areas, it appeared that the major sources of satisfaction and dissatisfaction in the mathematics learning experiences were, in general, similar to those relating to other areas of learning in school as described above: that is, satisfaction tended to be attributed to involvement or success in work and dissatisfaction more likely to be blamed on the teacher. However, within the sorts of reasons and feelings described in all the stories, some quite marked differences in emphasis were apparent in the mathematics stories.

This difference was exemplified by a tendency to focus on 'self' rather than 'work' or 'task in hand' in the mathematics stories, both good and bad. Tables II and III illustrate this tendency in the distribution of the main categories of reasons.

TABLE II

Comparison of the main categories of reasons in good mathematics stories and good stories in other areas

Main categories of reasons	Mathematics		Other		Total	
	No.	%	No.	%	No.	%
Work	20	22.2	76	39.8	96	34.2
Context	18	20.0	24	12.6	42	14.9
Self	29	32.2	40	20.9	69	24.6
Recognition	23	25.6	51	26.7	74	26.3
Total	90	100.0	191	100.0	281	100.0

TABLE III

Comparison of the main categories of reasons in bad mathematics stories and bad stories in other areas

Main categories of reasons	Mathematics		Other		Total	
	No.	%	No.	%	No.	%
Work	17	13.1	17	14.0	34	13.5
Context	62	47.7	68	56.2	130	51.8
Self	35	26.9	25	20.7	60	23.9
Recognition	16	12.3	11	9.1	27	10.8
Total	130	100.0	121	100.0	251	100.0

Tables II and III show that in both good and bad stories the proportion of self factors is greater in mathematics than in other areas. The difference is significant in good stories ($\chi^2 = 4.20, p < 0.05$).

The proportion of work factors described in good stories in mathematics is significantly smaller than this proportion in good stories about other areas (22.2% compared to 39.8%, $\chi^2 = 8.39, p < 0.01$).

These findings therefore suggest that the pupil is very concerned with his own role in relation to his mathematical learning and in particular whether he or she can 'cope' with the work or have some control over what is going on. The distribution of main categories of feelings further exemplified this tendency to focus on self in the mathematics stories as shown in Tables IV and V.

TABLE IV

Comparison of the main categories of feelings in good mathematics stories and good stories in other areas

Main categories of feelings	Mathematics		Other		Total	
	No.	%	No.	%	No.	%
Within Self	12	28.6	32	34.3	44	32.6
Outside World	14	33.3	37	39.8	51	37.8
About Self	16	38.1	24	25.8	40	29.6
Total	42	100.0	93	100.0	135	100.0

TABLE V

Comparison of the main categories of feelings in bad mathematics stories and bad stories in other areas

Main categories of feelings	Mathematics		Other		Total	
	No.	%	No.	%	No.	%
Within Self	6	8.3	6	8.1	12	8.2
Outside World	32	44.4	50	67.6	82	56.2
About Self	34	47.2	18	24.3	52	35.6
Total	72	99.9	74	100.0	146	100.0

With reference to Table IV it can be seen that in good stories there is a tendency to express a greater proportion of positive feelings about self in mathematics stories than in other areas, although the difference is not significant at 5% level.

A significant difference is found when the distribution of the main categories of feeling in bad mathematics stories is compared with this distribution in bad stories in other areas ($\chi^2 = 8.85, p < 0.02$, d.f. = 2 – see Table V). This difference can be seen to be due to the much larger proportion of stories expressing negative feelings about self in mathematics (47.2% compared to 24.3%).

These results suggest that the quality of learning experiences in mathematics often seems to be coloured by rather general expectations of success or failure in the subject and the bad experiences, in particular, may tend to be associated with feelings of anxiety, hopelessness or shame. The following two interviews serve to illustrate this tendency to focus on self. It should be noted that the mathematical work being undertaken is not described in any detail in the stories but merely mentioned or named. This illustrates a general trend within the stories; that is the actual mathematical content of work was rarely talked about while, in marked contrast, stories about other areas regularly included vivid and detailed descriptions of the nature of the work undertaken. It was also of interest to note that, not only did the pupils tend not to describe the actual mathematical work being undertaken in their stories, but they also did not tend to comment on its interest, relevance or future use.

