

DO CLASSES AND SCHOOLS HAVE AN EFFECT ON ATTITUDES TOWARDS MATHEMATICS?

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Abstract

In this study we investigate differences among students, classes and schools in attitudes towards mathematics focusing on the student and home characteristics, group composition, and learning environment characteristics. We used data from TIMSS-R and our dataset consists of 4168 eighth-grade Flemish students, 261 classes and 133 secondary schools. Multilevel analyses showed that most of the difference in attitudes towards mathematics is situated between students from the same class (84.4%); 13.3% is between classes from the same school and 2.3% between schools. Cognitive abilities and the parents' education as well as the extent to which students experience the teaching as being constructivist (individually and as a group) and the class learning climate could explain differences. The school composition with respect to the sex mix causes differential effects for girls and boys (an equal sex mix favours boys) and also in relation to students with different comfort at home.

INTRODUCTION

Results from the Third International Mathematics and Science Study in 1999 (TIMSS-R) showed that Flemish students at the end of the eighth grade scored lower than the international average on attitudes towards mathematics (30th of 38 places). Nevertheless, Flemish students scored well above the international average on mathematics achievement (6th of 38 places). In other words, Flemish students perform well in mathematics although they don't like the subject. However, students who perform well in mathematics generally have more positive attitudes towards mathematics (Mullis et al., 2000, p. 137). This paradoxical result points to the need for a clearer understanding of students' attitudes towards mathematics.

The fact that some students have more positive attitudes towards mathematics than others is well studied (Aiken, 1974; Boekaerts, 1993; Brassell et al., 1980; Garaway,

1994; Haladyna, 1983; Hannula, 2002; Helmke, 1992; Kaiser-Messmer, 1993; Ma, 1997; McLeod, 1994). Differences in attitudes towards mathematics have been attributed to gender (Kaiser-Messmer, 1993), effects of the home (parental support, parental education), (Cai, Moyer & Wang, 1997; Schreiber, 2002) and cognitive abilities (Ma, 1997). Less is known about differences in attitudes between classes in the same school and between schools. Scholars in educational psychology emphasize the impact of the learning environment (e.g., De Corte, 1995). The few research studies on learning environments in relation to attitudes towards mathematics seem to support the importance of constructivist learning environments (see e.g., Vaughan, 2002) or indicate differential effects of such environments (Jacobs et al., 1996).

PURPOSE OF THE STUDY

In our study we examine the differences between student, class and school attitudes towards mathematics, focusing on the student and home characteristics (cognitive abilities, gender, indicators of the socio-economic status of the family, language at home), group composition characteristics based on the above-mentioned student characteristics, and learning environment characteristics (in particular with respect to principles of powerful learning environments). We also investigate the way in which students experience the teaching of mathematics in their class.

In the eighth grade of secondary education in Flanders, students have to choose among several optional programmes for a limited amount of hours per week. Research by Opdenakker, Van Damme, De Fraine, Van Landeghem and Onghena (2002) reveals that the optional programme can explain differences in achievement among students. Therefore, we also pay attention to the particular optional programme students attend.

METHOD

Dataset, Participants, and Method of Analysis

We use data from TIMSS-R, including information on students' attitudes towards mathematics as well as data on their social and cultural family background, their classroom, their school and national contexts within which mathematics learning takes place (Mullis et al., 2000, p. 3). Written questionnaires were administered to students, teachers and parents.

In addition to the international data collection in Flanders - the Dutch speaking part of Belgium - some supplementary data were gathered (see Van den Broeck, Opdenakker & Van Damme, 2003; in press). Among other things, the data collection was extended with an intelligence test, additional questions on attitudes towards mathematics, a question about the optional programme and questions about the way in which students and teachers perceive the learning environment in mathematics classes (the extent to which the learning environment is perceived as constructivist by the student and by the teacher). A short parent questionnaire with questions on the educational level of the parents was also added to the international data collection as well as additional questions about the teacher and his/her class to the teacher questionnaire.

The intelligence test consists of two numerical subtests (numerical symbols and

numerical approximations) and two spatial subtests (folded squares and cross-sections), each with 20 items (Demeyer, 1999). A 'Numerical and spatial intelligence' score was calculated on the basis of these four subtests.

The additional questions related to attitudes towards mathematics are based on a Dutch instrument (see Martinot, Kuhlemeier & Feenstra, 1988; Luyten, 2000). The original instrument consists of four scales: pleasure, confidence, effort/interest, and relevance. All eight items of the 'confidence' scale were included in the student questionnaire. For the other three scales, the four items with the highest item-test correlation to each scale were selected. Questions from both the international data collection and the additional Flemish data collection were used in order to achieve a scale of attitudes towards mathematics. Typical questions are: 'I like to study mathematics', 'Mathematics is an easy subject', 'Mathematics is boring', 'I think it's important to get good grades for mathematics'; the reliability of the scale scores (Cronbach's α) is .93.

