

Pupils' attitude towards mathematics : a comparative study of Norwegian and English secondary students. Beliefs and Beyond: Affecting the Teaching and Learning of Mathematics.

Citation for published version (APA):

Pepin, B. (2011). Pupils' attitude towards mathematics : a comparative study of Norwegian and English secondary students. Beliefs and Beyond: Affecting the Teaching and Learning of Mathematics. *ZDM : The International Journal on Mathematics Education*, 43(4), 535-546. <https://doi.org/10.1007/s11858-011-0314-9>

DOI:

[10.1007/s11858-011-0314-9](https://doi.org/10.1007/s11858-011-0314-9)

Document status and date:

Published: 01/01/2011

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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Pupils' attitudes towards mathematics: a comparative study of Norwegian and English secondary students

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Accepted: 4 February 2011 / Published online: 20 February 2011
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Abstract Comparing English and Norwegian pupils' attitude towards mathematics, in this article I develop a deeper understanding of the factors that may shape and influence 'pupil attitude towards mathematics', and argue for it as a socio-cultural construct embedded in and shaped by students' environment and context in which they learn mathematics. The theoretical framework leans on work by Zan and Di Martino (The Montana Mathematics Enthusiast, Monograph 3, pp. 157–168, 2007) to elicit Norwegian and English pupils' attitude of mathematics as they experience it in their respective environments. Whilst there were differences which could be seen to be accounted for by differently 'figured' environments, there are also many similarities. It was interesting to see that, albeit based on a small statistical sample, in both countries students had a positive attitude towards mathematics in year 7/8, which dropped in year 9, and increased again in years 10/11. This result could be explained and compared with other larger scale studies (e.g. Hodgen et al. in Proceedings of the British Society for Research into Learning Mathematics. 29(3), 2009). The analysis of pupils' qualitative comments (and classroom observations) suggested seven factors that appeared to influence pupil attitude most, and these had 'superficial' commonalities, but the perceptions that appeared to underpin these mentions were different, and could be linked to the environments of learning mathematics in their respective classrooms. In summary, it is claimed that it is not enough to identify the factors that may

shape and influence pupil attitude, but more importantly, to study how these are 'lived' by pupils, what meanings are made in classrooms and in different contexts, and how the factors interrelate and can be understood.

Keywords Pupil attitude towards mathematics · Comparative study · Situated-ness of pupil attitude

1 Introduction: the importance of context

Much research has been conducted in the area of 'affect in mathematics education': in terms of the role of emotions in mathematical thinking, in general; in terms of the role of affect in learning; and of the role of affect in social contexts such as the classroom (Hannula, et al., 2004). Critics (e.g. Lester, 1996) have argued that students' beliefs research has, until recently, not sufficiently informed, and influenced, classroom practice. Lester (1996) also emphasises the "tremendous influence socio-cultural context has on the formation of beliefs" which in his view goes "beyond the narrow confines of the classroom to include the total school environment, the educational system and society in general" (p. 353).

It is now widely agreed that learning can be conceptualised (away from the traditional 'transmission') as a social process, distributed over context, behaviour, personal beliefs and meanings (e.g. Lave & Wenger, 1991). Moreover, Bloomer and Hodkinson (2000) have proposed the notion of 'learning career' to describe the complexity of and often unpredictable nature of learning identity. They argue that educational decisions are often not the result of active choices, but the interaction of context, values and beliefs as parts of identity. Furthermore, Crossan et al. (2003) view learning as the 'subjective experience' (p. 62)

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of change, thus linking identity development and transformation to students' subjective life experiences. Wenger (1998) has conceptualised identity in terms of understanding individual participation, or learning, in a range of contexts and/or communities of practice. It appears that all knowledge, beliefs and skills are encoded, in light of complex interactions, which emerge from and contribute to personal identities.

If research on 'affect in mathematics education' has benefitted from including the influence of socio-cultural aspects, it is unclear why there are so few international studies in the field. Notable exceptions are the PISA studies which, in 2006, attempted to assess pupils' attitudes for the first time. There are also studies by Furinghetti and Pehkonen (1996) who identified nine characterisations of beliefs and explored these with well-known mathematics educators from different countries, and Greer et al.'s work includes international comparisons of 'realistic reactions' to selected question items (Greer et al., 1996).

From my own research (e.g. Pepin, 1999; 2009a +b), that of colleagues, and larger-scale studies such as PISA, it is clear that identity as learner of mathematics is likely to be different in different contexts, and may vary from country to country (e.g. Cogan & Schmidt, 1999). The literature has highlighted the importance of studying the definitions of, and relationships between, constructs such as 'belief', 'attitude', 'emotions' and 'values' (Zan et al., 2006), as well as methodological issues relating to how to measure such construct. Comparisons of how these constructs are 'lived' in different contexts and cultures (or countries) can not only identify similarities and differences but are also likely to deepen our understandings of what we mean by 'affect in mathematics education'.