Interview 1

I: Now, let us start. Can you describe anything to me?
P: Well, there is maths. I always find maths hard. That's why I switched from 'O'Level to CSE because I found 'O'Level too hard. Maths is my weakest subject and I'm useless at it.
I: Can you think of a time to tell me about which stands out as being particularly bad?
P: Well, there is maths all this year. I just cannot do it. I can't remember what it was even, but it should all be easy. I just find it hard and it is all the easy stuff.
I: What happens exactly?
P: I'm trying to do my homework, at home like, it's always the same. I keep trying and trying and just nothing comes out. I feel so tight inside, I want to explode. You know, sick and sweating, shaking. The longer I sit there the worse it gets. I feel I ought to give up, I'm in such a state.
I: You're in a state?
P: I just know I'm useless at maths. When I am sitting there I know I will not be able to do it. Once it was straight lines, the gradients and things, it was terrible. I didn't have a clue and I just felt sick with anxiety. But it's always happening. It affects part of my life. I say at home 'I did badly in maths today and have not learnt as much as I should'.
I: Is there anything more you can tell me?
P: Not really, I just give up in the end, I suppose. There is nothing else I can do. I get so het up sometimes, it's just not worth it. I think I give up straight away more now and I don't do much worse. But I still feel sick though when I get maths homework.

Coded story	Categories
STORY CONCERNS INDIVIDUAL LEARNING	
TYPICAL WHEN (I FELT REALLY ANXIOUS, TENSE, SICK)	ABOUT SELF: Security⁻
BECAUSE (I COULD NOT DO WORK)	SELF: Coping⁻

(continued)

Coded story	Categories
EVEN THOUGH (I TRIED VERY HARD)	SELF: Effort$^+$
EVEN THOUGH (WORK WAS EASY)	WORK: Easiness$^+$
ALSO (I AM USELESS AT WORK)	ABOUT SELF: Confidence$^-$
SO (I GIVE UP MORE EASILY)	SELF: Effort$^-$

COMMENTS This pupil's reaction to mathematics seemed to be particularly extreme.

Interview 2

P: Oh, I know, we once did these triangles.
I: Now, when was this?
P: I'm not sure. Yes, I know, it was the third year because we had Mr . . . ; it was in his lesson.
I: Now what happened exactly? I want to try to imagine being there, seeing what was going on?
P: Well, I just seemed to be able to do these triangles. It was amazing because I'm usually no good at maths and way behind. Every question came along and I just did it O.K. It's not like that now, I can't do anything and find it all awful.
I: Now, going back to this nice time with triangles, can you remember what you felt like when it happened? What did it mean to you?
P: I felt I could see what it was all about for a change. It was amazing but I know I was doing well because I was way ahead of my mates in the book. It was great to feel that you were good at it, you know, expect to get it out.
I: You expected to get it out then?
P: Yes, I was doing it all and getting on instead of just sitting there letting it pass.
I: Why was that, do you think?
P: I don't know, it was one of those things – it just clicked, I suppose, and I was doing well.

Coded story	Categaories
STORY CONCERNS LESSON PARTICULAR/ TRIANGLES WHEN (I FELT I WAS GOOD AT IT, EXPECTED TO SUCCEED)	ABOUT SELF: Confidence$^+$
BECAUSE (I COULD DO WORK)	SELF: Coping$^+$
EVEN THOUGH (I AM USUALLY NO GOOD AT WORK)	ABOUT SELF: Confidence$^-$
ALSO (AHEAD OF PEERS)	RECOGNITION: Class Position$^+$

COMMENTS Little confidence in ability, therefore just felt surprise at acheivement.

In both the stories above, the feelings expressed were classified in the main category 'About Self', that is they seemed to flow from some sort of judgment of the pupil about himself or herself; a judgment which appeared to have a close relationship to the factors in the event described. A great many stories about mathematics were concerned with such feelings about self. The following interview, however, serves as an example of a time when the feeling expressed was classified as 'Within Self', that is it appeared to represent a broader, more general emotion apparently less specifically related to the incident described and without any hint of self judgment or criticism.

