Japanese teachers' and pupils' perceptions of the effects of different teaching methods on their attitudes towards learning mathematics: age differences

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INTRODUCTION

The Ministry of Education in Japan (see Ministry of Education, 1999) introduced changes to the Course of Study, the series of documents which provides guidance for teachers, to be implemented in 2002. In mathematics, these educational reforms emphasised promoting positive attitudes towards learning mathematics in addition to developing pupils' fundamental mathematics competencies. The former arose because of the negative attitudes of Japanese students towards mathematics revealed in international surveys, for example, the Second International Mathematics Study and the Third International Mathematics and Science Study. These surveys revealed that Japanese pupils' attitudes worsened as they proceeded through the grades (National Institute for Educational Research, 1997, 1998) and that junior high school students' attitudes towards mathematics had deteriorated over time, in comparison to the results of the First International Mathematics Study in 1964 (Husen, 1967).

The measures suggested by the Ministry of Education to promote positive attitudes towards learning mathematics were a reduction in curriculum content and a widening of the range of teaching methods adopted. Although early evidence had suggested that Japanese teachers were eclectic in their approach to teaching mathematics (National Institute for Educational Research, 1997) as illustrated by the use of problem-solving teaching methods which provide opportunities for individuals to put forward their ideas and enable them to be discussed and elaborated in a whole-class session (Whitman, 1997) there were a perceived need to introduce newer more pupil centred approaches.

Some research has explored the relationships between teaching methods and pupil attainment. For instance, studies of the relative effectiveness of different teaching methods have been conducted since the 1970s in the UK and USA, while aptitude-treatment interaction (ATI) studies have explored the relationships between the effectiveness of different teaching methods and pupils' individual characteristics (Entwistle, 1972; Hodges, 1983; Dunn, 1989). However, there has been little research considering the relative effectiveness of different teaching methods for improving pupils' attitudes to learning. This may partly be due to the influence of behaviourism on educational psychology and partly due to the difficulty and complexity of investigating pupils' attitudes (Gardner, 1985; McLeod, 1992). However, such research is important as negative attitudes may have a detrimental effect on performance (e.g. Imai, 1990; Imai, 1993; Kusumoto, 1998).

The aim of this research was to explore whether Japanese teachers and pupils perceived that different teaching methods had more or less positive effects on their attitudes towards learning mathematics and whether there were differences in these perceptions between participants of 5th and 8th grade. Attitudes towards learning mathematics were assessed in relation to enjoyment, motivation, sense of security and sense of progress. This study also examined the participants' perceived factors contributing to these aspects of pupils' affective attitudes in order to deepen the understanding towards the participants' perceptions of the effect of teaching methods on pupils' affective attitudes.

METHOD

A cross-sectional questionnaire survey strategy was adopted. The sample consisted of 1479 5th graders and 48 their teachers belonging to 28 elementary schools, and 2156 8th graders and 42 their teachers belonging to 19 junior high schools in Tokyo. Eight teaching methods; practical work, using computers, reading textbooks, teachers' explanation, individual work, individual help, whole-class discussion and group discussion were selected for inclusion in the study. These methods are those recommended by the Ministry of Education (1999) for use in mathematic classes.

The study examined, through a five-point rating system, pupils' reported frequency of experiencing different teaching methods and pupils' enjoyment, motivation, sense of security and sense of progress promoted by each teaching method. These features of pupils' attitudes towards learning mathematics were those Japanese children were perceived to lack as evidenced in international surveys (Third International Mathematics and Science Study; the National Institute for Educational Research, 1997, 1998).

The participants were required to write their views of the perceived factors contributing to pupils' affective attitudes in their own language. The responses were analysed using, Cooper et al.'s (1993) method.

DATA ANALYSIS

The data were analysed in terms of the following questions.

1) Do participants perceive that their attitudes towards learning mathematics are influenced by the different teaching methods adopted in mathematics classes in a similar way?
2) What are the relationships between different teaching methods in promoting positive attitudes towards mathematics learning?
3) What are the relationships between different aspects of affect in relation to different teaching methods?

Table 2 suggests that teachers of both age groups were likely to adopt teaching methods that they believed promoted pupils' sense of security and sense of progress rather than enjoyment and motivation, i.e. *Individual work* and *Individual help.* Teachers of both age groups appeared to use *Teacher explanation* and *Reading a textbook*, even though they perceived that these methods were at best neutral in promoting pupils' positive attitudes. Wide variation existed in the reported deployment of these teaching methods and the teachers' perceptions of the extent to which they enhanced pupils' sense of security.