Over more than 10 years I have studied mathematics classrooms, teachers and their pedagogic and curricular practices in mathematics classrooms in different countries, particularly in England, France and Germany (e.g. Pepin, 1999). More recently, I have studied Norwegian classrooms more closely, and in particular pupils' attitudes towards mathematics at lower secondary level. The goal of these studies has been to develop a deeper understanding of what is going on in mathematics classrooms, especially with respect to teacher pedagogic practice and learning mathematics with understanding (e.g. Hiebert & Carpenter, 1992). The comparative perspective has helped to highlight particular features, and influences, that shape the actions and attitudes of participants, to discover alternatives and, in turn, to develop a deeper understanding of those features and practices, and to stimulate discussion about potential changes and choices within pupils' working and learning environments and countries.

2 Affect in mathematics education: constructs and frameworks for study

Several researchers have reviewed the field of affect in mathematics education (e.g. Hannula et al., 2004). Without repeating what has been presented in other papers, these reviews identify (1) the variety of definitions and constructs of beliefs, attitudes, emotions and values in mathematics education (e.g. Toerner, 1996); and (2) the theoretical frameworks that were used to study affect in mathematics education (e.g. Zan et al., 2006).

In terms of theoretical frameworks for the study of affect, Hannula et al. (2004) have outlined four stances: (1) Goldin (2000) interprets affect as a representational system (similar to cognitive systems): a system that encodes important information regarding problem solving in mathematics. He also links affect with language and communication. In his tetrahedral model he connects, and distinguishes between emotions, attitudes, beliefs and values. Moreover, his claim is that the meta-affect (the affect about affect) is the most important aspect of affect. (2) Malmivuori (1996) claims to have a more dynamic view and sees affect as in the 'functioning of self-system processes' (Hannula et al., 2004). She emphasises the personal learning processes and the role of affective factors and emotional experiences in this process. Self-regulation plays a central role in this frame, and so does affective feedback and self-awareness. (3) Op 't Eynde (together with De Corte & Verschaffel, 2006) view affect in a socio-constructivist framework. They emphasise the construct of identity development in the social context of the classroom and school, and view student affect as situated and integrated in, and constituted by, the social-historical context in which they occur. (4) Brown and Reid (2006) regard affect as 'embodied'. They introduce the notions of 'somatic markers' and 'emotional orientations' in their endeavour to better understand how teachers and students make decisions in mathematics classrooms. The two concepts are principally underpinned by 'primary emotions' and acquired through experience, and not based on conscious reflection.

These different notions of affect are likely to have implications for 'measuring' affect in mathematics education. Leder and Forgasz (1996) also identify different definitions, and key elements, of beliefs in mathematics education, and summarise selected methods for studying attitudes and beliefs. They provide a useful comparative table of how beliefs are viewed and measured by particular authors (including their own work, and that of Verschaffel et al., 1999). More recently, Leder (2010) has provided an overview of studies on teachers' and students' beliefs, including their 'measurement'.

In summary, the categorisation of McLeod (1992) provides a useful tool to distinguish between 'beliefs', 'attitude' and 'emotions' (p. 579)—where a fourth construct was subsequently added by DeBellis and Goldin (1999)—and McLeod provides examples of attitude in terms of 'dislike of geometric proof' or 'enjoyment of problem solving'. However, he also admits that "it is difficult to separate research on attitude from research on beliefs" (p. 582), which is supported by Di Martino and Zan (2010) who contend that attitude studies typically do not share the same definition of the construct. There are a variety of meanings attributed to the construct, and they outline three main types (the *simple*, the *tripartite*, and the *bi-dimensional* definition, see next section). In this study, and in terms of a 'working definition' (Daskalogianni & Simpson, 2000), I recognise three components in attitude: actions related to mathematics, beliefs regarding mathematics, and emotional response towards mathematics. Whilst not putting any judgement on any particular constructs and frameworks, for this comparative study where culture is likely to play a significant role, the socio-constructivist view of learning and affect seems most appropriate, as it stresses the situatedness of learning activities and connects the "cognitive, conative and affective factors in students' learning" (Op 't Eynde et al., 2006).

I now turn to the framework used in this study.

3 Attitude towards mathematics: a conceptual framework

Zan et al. (2006) claim that in the 1960s and 1970s, education research on affect had two different foci: 'mathematics anxiety' and 'attitude towards mathematics'. Most studies in these fields were underpinned by psychology theories (e.g. anxiety) and applied positivist research designs using predominantly questionnaires. The most extensive study at the time was conducted by Fennema (1989) investigating the role of beliefs about mathematics and their influence on achievement. The most widely used attitude measure has been the *Mathematics Attitude Scales* (Fennema & Sherman, 1976) which differentiated between values (e.g. 'attitude to success in mathematics'), beliefs (e.g. 'mathematics as a male domain'), confidence in learning mathematics, maths anxiety and disposition towards problem solving ('effectance motivation').