Interview 3

P: Oh yes. In maths, well we did these cards, you know.
I: You liked doing the cards then?
P: Yes, when we stopped doing it I didn't like the lesson no more.
I: When was this then?
P: In the first year.
I: Can you tell me more, about why this was good for you?
P: Well, they seemed easier – the cards.
I: Seemed easier?
P: Yes, but some of them was, you know, quite hard. But, because of explaining, my friends could tell me how to do it – we helped each other, which made it good and I could do the hard ones too.
I: So what did you feel in these maths lessons, with the cards?
P: Well, I felt happy.
I: Happy?
P: Well, I could do them, I enjoyed it all. It was nice.

Coded story	Categories
STORY CONCERNS LESSONS TYPICAL/ WORKCARDS WHEN (I FELT HAPPY)	WITHIN SELF: Satisfaction$^+$
BECAUSE (I COULD DO WORK)	SELF: Coping$^+$
EVEN THOUGH (I DID NOT EXPECT TO BE ABLE TO DO WORK)	ABOUT SELF: Confidence$^-$
ALSO (WORK SEEMED EASIER)	WORK: Easiness$^+$
ALSO (WORK PROVIDED SOME CHALLENGE)	WORK: Difficulty$^+$
ALSO (PEERS AND I WORKED TOGETHER)	WORK: Co-operation$^+$

One further finding of interest was that nearly 22% of all bad stories contained statements categorised in a sub-category called Teacher Pace, Pressure.

All these statements were concerned with the perceived presence or absence of sources of stress imposed by the teacher in the learning process. In the

positive sense, the pupil, for example, might have said that the teacher had not put him under unnecessary pressure. He had, for example, proceeded at a 'reasonable' pace and presented work at the 'right' level in a systematic manner. He had not picked on the pupil to demonstrate his learning or 'shown him up' in his work. In the negative sense, the pupil might have said that the teacher had proceeded too fast, had imposed an unreasonable work load or had presented work in an unplanned or discontinuous manner. The pupil might also have described how the teacher put him under pressure by, for example, demanding instant answers or telling him to work something out in front of the class. It should be noted that the statements in this sub-category were about pressure thought to be imposed by the teacher. They were distinguished in the categorial scheme from statements describing either pressure thought to emanate from the work itself and its level of difficulty or pressure felt because of lack of confidence on the part of the pupil himself. The statements were also concerned with teacher-imposed pressure which was seen to be associated with learning and were distinguished from statements concerned with teacher-imposed pressure, seen to be associated with discipline or control.

This sub-category also had particular significance in mathematics since one quarter of all bad stories in mathematics included statements classified within it. In addition, the negative statements in this sub-category tended to be associated with feelings of lack of confidence and inadequacy in the bad mathematics stories. This was not found to be the case to the same extent in stories about other areas where feelings of dislike for the subject seemed more likely to be aroused by such factors. Thus, in comparison with other areas, pupils showed some tendency to describe stress, in the form of excessive workload or public humiliation, in their stories of mathematics experiences and this stress did seem to have some adverse effect on the pupil's confidence.

In a review of the literature, there appears to be little work on the pupil's reaction to pressure from the teacher in their learning. However, it has been found that teacher behaviour may vary according to the teacher's perception of the pupil's ability. For example, differences in quality and quantity of teacher interaction according to perceived pupil's ability was noted by, for example, Willis (1970), Lawlor and Lawlor (1973) and Bryan (1974). In addition, pupils designated as high achievers were given longer to respond to a teacher's questions (Rowe, 1969) and were more likely to be given a second chance if their first response was incorrect (Brophy and Good, 1970). These findings do suggest a possible explanation for the importance of the sub-category Teacher Pace, Pressure in the present research; that is, the pupil might perceive that the amount of pressure he or she feels is imposed on him

or her by the teacher is, at least partly, a reflection of the teacher's evaluation of his/her ability.

In the literature on mathematics learning there is again little reference to a teacher factor concerned with the pressure of work imposed on the pupils as perceived by the pupils themselves, except indirectly perhaps in the research of Werdelin (1966). He identified a factor in attitude to mathematics which included pupil opinions about the time spent on their problems by their teachers and pupil opinions of the pace and clarity of explanation. More recently Buxton (1979, 1980) also suggested that time pressure and an authoritarian teaching style could induce anxiety amongst adults in mathematics classes.