Teachers of both age groups did not appear to adopt teaching methods which they believed were less beneficial for promoting pupils' sense of progress and sense of security, even if they believed that these teaching methods promoted pupils' enjoyment and motivation. *Practical work* fits this category. Actually both teachers and pupils perceived that this teaching method promoted pupils' affective attitudes at 5th grade but this teaching method was not frequently employed at even this grade. Computers were rarely used. *Whole-class discussion* was relatively frequently deployed at 5th grade, but a wide distribution exists in the responses. This suggests that the frequency of adopting *Whole-class discussion* varies from one teacher to another. The deployment of *Group discussion* was much less than *Whole-class discussion*.

Pupils perceived less positive in their responses regarding the deployment and impact of teaching methods than their pupils at both grades. The most frequently deployed methods were well matched with pupils' preference at 8th grade. 8th graders perceived that *Teacher explanation*, *Individual work*, and *Individual help* were frequently deployed in their mathematics classes and reported that these teaching methods had the least negative

effects on their attitudes towards learning mathematics. *Reading a textbook* was also perceived as being relatively frequently deployed in mathematics classes at 8th grade, but this was seen as a negative influence on enjoyment and motivation. 8th graders perceived that the teaching methods deployed in their mathematics classes were likely to be limited to these four methods. *Practical work*, *Using a computer*, *Whole-class discussion* and *Group discussion* were not deployed and were also perceived as negatively influencing attitudes with the exception of *Using a computer* which was perceived as neutral.

At 5th grade, the frequency of deployment of teaching methods and pupils' preferences for them were less matched than at 8th grade with the exception of *Teacher explanation*. *Teacher explanation* was frequently deployed at 5th grade and was also perceived to have the least negative effect on attitudes towards learning mathematics. Overall, 5th graders did not express preferences for individualised teaching methods. *Individual work* was perceived as relatively frequently deployed at 5th grade but negatively affected enjoyment and was neutral in relation to other attitudinal aspects. *Individual help* was perceived as infrequently adopted while this was perceived as neutral in promoting a sense of progress but negative in promoting other attitudinal aspects. *Practical work* positively promoted attitudes towards learning mathematics, but was infrequently deployed. *Whole-class discussion* was perceived as being deployed sometimes and more frequently than *Group discussion.* Both were perceived as neutral in promoting positive attitudes. *Using a computer* was reported as never being deployed. It was perceived as neutral in promoting positive attitudes.

Fifth graders reported more frequent deployment by their teachers of *Practical work, Using a computer*, *Reading a textbook*, *Whole-class discussion* and *Group discussion* than 8th graders. In addition, 5th graders were more likely to perceive that these teaching methods promoted positive attitudes than 8th graders. 8th graders reported more frequent deployment of *Individual work* and *Individual help* than 5th graders, and were more likely to perceive that *Individual work* and *Individual help* would have positive affects than 5th graders. The age difference in the perceived effects of *Teacher explanation* on attitudes was small.

Table 3 summarises the data regarding the relationships between the different teaching methods in promoting positive attitudes towards mathematics. Correlations were examined and only significant correlations .3 are reported. In relation to pupils' affective attitudes, there is a degree of consensus that practical activities, discussion and using computers are linked as are teacher explanation, reading textbooks, and individual work and help. This division was more strongly found among the perceptions at 8th grade. Some links between the two groups were found among the perceptions at 5th grade. More integrated features were found in 5th grade teachers' perceptions of the degree each teaching method could promote enjoyment and motivation.

The deployment of teaching methods was divided into active participatory activities and those of teacher explanation, and teacher help for individuals and setting individual work at 8th grade. Links between the deployment of teacher explanation and class discussion, both of which provide interaction under teacher supervision, were found among the perceptions of 5th graders.

As Table 4 suggested, overall, the findings demonstrated that for pupils of both age groups, the four attitudinal aspects promoted by individual teaching methods were strongly correlated, showing a coherence in their perceptions of the effects. Teachers were more likely to perceive pupils' affective attitudes divided into enjoyment and motivation as one group and sense of security and sense of progress as another. This tendency was greater for the 8th grade teachers. In most cases, frequencies of the deployment of the teaching methods were not significantly correlated with pupils' perceptions of affective attitudes.