However, there has also been critique of attitude research (e.g. McLeod, 1987), both in terms of theoretical as well as methodological considerations. Many researchers claim that attitude is an 'ambiguous construct' (e.g. Hannula, 2002) that needs to be developed further, but it is not clear how this could be done (e.g. Daskalogianni & Simpson, 2000). Moreover, Ma and Kishor (1997)

conclude that the correlation of attitude/achievement (examining 113 classical studies) is not statistically significant, and thus highlights the need for refinement of instruments. In a similar vein, McLeod (1987) laments that attitude research appears to be driven by "statistical methodology rather than the theory", and that there is a lack of conceptual clarity in terms of definitions of constructs (which he traces back to 'heritage' of psychology), in the sense that instruments and constructs were transferred without due consideration and theoretical elaboration for mathematics education (Di Martino & Zan, 2010).

The theoretical framework of 'attitude' used in this study builds on Zan and Di Martino's (2007) work who had investigated this construct for many years in an Italian project. Their project aimed at investigating and potentially overcoming the 'negative attitude towards mathematics'. The work developed from different definitions of attitude towards mathematics:

1. the 'simple' definition assuming that attitude towards mathematics is an either positive or negative emotional disposition towards mathematics (e.g. McLeod, 1992);
2. the bi-dimensional definition regarding attitude as the patterns of beliefs and emotions associated with mathematics (e.g. Daskalogianni & Simpson, 2000); and
3. the multi-dimensional definition which recognises three components (emotional response; beliefs regarding the subject; behaviour related to the subject) thus including actions and behaviour in the theoretical framework (e.g. Hart, 1989).
4. In their project, Zan and Di Martino observed students, surveyed and interviewed them, and asked them to "tell their own story with mathematics through an autobiographical essay" (p. 163). Analyses of their data identified three core themes:
 - Emotional disposition towards mathematics expressed with "I like/dislike mathematics";
 - Perception of being/not being able to be successful in mathematics, expressed with "I can/cannot do mathematics";
 - Vision of mathematics expressed with "mathematics is..."
 (amended from Zan & Di Martino, 2007, p. 163)

In addition, the most frequent connection with these core themes appear to be the word 'because', and the scheme (Fig. 1) shows the relationships between the core themes that emerged from their analyses.

The rationale for choosing this frame was based on the feature that it provides a strong link to practice and educational experiences of pupils. Moreover, students are given the opportunity to narrate their story (Bruner, 1990),

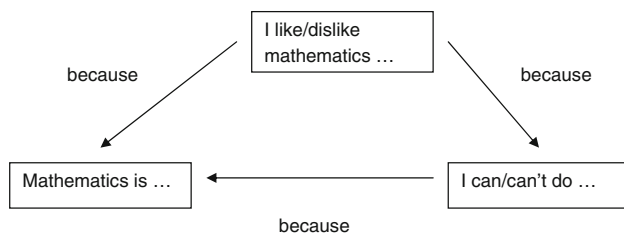


Fig. 1 Triad of Zan & Martino (2007)

their experiences when doing mathematics in class, and it is not important whether the story is ‘likely’ or ‘true’, but students’ perceptions of what they have done, the underlying reasons, and the types of situations they encountered are at the core of this frame. According to Bruner (1990), the narrative is concerned with the explication of the person’s intentions ‘in the context of action’ and through the telling of stories, one is likely to be able to make sense of events, or work out meanings of actions and processes. It was also appreciated that the questionnaire (based on Zan and Di Martino ‘scheme’) is a relatively simple scheme to administer (see description in next section) in two very different settings (England and Norway) where translation of questionnaires can make a difference.

4 The study

In a previous study (Pepin, 2009a +b) I have developed an understanding of identity and ‘culturally figured worlds’ (Holland et al., 1998) in mathematics classrooms in England, France and Germany, using an ethnographic framework. It emerged that national educational traditions are a large determinant and influence on teacher pedagogic practice and the mathematics classroom culture (e.g. Pepin, 1999). More recently, I have investigated Norwegian and English classrooms, in particular, with respect to ‘attitude towards mathematics’. The collected data (for this study) consisted of qualitative questionnaires (see Appendix), and selected lesson observations (one lesson observation for each group/class) to develop an understanding of their working environments. The qualitative questionnaire was based on three questions/statements (‘I like/dislike mathematics because...’; ‘I can/cannot do mathematics because...’; ‘Mathematics is...’; see Appendix) where pupils could add their comments, describe their experiences and generally tell their story. When the questionnaire was administered, pupils were encouraged, and it was stressed, to give examples of their experiences and statements.

The questionnaires were administered to 194 English pupils in grades 7–11, altogether to nine groups/classes (in one school), and the same (translated) questionnaires to

307 Norwegian pupils in grades 6–11, altogether to 13 groups/classes (distributed over three comparable schools).

As two very different environments were compared, the idea of ‘figured worlds’ as places ‘where agents come together to construct joint meanings and activities’ (Boaler and Greeno 2000: 173) was particularly useful here:

A figured world is peopled by the figures, characters, and types who carry out its tasks and who also have styles of interacting within, distinguishable perspectives on, and orientations toward it. (Holland et al., 1998, p. 51)

It is acknowledged that the data sets are too small and are not likely to be representative for England or Norway (and that the results are not statistically significant). However, in terms of catchment areas and situation of schools, they are comparable: the English data were taken in one inner city comprehensive school in a large city in the Mid-North of England; and the Norwegian data were taken mainly in one ‘inner city’ school of the largest city in the Mid-North of Norway. Considering that the population of the whole of Norway is only half of the population of London, it may not be appropriate to talk about ‘inner city schools’ in Norway; but for Norwegian standards the schools was situated in a large city environment.