The following two interviews serve as illustration of teacher imposed pressure as viewed by the pupils.

Interview 4

I: Now these lessons with Mr – with all these work sheets.

P: Sometimes, you know, he used to give us work sheets and when we come into the year we had these books, SMP books. And then we hadn't finished it and then he gave us another SMP book D and Mr – said that we must get two SMP books done in a term, I think But how can we do that when there are all these things in it that you don't even understand and we used to skip through pages. Like one day we'd be on 42 and the next day we'd be up to 50, and something like that.

I: You said, all these things in it. What sort of things do you mean?

P: In maths, You know in these SMP books, like – um – I don't know. Because when I ask my Mum, you know, sometimes I used to go and ask Mum "can you do this". "Help me do this in the book", and she said that she'd never done that at school so she doesn't know what it's about.

I: She doesn't know what it is about?

P: That's right, Mum said that when she was small she used to know her times tables, you know, like now some people don't know their times tables. They used to learn it, they used to have to stand up in class and say it and everything like that. What we do now is not important.

I: How did you feel during these lessons?

P: Well just hopeless, it was all too much, like a growing mountain on top of me I never had a chance to get anything explained or to finish anything.

Coded story	Categories
STORY CONCERNS LESSONS TYPICAL	
WHEN (I FELT HOPELESS)	ABOUT SELF: Confidence⁻
BECAUSE (TEACHER DISORGANISED)	
ALSO (TEACHER WENT THROUGH BOOK TOO FAST)	CONTEXT: Teacher pace/ pressure⁻
ALSO (TEACHER HAD NO TIME TO EXPLAIN)	
ALSO (WORK NOT RELEVANT)	WORK: Interest/relevance⁻

Interview 5

P: That was in the first year. I remember it well.
I: What happened then?
P: Well the teacher was always picking on me.
I: Picking on you?
P: Yes, and in one lesson she jumped on me; I wasn't doing anything but she said come to the board and do this sum – fractions it was. My mind went a blank. Couldn't do nothing, couldn't even begin.
I: What did you feel then?
P: Awful, shown up. All my mates were laughing at me and calling out. I was stuck there. They thought it was great fun. I felt so stupid I wanted the floor to open up and swallow me. It was easy you know. The teacher kept me there and kept on asking me questions in front of the rest. I just got worse. I can remember sweating all over.

Coded story	Categories
STORY CONCERNS LESSON PARTICULAR/	
1ST YEAR WHEN (I FELT SHOWN UP, ASHAMED)	ABOUT SELF: Pride$^-$
BECAUSE (I COULD NOT DO WORK)	SELF: Coping$^-$
EVEN THOUGH (WORK WAS EASY)	WORK: Easiness$^+$
ALSO (TEACHER PICKED ON ME)	CONTEXT: Teacher pace/ pressure$^-$
ALSO (PEERS LAUGHED AT ME)	CONTEXT: Peer relations$^-$

7. OVERVIEW OF FINDINGS AND CONCLUSIONS

The study reported here was essentially exploratory. It aimed to devise a systematic means of collecting and analysing pupils' spontaneous stories with the hope that such an analysis would furnish teachers with a deeper understanding of pupils' perceptions of some aspects of school learning. The research, therefore, did not set out to provide widely generalisable empirical results. Rather it hoped that the stories and their analysis would strike chords of recognition or stimulate insights in the reader and by this means be of value in teaching.