The number and percentage of participants mentioning each factor according to each aspect of students' affective attitudes were summarised in Table 5. Both teachers and students pointed out that 'Encouraging students' involvement in mathematics learningcontributed to students' affective attitudes. Involvement indicated encouraging

students' autonomous and positive learning for the teachers but it was based on self-reliance for pupils. Teachers pointed out *Practical work* and discussion which secure students' autonomous could achieve this. Students perceived that *Individual work* was most likely to achieve this.

Promoting students' interest in mathematics learning was a factor contributing to students' affective attitudes towards mathematics learning, especially enjoyment and motivation. Approximately 20%-30% of teachers and students pointed this out as the factor promoting students' interest in mathematics learning. Few teachers and students perceived that this factor contributed to students' sense of security and sense of progress. Teachers believed that new experience in mathematics learning satisfied this factor, while the teaching methods pupils pointed out as promoting this factor were more diverse.

More than half of teachers perceived that meeting students' individual needs in mathematics learning was a factor promoting students' affective attitudes towards mathematics learning, especially sense of security. Some teachers pointed out that this factor contributed to students' enjoyment, motivation and sense of progress, but the number of these teachers was much less. Few students perceived that meeting their individual needs in mathematics learning was a factor contributing to their affective attitudes.

Promoting students' understanding of the curriculum was also a factor, which both teachers and students perceived to contribute to all of four aspects. Especially, one out of four or five students pointed out this factor. Both teachers and students perceived that this factor contributed especially to enjoyment and sense of progress. The teaching methods both teachers and students pointed out as promoting students' understanding of the curriculum varied across all the teaching methods take up in this study, although the traditional methods such as listening to teacher explanation and doing individual work and help were emphasised for sense of security and sense of progress. Some teachers mentioned that adopting a wide range of teaching methods together might be beneficial to promote students' understanding of the curriculum.

Developing students' mathematics thinking ability is another factor both teachers and students pointed out as a factor contributing to students' affective attitudes, although the number of students pointing out this factor was very small among both teacher and pupil participants. The teaching methods both teachers and students pointed out as developing students' mathematics thinking ability is discussion either in a class or a group. Some referred practical work.

Some students pointed out interaction with the teachers and peers, and concentration on task as the factors contributing to their affective attitudes but the teachers did not point out this factor. Few teachers and pupils pointed out multiple reasons.

Discussion

The teaching methods examined in the questionnaire survey were selected according to the recommendations of the Ministry of Education in Japan. The results of the current research showed that some of these teaching methods were hardly ever adopted in mathematics classes at the time of research. Thus, participants' replies of the extent to which these teaching methods promoted pupils' affective attitudes were based on expectations rather than actual experience. This is clearly a limitation. Further research will be needed to examine whether participants maintain or change their perceptions of teaching methods and their effects when the enactment of the educational report of 2002 occurs. Although attempts were made in the pilot study to ensure that pupils understood to what each term referred they may not have known how these related to the teacher's practice in a classroom. This might particularly apply if teachers adopted several teaching methods simultaneously. The results also showed that individual differences existed in pupils' perceptions of the frequency

of adopting each teaching method so the data do not necessarily reflect the actual amount of time the teachers spent using a particular method.

No deterioration in affective attitudes to learning mathematics was found between pupils' in 5th and 8th grade, a finding which contrasts with research in the USA (e.g. Wigfield et al., 1994, Harter, 1981, 1992). However, pupils in both age groups did not perceive that any particular teaching method had markedly positive effects on their attitudes towards learning mathematics. This supports the TIMSS data which indicated generally negative attitudes towards mathematics in Japanese students (NIER, 1997, 1998).

There were age differences in pupils' preferred teaching methods. 8th graders preferred the provision of opportunities for learning mathematics individually following teacher explanation. They did not like recently developed teaching methods such as practical work and discussion, which required them to work together. These methods were more preferred by pupils at 5th grade who reported that individualised teaching methods did not positively promoted their affective attitudes towards mathematics learning. The stronger preference for the more active teaching methods found in the younger students may be because these can assist in promoting understanding in 5th graders (10 years-olds) who have not yet reached Piaget's (1969) 'formal operation' stage. The stronger preference of the individualised learning methods found in older students may reflect the move from a more group-based system of learning at elementary school to a more individualised approach at junior high schools in Japan. Interactions with teachers and peers seem to be more important for elementary school children (e.g. Shwalb et al., 1985).