Moreover, and in terms of the validity of the data, I was mainly interested in the qualitative nature of pupils’ comments. Thus, I analysed the data on the basis of my understandings of the construct of ‘attitude’ (see end of Sect. 2), of the potential influences on attitude; and using a socio-cultural approach to gain new understandings about ‘attitude’. The main questions addressed are:

- (1) How do students perceive their learning of mathematics, and what are the aspects of their attitude towards mathematics?
- (2) What are the main influences which appear to shape pupil attitude towards mathematics?
- (3) What are the similarities and differences in the different settings, and how does that influence our understandings of the ‘attitude’ construct?

In terms of analysis the main emphasis was on discovery rather than testing of theory, and the analysis involved category generation and saturation based on *constant comparison* as advocated by Glaser and Strauss (1967). Concepts emerged from the data, they were checked and re-checked against further data, were compared with other material, strengthened and refined, similar to a procedure described by Woods (1996). Di Martino and Zan (2010) used a related way of analysing their data.

Moreover, I tried at one level to maintain the coherence of the groups’ responses in schools, by analysing the responses in the light of the classroom observations; at

another level I analysed across groups of pupils (within each country), using the conceptual framework of 'attitude' and testing the hypotheses offered by the literature, and building explanations and theorisations grounded in the data. On a third level, I looked for similarities and differences of pupil attitude towards mathematics across the two countries and contexts. However, due to the additional cross-cultural dimension, it was important to address the potential difficulties with cross-national research, in particular issues related to conceptual equivalence (e.g. what pupils said), equivalence of measurement, and linguistic equivalence (e.g. translation of questionnaire) (e.g. Warwick & Osherson, 1973). Particularly important were the validity checks with respect to the qualitative questionnaires, and considerable time was spent amongst researcher colleagues to ensure 'equivalent' meanings and constructs. This highlights the need for awareness of these issues in data collection and analysis exactly because the study is *comparative* and, ultimately, the aim is, in the analytical stage, to compare like-with-like.

In this respect, it was also important to locate and understand mathematics classroom practices and the classroom cultures in England and Norway, and it was useful to draw on knowledge gained from earlier research (e.g. Pepin, 1999; Pepin, 2010) which highlighted the complex nature of classroom practices and environments in the two countries. In addition, national curriculum documents and guidelines (including textbooks) were analysed in order to study the contextual background of mathematics classrooms and the potential influences of these texts in each country.

5 Mathematics classroom environments

Learners of mathematics at secondary level work in different environments in England and Norway. In both countries most pupils go to comprehensive schools until the age of 16 (although in England the private school sector is very strong). Perhaps more importantly, pupils in the two countries experience different organisations of schooling, which, in turn, is likely to have implications for the 'mathematical diet' they are provided with and their mathematical experiences. In England, most schools apply a 'setting system' to teach mathematics in achievement sets, using differentiated texts which provide sets at different 'levels' with different mathematical 'diets'.

In Norway, most pupils are taught in mixed-ability groups (and provided with the same textbook): pupils are said to be 'entitled' to the same curriculum. However, textbooks differentiate between red, blue and golden exercises, indicating that there are likely to be three tiers in each group reflecting the perceived abilities of pupils.

Interestingly, and in order to be able to include pupils with different achievement levels in the same class, Norway has introduced 'work sessions'. A work session covers a period of 1–3 school lessons where the students work individually with assignments from a 'work plan', and the students chose themselves which subject to focus on. During these sessions teachers are available for questions and guidance (Klette, 2007). In terms of organisation of pupils for these 'work sessions', schools seem to work in different ways. For example, one school had between 100 and 120 students in grade 9, which were divided between two teachers. One of the teachers had 58 pupils which were then subdivided into three groups (and supported by an assistant teacher), for the guidance time and individual work. Participation in those groups was often made on the basis of tests, where pupils were subsequently put into the 'weak', 'middle' or 'clever' groups.

In previous studies (e.g. Pepin, 1999), I identified characteristic 'profiles' of classroom situations, also in England. Teachers assigned significance and value to particular practices which are commonly concerned with pupil engagement and assessment of understanding. For example, in the English classroom, the main pedagogic strategy was to (relatively briefly) explain a particular mathematical notion and let pupils get as much practice as possible. Of particular importance was that pupils were attentive during teacher explanations and subsequently worked on their own whilst teachers attended to individual pupils' needs. This was similar in Norway. However, it is important to acknowledge that mathematics teachers in any one country do not all work in similar ways, thus recognising that differences between different classes (i.e. classes with different teachers) can be greater than the differences between classes from different countries.