The questions referring to how students and teachers perceive the learning environment in mathematics classes (the extent to which they perceive it as constructivist) are based on the 'Constructivist Learning Environment Survey' (CLES) (Taylor, Fraser & Fisher, 1997). However, the items were reformulated because a direct translation into Dutch was not useful and a selection of six items was made. The same questions were administered to the students and teachers and asked whether students get the chance to discuss methods to solve problems and whether the teacher asks how much time students need to solve a problem. The reliabilities of the scale scores (Cronbach's α) for students and teachers are .76 and .74, respectively.

The question on the optional programme indicates which additional courses a student attends (classical languages with Latin and/or Greek, general subjects or technical subjects). A class can be composed of students who follow the same optional programme or students who chose different programmes.

The additional questions about the class group in the teacher questionnaire concerned, among other things, the study-orientation of the class group. The questions are based on a 'learning climate' scale from the teacher questionnaire of the LOSO-project (see Opdenakker et al., 2002), and more precisely on the subscale 'study-orientation of class group' (Van Damme, De Fraine, Van Landeghem, Opdenakker & Onghena, 2002). The scale consists of four items and the reliability of the scale scores (Cronbach's α) is .87 (Van Damme et al., 2002).

The dataset consists of 4168 students, who are nested within 261 classes, which are nested within 133 secondary schools. Multilevel models with three levels (the student, the class, and the school) and the program MLwiN (Goldstein et al., 1998) were used to analyse the data.

RESULTS

Distribution of the Variance over the Three Levels and Importance of Student Background

The multilevel analyses showed that most of the differences in attitudes towards mathematics are situated between students from the same class (84.4%); 13.3% of the differences may be attributed to differences between classes from the same school and only 2.3% of the differences may be attributed to differences between schools. When we controlled for intake we found that differences between students in the same class were reduced by 9.1%, the differences between classes within the same school by 6.7% and the differences between schools by 0%. (In particular, the cognitive abilities and the education of the parents seemed to be important). As 11% of the variance between students within classes is explained by student background and 50% of the variance between classes within schools is explained by recruitment differences, there are still a lot of differences between students and between classes within the same school that need to be explained.

Importance of Educational Practice, Curriculum, and Group Composition

Further analyses revealed that almost 5% of the variance in attitudes towards mathematics can be explained by the way in which students experience the teaching of mathematics and by the optional programme they choose. The student background, the study-orientation of classes, and the way in which students as a group experience the teaching of mathematics could explain additional variance in attitudes towards mathematics. In addition, the analyses indicated that the effect of the optional subjects students choose can partially be explained by the study-orientation of classes. With respect to school characteristics, the analyses indicated that the frequency of problem behaviour had a significant negative effect on the attitudes towards mathematics, even after factoring in student background and the way in which students experience the teaching of mathematics. Taken together, almost two-thirds of the variance at class and school level could be explained by these student, class and school characteristics.

Evidence for Differential Effects of Schools

It was found that in schools of equally mixed gender the attitudes towards mathematics of girls were rather negative and strongly positive for boys in comparison with other school types. The effect of comfort at home on the attitudes towards mathematics (mean effect of zero) seemed to vary from school to school and could be explained by the percentage of girls at school. In all-girl schools the attitudes towards mathematics are negatively related to the comfort at home, in equally mixed schools there is no relation between the two variables, and in schools with a low percentage of girls there is a positive relationship between comfort at home and attitudes towards mathematics.

CONCLUSIONS

In summary, the study indicates that class and school characteristics have an effect on student attitudes towards mathematics, even after factoring in student background characteristics. Classroom climate characteristics such as study-orientation and the extent to which students as a group experience the teaching of mathematics as constructivist seem relevant to attitudes. The school composition with respect to the mixing of sexes also seems important, and causes differential effects for girls and boys and for students with different comfort at home.

Thus, although attitudes towards mathematics are - like many other non-cognitive outcomes such as well-being and academic self-concept - strongly dependent on student background characteristics, our study reveals that class and school characteristics affect students' attitudes and that there is some evidence for differential school effects, in particular with respect to gender group composition. Based on our research, it seems that factors that could enhance the study-orientation of classes can play an important role in enhancing student attitudes towards mathematics. Our study also indicates the importance of school mix with respect to gender and poses a problem not easy to solve: schools equally mixed with respect to gender lead to rather negative attitudes towards mathematics among girls and strongly positive attitudes for boys. So, what is good for boys seems to be rather bad for girls. From another perspective, it might be that boys need girls (and perhaps the possibility of making comparisons with girls) to have positive attitudes towards mathematics.

In addition to these results, evidence was found for the importance of students' perceptions of the learning environment. The teacher's perception of the learning environment did not seem relevant, but the perceptions of the individual student and his/her classmates seem to affect student attitudes. The importance of people's perceptions of the environment on their behaviour is often mentioned in the literature, and there is some evidence that perceptions are more important than more 'objective' measurements of the environment (Bennet & Ward, 1993; McDowell, 1995; Zeidner, 1987).

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