The study showed that 5th graders perceived that *Individual help* was much less frequently adopted than 8th graders. The reason for this requires further investigation. *Teacher explanation* was the teaching method pupils perceived could best promote their affective attitudes towards mathematics learning at both grades. It was also perceived by pupils to promote pupils' sense of security and sense of progress. *Whole-class discussion*, perceived as a positive way to develop pupils' mathematical thinking ability through interaction under the teachers' guidance, should also be encouraged in mathematics classes. The over loaded curriculum might be one of the main reasons 8th grade teachers were reluctant to adopt this teaching method.

Pupils of both age groups perceived that the teaching methods adopted in mathematics classes were largely limited to the traditional Japanese methods such as *Teacher explanation*, *Reading a textbook* and *Individual work.* The teaching methods adopted in mathematics classes narrowed as the grades proceeded. The teaching methods adopted tended to be those that the pupils preferred particularly at 8th grade although less so for 5th graders. Traditional teaching methods were more frequently adopted and preferred at 8th grade than 5th grade. Recently developed teaching methods were preferred by 5th graders but infrequently adopted, although *Whole-class discussion* was more often adopted at 5th grade.

The limited variety of teaching methods adopted may be explained by the perception among Japanese teachers and parents that enjoyment in learning mathematics and being successful may not be related (e.g. Mori, 1998; Robitaille, 1989). This study suggests that teachers overall perceived that encouraging pupils' involvement and pupils' interest in mathematics learning contributed to pupils' enjoyment and motivation and new teaching method might satisfy this factor. They perceived that satisfying individual needs and promoting pupils' understanding of the content contributed to pupils' sense of security and progress and the traditional teaching methods might satisfy these factors. For pupils, promoting their understanding was the factor contributing to the four aspects of their affective attitudes, and the attitudinal aspects promoted by each teaching method are related.

Adoption of a broad range of methods is important because it is beneficial for satisfying individual differences in current attainment (e.g. Ishida et al., 1986, Kajita et al.1985). This study indicates that it may also be beneficial in satisfying individual differences in promoting positive attitudes towards learning mathematics. This is especially applicable for

Japanese schools which value egalitarian approaches to teaching (Green, 1998). Pupils' preferences for different teaching methods broadly fall into two groups with some pupils preferring traditional teaching methods, i.e. *Teacher explanation*, *Reading a textbook*, *Individual work* and *Individual help,* while others prefer more recently developed teaching methods, i.e. *Practical work*, *Using a computer*, *Whole-class discussion* and *Group discussion*.

8th grade teachers may be reluctant to adopt a wide range of teaching methods because of the pressure of an overloaded curriculum and the need for pupils to perform well in high school entrance examinations. This phenomenon of 'backwash' Biggs (1993), where the means of assessment determines what is learning and how is well documented. To change the emphasis in teaching would require the introduction of a high school entrance examination, which put less emphasis on the amount of knowledge acquired and the extent of skill development. The introduction of criterion-referenced evaluation, avoiding too strict norm-referenced evaluation may also have positive effects (e.g. Harter, 1986; Ames, 1992; Wigfield et al. 1994, Kage, et al. 1990). Many high schools have already begun to make changes deploying multiple criteria, including school records, recommendations, interviews, short essays, etc. (Green, 1998) but if these approaches continue to assess extensive knowledge and skills acquisition retaining the already over loaded curriculum, achievement focused lessons will continue.

The evidence suggests that teachers need to acknowledge that their dichotomised views of the effects of different teaching methods on pupils' attitudes to enjoyment, motivation, sense of security and sense of progress are oversimplified. [i]The literature has suggested that teachers most frequently deploy the teaching methods, which they perceive promote pupils' sense of security and sense of progress. This is especially the case at 8th grade because of the pressure of the entrance examination for senior high school. Pupils hold more coherent conceptions of the ways that different aspects of attitudes towards mathematics are related to each other than teachers assumed.

Reading a textbook is perceived to have negative effects on enjoyment and motivation, although it was a frequently adopted approach at both grades. One reason for this may be the nature of the textbooks. The analysis on the nature of the mathematics textbooks mentioned that those in Japanese schools contain ample worked-out examples and explanation, but few exercises for consolidation and practice by pupils, so they are suitable for using through verbal communication in whole-class teaching but not individual work (Stevenson, 1992; Mayer et al., 1995; Whitman et al., 1997; Whitburn, 2000). Participants of this study might examine the effects of reading a textbook on pupils' affective attitudes in the case a textbook being used in individual work. However, if pupils' independent learning is to be developed, the textbooks may need to be more innovative in their design and modes of presentation to help pupils learn from reading a textbook by themselves. Lepper et al. (1989) have indicated that challenge, curiosity and fantasy in materials could promote intrinsic motivation. Textbooks need to be designed taking account of these factors.