Moreover, there appeared to be particular 'customary ways' that all teachers used in their teaching. For example, teachers in both countries asked pupils to work on exercises from textbooks for a considerable amount of time so that pupils could practice what has been explained and teachers could monitor understanding. However, in England, many pupils at Key Stage 4 (ages 14–16) and almost all at Key Stage 3 (11–14) had not been issued with a textbook to use in school and at home; they only worked from textbooks during lessons under teacher guidance. Thus, it is likely that the majority of these pupils only ever had access to the textbook in class and consequently had to rely entirely on teacher-guided input (Pepin, 2010). In Norway, the situation was quite different: every pupil had a textbook provided by the school to be used in school and at home. Thus, already at the outset there are differences in the roles and importance assigned to curricular texts in the classroom environment, and for students in terms of access to texts (Pepin, 2009a).

6 Pupil attitudes in English and Norwegian secondary classrooms: quantitative results

In English classrooms nine groups were surveyed (see Table 1 below): three year 7 (age 11/12) classes; three year 9 (age 13/14) classes; and three year 11 (age 15/16) classes, altogether 194 pupils. From those who participated in the survey, the percentage of pupils who liked mathematics ranged from 38% (Y9) to 42% (Y7), thus varied slightly but was relatively ‘stable’, around 40%, across the groups surveyed. However, it appeared that the attitudes seemed to be more ‘polarised’ in year 7 where 42% liked, and 49% of pupils did not like mathematics. In Y9 this ‘evened’ out slightly (38% liked mathematics), but still the majority of pupils did not like mathematics. Only in Y11 did the number of pupils who liked mathematics overtake those who did not. This is interesting in the light of findings by Hodgen et al. (2009) who surveyed approximately 3,000 students at Key Stage 3 (corresponding to our year 9 groups). In contrast to my findings, they claimed that students’ attitudes dropped as they got older: 63% of 12-year olds responded that they enjoyed mathematics lessons, but this fell to 54% for 14-year olds (and the drop was greater for girls than for boys). One reason for the discrepancies in the results could be that the survey questions were of different types (e.g. asking about ‘enjoyment of mathematics’ in the Hodgen et al. study, as compared to ‘I like/dislike mathematics’ in our study) and therefore are likely to elicit different responses. In addition, Hodgen et al. (2009) surveyed over a much larger sample of pupils, and their results are thus more reliable (for the questions they were asking). A third reason is likely to be that Hodgen et al. (2009) did not survey students after KS 3 (grade 9), whereas my results covered up and including grade 10/11.

In Norway, altogether 307 pupils were surveyed, and in 13 classes/groups: one year 6 (age 11: 12 pupils); two year 8 groups (age 13/14: 41 pupils); six year 9 classes (age 14/15: 158 pupils); three year 10 (age 15/16: 79 pupils);

and one year 11 (age 16/17: 17 pupils). In Table 1, only the year 8, 9 and 10 pupils were considered for comparative purposes; it did not seem to be appropriate to elicit statistical results over groups of 12 (year 6), or 17 pupils (year 11). In addition, the year 11 pupils did attend an upper secondary school which has its own characteristics and particular environments. From those pupils in years 8, 9 and 10, the percentage of pupils who liked mathematics varied from 32% in year 9, to 44 and 46% in years 8 and 10, respectively. The data seem to suggest that pupils like mathematics when they enter year 8, and this is connected to entering a new school for some, then lose interest, but pick it up in year 10 which is the official school leaving age. The ‘indifferent’ attitude was generally high, ranging from 16 to 23%, and decreases in year 10, possibly because pupils know that they have to make choices for their upper secondary education. The ‘dislike’ figures slightly go up from years 8 to 10 (from 34 to 38%), whilst peaking in year 9 (45%).

Comparing the two sets of data, interestingly, slightly more students liked mathematics in year 8 in Norway than in year 7 or 9 in England, and especially the English year 9 data (which are comparable in terms of age) stand out here. At school leaving age (year 10 for Norway, year 11 for England) slightly more pupils like mathematics in the Norwegian schools than in English ones. It is also interesting to note that the same trend that Hodgen et al. (2009) claimed, namely the drop of interest in mathematics from age 12 to 14 can also be claimed in both the Norwegian and the English data. However, after age 14 it seems that the interest increases again, and this is evident in both countries’ data sets: in Norway, the positive attitude towards mathematics in year 10 even overtakes the year 8 ‘marks’. Thus, it is suggested that Hodgen et al. (2009) may have found a similar increase in interest, had they surveyed older children. Perhaps, the most interesting finding here is that the ‘trends’ in pupil attitude, going from years 7 to 11, are rather similar in both countries’ data sets.