To this limited extent the research can claim some success. For example, the stories collected in this research did seem to show that pupils were much more concerned with their own role in relation to learning mathematics than learning other subjects. Pupils had strong ideas about what they were capable of doing and what they were capable of understanding in mathematics and their mathematical experiences were dominated by this focus on self and feelings about oneself. There was, however, diversity within the mathematics stories which suggested that pupils differed in the goals they set themselves with regard to

mathematics. For example, some pupils liked being able to do their mathematics on their own and liked to know 'why' as well as 'how'; some pupils enjoyed challenge in the subject; some pupils were well satisfied if they could just grasp 'what to do' in order to reach a successful solution; a great many pupils were very concerned with the outcome of their work, its rightness or wrongness and the marks they received. Despite these individual differences of goal, however, the stories indicated that it was when a pupil failed to reach his or her particular goal, whatever it happened to be, that he or she began to doubt his or her ability. The following quotation from one of the interviews is given as an illustration of this tendency –

> I just wanted to get something down on paper, that's all . . . just be able to write down a few lines to show I'd at least tried and was not completely stupid. It was no good. I was just a failure . . . I knew I would never be able to get anywhere with it, no matter how long I sat there . . . .

Further investigation is needed in order to find out in more detail the types of goals to which pupils aspire in mathematics, how they come to choose these goals, and the consequences for them of failure to reach these goals.

The stories also showed that anxiety, feelings of inadequacy and feelings of shame were quite common features of bad experiences in learning mathematics. In addition, from some of these stories it is possible to speculate as to the type of situation which seemed to provoke or accentuate such feelings. For example, there was some indication that pupils in mathematics were particularly fearful and resentful of teachers who seemed to impose additional demands on them. Pupils were appreciative of a secure, encouraging environment in their mathematics lessons and liked teachers to provide a structured logical progression in their work, with plenty of patient explanation, encouragement and friendliness. Pupils, therefore, seemed to want teachers to 'make it easy' or 'tell them the way', perhaps in order to relieve any tension they might feel in their mathematics learning.

The pupils' stories about mathematics learning in this research can be seen to highlight certain problems for the teacher and mathematics educator, firstly in terms of apparently conflicting expectations between pupils, and secondly in terms of pupil expectations which would appear to be at variance with good educational practice. For example, the stories indicated that pupils want security and structure in their mathematics, but the provision of too much structure would probably discourage creativity and exploration in the subject and mitigate against pupils taking any responsibility for their own work and progress. Pupils were extremely concerned with the outcome of their work, they wanted to 'do it', 'finish it' and 'get it right', but this very concern could mitigate against involvement in the subject itself. The absence of this

involvement, according to Lefcourt (1976) could also, at least partly, explain why any anxiety in mathematics learning tends to be debilitating rather than facilitating.

Pupils appeared to demand grades and assessment yet seemed to see these as 'information' as to their mathematical ability and therefore judged themselves highly if they did well in mathematics but found if difficult to rationalise any failure in the subject. This also seemed to lead them to associate such failure with feelings of inadequacy and anxiety. Pupils wanted to be given mathematics of an 'appropriate' standard but quickly lost confidence if teachers left them behind or put pressure on them. Pupils did not talk about what their mathematics was about, or how it may be used. They did not appear to see that the subject could be of any interest in itself but only as something to be done, something to be mastered, something with an existence of its own.

This research has left many questions unanswered, the most obvious of which is the extent to which pupil variables influence the nature and content of the stories recalled. The work of Fennema (Fennema and Sherman, 1977; Fennema, 1979), for example, suggests that there are sex-related differences in confidence and anxiety in relation to mathematics learning. Wolleat (1980) also contends that even when females succeed in mathematics, they tend to attribute their successes to factors other than their own abilities. Because of these and many other findings, work is at present being uundertaken to find out whether spontaneous stories told by boys and girls do in fact exhibit different characteristics.

It is also hoped later to compare and contrast the stories collected from pupils of different ages and abilities and, in particular, to analyse the incidents in mathematics learning judged as good by those who see themselves, or are seen as, poor at mathematics and vice versa.

It is hoped that the methodology developed here may be useful in teacher training as a 'way in' to individual interaction with pupils. The importance of the pupil perspective is seen as crucial so it is perhaps appropriate and in keeping with the 'spirit' of the research to end with a quotation from one pupil after he had told his stories: "I really enjoyed that, miss, you sitting there and listening to me – makes a change somehow, doesn't it?"

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NOTES

[1] The critical incident technique has also, in the past, been used in a wide variety of contexts, for example by Flanagan (1949, 1950, 1954, 1956) and Ryans (1960).

[2] The order in which the reasons and consequences were written was not important and the number of these reasons and consequences obviously varied between stories.

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