If the range of teaching methods are to be broadened government support will be required to provide resources and teacher training. The scarce deployment of some teaching methods is partly due to teachers' lack of confidence in teaching mathematics using 'modern' methods and lack of resources (DFE, 1992, NIER, 1995). Enhancing teachers' confidence is important, as Japanese teachers believe that the improvement of pupils' mathematics performance depends on the teacher's effort and skills (Lee et al., 1998).

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Table 2: Participants' perceptions of teaching methods

	5th grade				8th grade			
	Pupils		Teachers		Pupils		Teachers	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Enjoyment								
Practical work	3.29	1.33	4.48	.58	2.82	1.36	3.93	1.05
Using a computer	3.31	1.56	3.87	.90	3.05	1.52	3.68	1.00
Reading a textbook	2.84	1.18	2.52	.87	2.62	1.19	2.36	.93
Teacher explanation	3.43	1.23	2.98	.79	3.37	1.24	3.33	.79
Individual work	2.92	1.32	3.54	.74	3.24	1.26	3.52	.71
Individual help	2.44	1.23	3.79	.85	2.97	1.32	3.76	.82
Class discussion	3.16	1.21	3.81	.82	2.55	1.22	3.48	.71
Group discussion	3.12	1.23	3.83	.69	2.74	1.31	3.38	.79
Motivation								
Practical work	3.26	1.34	4.38	.79	2.66	1.29	3.95	.76
Using a computer	3.33	1.50	3.77	1.04	2.90	1.39	3.50	.78
Reading a textbook	2.77	1.28	2.48	.95	2.45	1.17	2.45	.94
Teacher explanation	3.30	1.27	3.17	.89	3.20	1.22	3.43	.74
Individual work	3.03	1.40	3.69	.75	3.33	1.29	3.55	.63
Individual help	2.61	1.34	3.81	.94	3.26	1.35	4.05	.73
Class discussion	3.13	1.24	3.85	.87	2.47	1.19	3.31	.84
Group discussion	3.12	1.24	3.75	.81	2.68	1.28	3.55	.86
Sense of security								
Practical work	3.18	1.30	4.11	.67	2.53	1.20	3.59	.82
Using a computer	3.09	1.46	3.24	.85	2.61	1.28	3.32	.66
Reading a textbook	2.96	1.32	3.15	.93	2.79	1.24	3.08	1.00
Teacher explanation	3.37	1.27	3.47	1.02	3.44	1.23	3.60	.78
Individual work	3.17	1.39	3.96	.72	3.58	1.27	3.93	.76
Individual help	2.75	1.37	4.21	.81	3.51	1.33	4.33	.73
Class discussion	3.12	1.26	3.57	.71	2.41	1.14	3.33	.73
Group discussion	3.11	1.23	3.70	.72	2.58	1.20	3.55	.78
Sense of progress								
Practical work	3.38	1.31	3.98	.73	2.75	1.26	3.57	.83
Using a computer	3.11	1.37	3.15	.72	2.57	1.22	3.05	.81
Reading a textbook	3.42	1.34	3.15	.85	3.15	1.26	3.05	.94
Teacher explanation	3.82	1.20	3.54	.77	3.83	1.10	3.86	.72
Individual work	3.46	1.34	4.15	.68	3.79	1.16	4.14	.78
Individual help	3.20	1.39	4.46	.77	4.03	1.15	4.38	.62
Class discussion	3.33	1.28	3.73	.76	2.52	1.15	3.45	.74
Group discussion	3.23	1.23	3.71	.77	2.62	1.19	3.71	.71
Deployment								
Practical work	2.41	.92	2.96	.77	1.42	.61	2.12	.86
Using a computer	1.53	.80	1.77	.78	1.34	.67	1.48	.74
Reading a textbook	3.41	.97	3.50	1.11	3.04	1.15	3.12	1.27
Teacher explanation	3.61	1.05	4.48	.65	4.00	1.01	4.50	.67
Individual work	3.48	1.00	4.50	.65	3.84	.90	4.17	.73
Individual help	2.84	1.03	4.33	.63	3.10	1.09	4.00	.86
Class discussion	3.26	1.10	3.90	1.06	1.86	.94	2.52	1.13
Group discussion	2.41	.92	2.46	.92	1.53	.77	1.90	1.01