Table 1 Pupil attitude (%) per year group and country

| | Like mathematics | Indifferent (%) | Dislike mathematics (%) |
|--------------------------------------|------------------|-----------------|-------------------------|
| England (194 pupils) | | | |
| Y7 (age 11/12) 74 pupils: 3 classes | (31/74=) 42% | 9 | 49 |
| Y9 (age 13/14) 57 pupils: 3 classes | (22/57=) 39% | 16 | 46 |
| Y11 (age 15/16) 63 pupils: 3 classes | (26/63=) 41% | 22 | 37 |
| Norway (278 pupils) | | | |
| Y8 (age 13/14) 41 pupils: 2 classes | (18/41=) 44% | 22 | 34 |
| Y9 (age 14/15) 158 pupils: 6 classes | (51/158=) 32% | 23 | 45 |
| Y10 (age 15/16) 79 pupils: 3 classes | (36/79=) 46% | 16 | 38 |

7 Discussion of pupils' comments

Leaving the quantitative results aside, there were interesting findings with respect to pupils' perceptions of why they liked, or disliked mathematics ("I like/dislike mathematics"); their perception of being/not being able to be successful in mathematics ("I can/cannot do mathematics"); and their vision/perception of what mathematics is.

Looking across pupils' comments (on the questionnaires) there were seven themes that emerged from the data:

- (1) Mathematics for jobs and 'later life'.
- (2) Mathematics is interesting, but hard and challenging for some, and boring and frustrating for others.
- (3) Repetitive nature of mathematics in classroom lessons.
- (4) Importance of working in groups (also for thinking) and support of friends.
- (5) The role of the teacher.
- (6) The support of the family and primary school for being able to do mathematics.
- (7) Examinations play an important part, both in terms of individual success as well as what doing mathematics means.

I now analyse and look across the two contexts' data in order to identify commonalities and differences, and how we can understand these in the light of the Norwegian and English 'figured' classroom environments. [In the brackets after the quotes it is indicated whether the pupil was an English (E) or Norwegian (N) pupil and in which year group s/he was.]

Theme 1: Mathematics for jobs and 'later life'

Looking across pupils' comments it appears that in terms of liking/disliking mathematics most students stated that 'mathematics is necessary for life'. In Norway, this is supported by curricular guidelines. Large scale international comparative studies in mathematics and science (TIMSS; PISA) have shown that Norwegian pupils perform relatively poor and significantly lower than the mean of other countries (e.g. Grønmo & Onstad, 2004), and there has also been noted a decrease in recruitment to science-related studies (Schreiner, 2008). This together with the low performance on international achievement tests is likely to have influenced the Government in terms of increasing the emphasis on sciences and mathematics education.

Many pupils in the study had dreams of particular professions and needed mathematics to fulfil those dreams.

"You get to learn new skills and it will help you later on in life ... because algebra etc. can help you in jobs such as an accountant..." (EY7-SO)

"... Maths can be tiring, but it opens opportunity doors." (EY11-U8)

"... I struggle with any work... my dream is to become a police officer and you need to have a GCSE in maths." (EY9-JF)

However, this emphasis on the utilitarian aspect of mathematics, in the sense of using it as a means to achieve their own particular 'distant' goal, was more evident in English pupils' comments than in Norwegian answers (from the questionnaires). This can be understood in the light of the different contexts in which pupils were working and living. In particular, the education system in England expects pupils to direct their studies very early, and pupils have to decide latest at GCSE level (age 16) what kind of line they want to pursue at A level, which, in turn, has implications for further study (e.g. Higher Education) and hence for job opportunities. This also means that depending on their A level choices, they may not have any mathematics instruction after GCSE. In Norway, every child has the right for upper secondary education regardless of their grades at the end of compulsory schooling (grade 10), and they have to continue mathematical studies for at least another 2 years after age 16. More than 95% of students in Norway continue with upper secondary education, either in 'professional' (e.g. for apprenticeships) or in 'theoretical' (e.g. traditional upper secondary mathematics and science) tiers.

Theme 2: Mathematics is interesting, but hard and challenging for some, and boring and frustrating for others

Approximately half of the pupils, in particular those who seemed to succeed in mathematics (according to their comments), talked about mathematics as a 'challenging', 'interesting' but 'hard' subject to learn. Others characterised it as 'boring', 'non-creative' and 'confusing'. These perceptions went right through all classes, ages, and achievement groups.

"It is fun and easy and very interesting subject ... I like being made to think in maths ... I also like to be made to write and do many activities in maths. I love maths so much that I make sure I don't forget a calculation ..." (EY7-TO)

"... it is boring and it does not allow you to be creative. ... mathematics is also very complicated as you have to use many different formulas... it is stressful..." (EY11-U12)

Theme 3: Repetitive nature of mathematics in classroom lessons

Pupils' perceptions were often linked to particular classroom practices and atmospheres. For example, many

Norwegian pupils commented that it was a very theoretical subject where topics build on and connect to one another, and where very little practical work was done.

“I don’t like mathematics because it is such a theoretical subject. If you miss one theme the class works on, you don’t get the next theme. Mathematics builds upwards. And it is some calculations I don’t get so I have given up, so now I’m lost in mathematics classes. In addition, I have fear of failure in this subject, so I don’t give a crap about anything called mathematics.” (NY9-GN1)

English pupils perceived the nature of mathematics more rigidly as ‘getting the right answer’, and where little creativity is encouraged.