Table 3: Relationships between teaching methods

5th graders	Enjoyment	Motivation	Sense of security	Sense of progress	Deployment
Practical work x Group discussion	r=.359, p<.01	r=.335, p<.01	r=.349, p<.01	r=.348, p<.01	r=.571, p<.01
Practical work x Class discussion		r=.362, p<.01	r=.389, p<.01	r=.372, p<.01	
Class discussion x Group discussion	r=.467, p<.01	r=.529, p<.01	r=.557, p<.01	r=.570, p<.01	
Practical work x Reading a textbook				r=.320, p<.01	
Class discussion x Teacher explanation		r=.302, p<.01			r=.342, p<.01
Reading a textbook x Class discussion			r=.323, p<.01		
Teacher explanation x Reading a textbook	r=.403, p<.01	r=.405, p<.01	r=.396, p<.01	r=.364, p<.01	
Teacher explanation x Individual help		r=.323, p<.01			
Reading a textbook x Individual work	r=.321, p<.01	r=.302, p<.01			
Individual work x Individual help	r=.314, p<.01	r=.411, p<.01	r=.391, p<.01	r=.430, p<.01	
5th grade teachers	Enjoyment	Motivation	Sense of security	Sense of progress	Deployment
Practical work x Group discussion		r=.415,p=.003			r=.537,p=.000
Practical work x Teacher explanation	r= -.396, p=.005				
Practical work x Using a computer		r=.368,p=.010			
Practical work x Individual help		r=.385,p=.007			
Class discussion x Group discussion	r=.544 p=.000	r=.786,p=.000	r=.594,p=.000	r=.477,p=.001	r=.378,p=.008
Class discussion x Individual help	r=.618, p=.000	r=.407,p=.004		r=.396,p=.005	
Reading a textbook x Class discussion					
Teacher explanation x Reading a textbook	r=.543, p=.000	r=.569,p=.000	r=.589,p=.000	r=.559,p=.000	r=.485,p=.000
Teacher explanation x Individual work					r=.375,p=.009
Teacher explanation x Individual help	r=.568, p=.000	r=.657,p=.000	r=.485,p=.001		r=.380,p=.008
Teacher explanation x Class discussion	r=.525, p=.000	r=.529,p=.000			
Teacher explanation x Group discussion		r=.386,p=.007			
Reading a textbook x Individual work		r=.367,p=.010			
Reading a textbook x Group discussion					r= - .436, p=.002
Individual work x Individual help	r=.385,p=.007	r=.429,p=.002			
8th graders	Enjoyment	Motivation	Sense of security	Sense of progress	Deployment
Practical work x Group discussion	r=.474, p<.01	r=.444, p<.01	r=.461, p<.01	r=.489, p<.01	r=.540, p<.01
Practical work x Whole-class discussion	r=.489, p<.01	r=.490, p<.01	r=.501, p<.01	r=.518, p<.01	r=.316, p<.01
Practical work x Using a computer	r=.439, p<.01	r=.368, p<.01	r=.358, p<.01	r=.397, p<.01	
Class discussion x Group discussion	r=.640, p<.01	r=.679, p<.01	r=.714, p<.01	r=740, p<.01	r=.342, p<.01
Group discussion x Using a computer	r=.307, p<.01				
Teacher explanation x Reading a textbook	r=.423, p<.01	r=.442, p<.01	r=.436, p<.01	r=.400, p<.01	
Reading a textbook x Individual work	r=.316, p<.01	r=.309, p<.01		r=.306, p<.01	
Teacher explanation x Individual work	r=.441, p<.01	r=.377, p<.01			r=.313, p<.01
Teacher explanation x Individual help	r=.386, p<.01	r=.394, p<.01	r=.404, p<.01	r=.348, p<.01	r=.344, p<.01
Individual work x Individual help	r=.315, p<.01	r=.363, p<.01			
8th grade teachers	Enjoyment	Motivation	Sense of security	Sense of progress	Deployment
Practical work x Group discussion					r=.548,p=.000
Practical work x Class discussion			r=.625,p=.000		
Practical work x Reading a textbook	r= -.424, p=.005				
Practical work x Using a computer				r=.479,p=.002	
Class discussion x Group discussion	r=.538, p=.000	r=.636,p=.000	r=.442,p=.004	r=.579,p=.000	r=.473,p=.002
Teacher explanation x Reading a textbook			r=.403,p=.010		
Teacher explanation x Individual work		r=.426,p=.005			
Teacher explanation x Individual help				r=.397,p=.009	
Teacher explanation x Group discussion		r=.428,p=.005			
Individual work x Individual help	r=.515, p=.000	r=.417p=.006	r=.459,p=.003	r=.586,p=.000	