“... I find it easy to understand and because it is the same wherever you go. Numbers are always the same in every country, so anyone can do it. With maths, the answer is either right or wrong, whereas with other subjects like English and History, there are many different answers.” (EY11-DB)

“There is always a key book so there is always just one correct answer.” (NY9-GN5)

“... it is boring and it does not allow you to be creative. ... mathematics is also very complicated as you have to use many different formulas...” (EY11-U12)

In terms of classroom practices, and particularly in Norway, pupils commented on the repetitive nature of lesson, with textbook work and teacher presentation playing the main role.

“... mathematics could be funny if it was varied and not just writing ... I don’t like mathematics because it is too much of the same thing.” (NY9-GN2)

“... it is not an interesting subject. There is nothing fun towards this subject and a lot of it just feels like you’re doing the same thing all the time. I like the class I am in and how we really understand things...” (EY11-U13)

“... once you learn how to work out an equation or formula, you keep repeating the same method and there is always one correct answer. ...” (EY11-U14)

However, pupils wanted to work ‘differently’, in a problem solving way and with more open questions (than provided by textbooks), in order to develop a better understanding of the mathematics.

“I like problem solving. I think it is fun. I like to think and reflect long, because I then have a better chance of understanding. I become really happy when I manage

to solve the problem. With Pascal’s triangle it was quite fun and I got the system, but when we went back to calculating arithmetic problems again I became bored. ... there should be more variation in the teaching. All we do is star down in to a book all the time. I find it a total waste of useful time.” (NY6-GN10)

Theme 4: Importance of working in groups (also for learning) and support of friends

It appears that in both countries’ classrooms little practical investigative work was done, but when it was done, pupils enjoyed this aspect. They wanted activities in mathematics, and they preferred group work, working with their friends, in order to understand the mathematics better.

“Mathematics can be very varying. It is extremely boring when we sit there and do tasks on our own. In that way it is difficult to understand. But when we work with practical tasks it’s much easier because then we can hold the figures instead of trying to imagine them. Then it becomes easier to understand the problem and that’s more fun.” (NY9-GN4)

“Mathematics is fun when we do activities like Google sketch up. It is boring when all we do is arithmetical tasks on the blackboard.” (NY9-GN6)

“It is not as much fun and enjoyable as other subjects ... I don’t learn by being shown but I do learn by doing and playing games about different types of things. I also like doing presentations...” (EY7-KH)

“... sometimes it can be really good when we get involved by choosing groups to do peer work. I like working in groups, I can think better with people I know I can have a laugh with whilst doing the work...” (EY9-BW)

“... As I sit next to my friend I feel more relaxed in a new set and know that she will also help if I ever don’t understand.” (EY11-U7)

In both countries investigative practical activities are encouraged, at least ‘theoretically’ and in national documents. For example, the Norwegian National Curriculum in Mathematics states:

The mathematics subject in school contributes to developing the mathematical competence needed by society and each individual. To attain this, pupils must be allowed to work both theoretically and practically. The teaching must switch between explorative, playful, creative and problem-solving activities and training in skills. Mathematics shows its usefulness as a tool when we work with technology and design and when we work in practical

applications. In school activities, central ideas, forms, structures and relations in the subject are exploited. Both girls and boys must have the opportunity to gain rich experiences that create positive attitudes to and solid competence in the subject. In this way the foundation is laid for lifelong learning. (Mathematics subject curriculum)¹

Theme 5: Role of the teacher

In both countries pupils stressed the role of the teacher to help them learn and do mathematics, and thus to provide opportunities to develop a positive attitude towards mathematics. In particular, in Norway pupils felt that the teacher did not provide them with the help they needed. In England, despite the traditional emphasis on individual pupil support (see Government Initiative “Every child matters”),² there does not seem to be enough time to attend to individual pupils.

“I dislike it because I think the teacher should go over the bit you are learning about 2 or 3 times, and they should take a whole lesson to teach just one thing...” (EY7-GS)

“We just sit down, she tells us very fast and then she expects us to do it. Then we ask her for help, she reads out the question again and that is why I dislike maths.” (EY7-LB)

In terms of organisation of schooling it could be argued that the relatively recent initiatives by the Norwegian ministry of education, to introduce ‘work plans’ (see Klette, 2007) in schools is a response to the necessity of differentiation (see earlier section), more individualised help and support for pupils. In these ‘work plans’ teachers, in consultation with pupils, devise an individualised plan for each pupil’s work over 2 weeks. In terms of educational practices, and also in mathematics and science education, Norway, as one of the richest, amongst the Nordic countries, institutional welfare state, has a strong commitment to social equality and universal rights which can be traced to schools and individual classrooms (Stedøy, 2004). This has implications for pedagogic practices, and for example, it is seen as “undemocratic” if pupils are not part of the decision making about working methods.

In England, the established practice of ‘setting’ (where each pupil is ‘setted’ for each subject, i.e. put in sets according to their perceived achievement in the subject) can be seen as way of dealing with the diversity of achievement (Ruthven, 1987). However, these sets are likely to influence pupils’ attitude towards and identity of

mathematics, as different sets appear to do different mathematics, work with different textbooks, work with different pedagogic practices (Pepin, 2009a).

“... I am capable of doing maths and I think I am confident most of the time ... I am easily distracted. If I do not the work I get very wound up and stressed out. ... and the teacher is always shouting, then I have a headache and cannot concentrate and end up not doing my work. When I was in the bottom maths 6 set I learnt very well and was the smartest, but then I got moved up and I learnt less because my teacher is not strict enough...” (EY9-OS)

“... I’ve only started to enjoy maths recently (end of year 10/start of year 11) because I’ve only started to understand it. Being in a higher set and being put onto a higher paper for GCSE has boosted my confidence in maths and has given me an incentive to work hard to achieve a grade C or above.” (EY11-U7)

Theme 6: The support of the family and primary school for being able to do mathematics

Pupils, mainly in England, talked about their attitude towards mathematics being influenced by their family and parents helping them, or the primary school experiences giving them the confidence to have a positive attitude.

“I have help and support of my family. Also we did a lot of maths at primary school. I also find that homework helps me.” (EY7-SO)

“I learnt maths when I was little. My mum learnt me maths ... and now I am great at maths.” (EY7-DB)

“My dad is excellent at maths and helps me ... Also in my primary we did lots of maths... when I was younger I had lots of books for maths. Plus I am not allowed to go out until I do my homework, so I try really hard!” (EY7-KN)

Theme 7: Examinations play an important part, both in terms of individual success as well as what doing mathematics means

Finally, there was evidence of examinations influencing pupils’ attitudes.

“I’m good at it and I like it because it’s good trying to work it out. But sometimes I don’t like it, because of exams ...” (EY7-DB)

“... good because when you leave school you will have good exam results and you will be brainy. Also if you go to university you will get really good grades, and if you get good exam results in university then you will get a really good job.” (EY7-GE)

¹ http://www.udir.no/upload/larerplaner/Fastsatte_lareplaner_for_Kunnskapsloftet/english/Mathematics_subject_curriculum.rtf.

² <http://www.dcsf.gov.uk/everychildmatters/>.

It seemed that the assessment system played a crucial role in pupils' perceptions of what mathematics is and how to become a 'proficient' mathematics learner. For example, in both countries, but more in England, pupils practice on examination questions several months before the examination. This means that nearly all curriculum teaching is suspended, and pupils and teachers go over past examination papers—'teaching to the test'. Examinations appear to define whether a pupil is 'good at maths' or not.

8 Conclusions

This article argues in support of 'pupil attitude towards mathematics' as a socio-cultural construct that connects the cognitive, motivational and affective factors in students' learning of mathematics. Leaning on the work of Op 't Eynde et al. (2006) I argue that pupil attitude is embedded and shaped by the context in which it develops. Furthermore, and looking at the qualitative data, one can conclude that the main dimensions identified by Op 't Eynde et al. (ibid) are represented: beliefs about self; beliefs about social context; and beliefs about social norms in pupils' own classes.

Interestingly, whilst there are differences which can be seen to be accounted for by differently 'figured' environments, there are also many similarities. For example, it was interesting to see that, albeit based on a small sample, in both countries students expressed their liking of mathematics in year 7/8, which decreased in year 9, and increased again in years 10/11. The pupil comments appear to suggest that this was the case because students had accepted that, given the right conditions, they were ready to work at this subject in order to get good grades, which, in turn, were likely to give them more opportunities in life. Thus, the 'exchange value' of mathematics, and this is linked to the assessment system, appears to influence pupils' attitude towards mathematics.

In terms of differences it was interesting to see how pupils 'lived' their mathematics worlds, in school and 'at

home'. Pupil attitude appeared to be influenced by several factors which, in turn, were influenced by the different contexts in which pupils (and teachers) were working. For example, most pupils in both countries perceived mathematics as 'non-creative' and 'theoretical'. However, the perceptions that underpinned these notions were different. In Norway, 'theoretical' was explained as connected and topics logically building on each other. In England, however, the connotation was that it was theoretical if one could 'understand the workings out and how numbers and statistics work', in short a more formulaic approach—different from making connections in mathematics. This is likely to be influenced by how mathematics is perceived, also by teachers.

In theoretical terms, and summarising the seven before mentioned themes, it is argued that attitude towards mathematics is influenced and shaped by the following:

- work ambitions and opportunities to fulfil these,
- how mathematics is presented and 'done',
- teacher's pedagogic practice,
- a supportive environment outside school and
- the examination system and its associated practices.

Whilst not being entirely new, the identified influences emphasise the situated-ness of 'pupil attitude towards mathematics' within a 'meaningful' environment. Furthermore, I have shown how these constructs are intrinsically interwoven, and come together in 'attitude towards mathematics', when pupils write about their experiences. Thus, it is claimed that it is not enough to identify the factors that may shape and influence pupil attitude, but more importantly study how these are 'lived' by pupils, what meanings are made in classrooms and in different contexts, and how the factors interrelate and can be understood.

Acknowledgments I am grateful to the teachers and students in the English and Norwegian schools, and to my Master students, for their support with this study.

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