Table 4: Relationships between four aspects of affective attitudes

5th graders	PW	UC	RT	TE	IW	IH	CD	GD
Enjoyment x Motivation	r=.636, p=.000	r=.664, p=.000	r=.593, p=.000	r=.601, p=.000	r=.567, p=.000	r=.599, p=.000	r=.606, p=.000	r=.601, p=.000
Enjoyment x Sense of security	r=.572, p=.000	r=.630, p=.000	r=.506, p=.000	r=.561, p=.000	r=.529, p=.000	r=.542, p=.000	r=.523, p=.000	r=.529, p=.000
Enjoyment x Sense of progress	r=.483, p=.000	r=.495, p=.000	r=.396, p=.000	r=.525, p=.000	r=.437, p=.000	r=.366, p=.000	r=.438, p=.000	r=.438, p=.000
Motivation x Sense of security	r=.677, p=.000	r=.746, p=.000	r=.577, p=.000	r=.651, p=.000	r=.629, p=.000	r=.684, p=.000	r=.594, p=.000	r=.629, p=.000
Motivation x Sense of progress	r=.578, p=.000	r=.607, p=.000	r=.457, p=.000	r=.577, p=.000	r=.512, p=.000	r=.513, p=.000	r=.505, p=.000	r=.518, p=.000
Sense of security x Sense of progress	r=.647, p=.000	r=.688, p=.000	r=.553, p=.000	r=.608, p=.000	r=.566, p=.000	r=.572, p=.000	r=.546, p=.000	r=.554, p=.000
Deployment x Enjoyment			r=.344, p=.000		r=.317, p=.000		r=.369, p=.000	r=.309. p=.000
Deployment x Motivation								
Deployment x Sense of security			r=.300, p=.000		r=.319, p=.000			
Deployment x Sense of progress							r=.318, p=.000	
5th grade teachers	PW	UC	RT	TE	IW	IH	CD	GD
Enjoyment x Motivation	r=.434, p=.002	r=.362, p=.012	r=.850, p=.000	r=.588, p=.000	r=.656, p=.000	r=.725, p=.000	r=.736, p=.000	r=.754, p=.000
Enjoyment x Sense of security	r=.421, p=.003		r=.631, p=.000	r=.508, p=.000		r=.600, p=.000	r=.586, p=.000	r=.672, p=.000
Enjoyment x Sense of progress			r=.582, p=.000	r=.441, p=.002		r=.571, p=.000	r=.428, p=.002	r=.424, p=.000
Motivation x Sense of security	r=.461, p=.001	r=.410, p=.005	r=.713, p=.000	r=.443, p=.002		r=.709, p=.000	r=.537, p=.000	r=.679, p=.000
Motivation x Sense of progress			r=.706, p=.000			r=.651, p=.000	r=.480, p=.001	r=.425, p=.003
Sense of security x Sense of progress	r=.491, p=.000	r=.658, p=.000	r=.786, p=.000	r=.601, p=.000	r=.555, p=.000	r=.602, p=.000	r=.556, p=.000	r=.615, p=.000
Deployment x Enjoyment			r=.602 p=.000				r=.421, p=.003	
Deployment x Motivation			r=.557, p=.000				r=.374, p=.009	
Deployment x Sense of security			r=.578 p=.000					
Deployment x Sense of progress			r=.507 p=.000					

8th graders	PW	UC	RT	TE	IW	IH	CD	GD
Enjoyment x Motivation	r=.644, p=.000	r=.620, p=.000	r=.608, p=.000	r=.617, p=.000	r=.527, p=.000	r=.586, p=.000	r=.615, p=.000	r=.615, p=.000
Enjoyment x Sense of security	r=.551, p=.000	r=.552, p=.000	r=.528, p=.000	r=.529, p=.000	r=.427, p=.000	r=.518, p=.000	r=.541, p=.000	r=.541, p=.000
Enjoyment x Sense of progress	r=.506, p=.000	r=.497, p=.000	r=.447, p=.000	r=.478, p=.000	r=.394, p=.000	r=.382, p=.000	r=.493, p=.000	r=.493, p=.000
Motivation x Sense of security	r=.680, p=.000	r=.704, p=.000	r=.633, p=.000	r=.622, p=.000	r=553, p=.000	r=.653, p=.000	r=.670, p=.000	r=.670, p=.000
Motivation x Sense of progress	r=.597, p=.000	r=.621, p=.000	r=.518, p=.000	r=.542, p=.000	r=.493, p=.000	r=.536, p=.000	r=.590, p=.000	r=.590, p=.000
Sense of security x Sense of progress	r=.669, p=.000	r=.707, p=.000	r=.631, p=.000	r=.595, p=.000	r=.593, p=.000	r=.614, p=.000	r=.659, p=.000	r=.659, p=.000
Deployment x Enjoyment			r=.377, p=.000				r=.325, p=.000	
Deployment x Motivation			r=.312, p=.000					
Deployment x Sense of security			r=.312, p=.000					
Deployment x Sense of progress			r=.305, p=.000					
8th grade teachers	PW	UC	RT	TE	IW	IH	CD	GD
Enjoyment x Motivation	r=.546, p=.000	R=.639, p=.000	r=.839, p=.000	r=.547, p=.000	r=.598, p=.000	r=.589, p=.000	r=.526, p=.000	r=.579, p=.000
Enjoyment x Sense of security			r=.627, p=.000	r=.422, p=.007		r=.546, p=.000		
Enjoyment x Sense of progress			r=.539, p=.000					
Motivation x Sense of security	r=.465, p=.003	R=.445, p=.005	r=.580, p=.000	r=.537, p=.000		r=.657, p=.000		
Motivation x Sense of progress			r=.556, p=.000	r=.395, p=.010	r=.528, p=.000		r=.515, p=.000	r=.503, p=.001
Sense of security x Sense of progress		R=.531, p=.001	r=.425, p=.006			r=.477, p=.002	r=.617, p=.000	r=.649, p=.000
Deployment x Enjoyment			r=.621 p=.000					
Deployment x Motivation			r=.523, p=.000					r=.399, p=.009
Deployment x Sense of security			r=.584, p=.000					
Deployment x Sense of progress			r=.425 p=.000					

Table 5: Percentage of teachers of both age groups and 8th graders who referred to each aspect of promoting students' affective attitudes of learning mathematics

	8th grade teachers		8th graders	
Encouraging students' involvement in mathematics learning				
Enjoyment	32%	N=10	2%	N=11
Motivation	23%	N=7	7%	N=30
Sense of security	10%	N=3	13%	N=53
Sense of progress	19%	N=6	17%	N=69
Promoting students' interest in mathematics learning				
Enjoyment	20%	N=6	30%	N=142
Motivation	23%	N=7	27%	N=116
Sense of security	3%	N=1	9%	N=35
Sense of progress	0%	N=0	3%	N=14
Meeting students' individual needs in mathematics learning				
Enjoyment	16%	N=5	4%	N=17
Motivation	20%	N=6	4%	N=17
Sense of security	55%	N=17	11%	N=43
Sense of progress	28%	N=9	4%	N=17
Promoting students' understanding of the curriculum				
Enjoyment	20%	N=6	29%	N=136
Motivation	18%	N=5	25%	N=108
Sense of security	13%	N=4	22%	N=89
Sense of progress	25%	N=8	29%	N=122
Developing students' mathematical thinking abilities				
Enjoyment	6%	N=2	5%	N=23
Motivation	10%	N=3	3%	N=13
Sense of security	13%	N=4	5%	N=20
Sense of progress	13%	N=4	3%	N=14
Interaction with peers				
Enjoyment	----------		13%	N=59
Motivation			6%	N=26
Sense of security			5%	N=22
Sense of progress			3%	N=11
Interaction with the teacher				
Enjoyment	----------		4%	N=18
Motivation			13%	N=56
Sense of security			14%	N=58
Sense of progress			23%	N=95
Concentration				
Enjoyment	----------		3%	N=12
Motivation			10%	N=44
Sense of security			14%	N=58
Sense of progress			9%	N=36
Other reasons + Multiple reasons				
Enjoyment	6%	N=2	10%	N=48
Motivation	6%	N=2	5%	N=24
Sense of security	5%	N=2	7%	N=26
Sense of progress	15%	N=5	9%	N=40