TIMSS Science results seen from a Nordic perspective

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In this chapter we describe some characteristic features of the TIMSS science results as seen from a Nordic perspective, and in particular; Norway. Four out of the five Nordic countries participated in TIMSS: Iceland and the three Scandinavian countries, Denmark, Norway, and Sweden. (Finland did not take part, but participated as the only Nordic country in the repeat of TIMSS in 1999.) These four Nordic countries have much in common historically, culturally and politically. In the Scandinavian countries almost the same language is spoken, whereas Icelandic is different, but quite similar to the old common Nordic language. During the last six or seven hundred years Sweden and Denmark have rivaled each other for hegemony in the area, while Norway, Iceland, and Finland have been the smaller brothers in union with one or the other for most of the time.

Today all Nordic countries are independent democracies with a strong social democratic tradition. They are relatively homogeneous societies with highly developed welfare systems. There are also strong and friendly cultural links among the Nordic countries, even if the European Union has split these countries into members (Denmark, Finland, and Sweden) and non-members (Iceland and Norway). Sweden has the largest population, eight million, whereas Denmark, Finland, and Norway all have between four and five million. Iceland has a small population, about 200,000. It should also be mentioned that the climate is similar in all of these countries. Denmark stands out from the other Nordic countries in two respects: firstly, due to its position closer to the other North European countries it appears more “continental” both in climate and culture; and secondly, its relatively high population density makes Denmark somewhat different from the typical Nordic countries which have wilderness within easy reach of even the largest cities.

Nordic Education Policy and Science Education

Concerning education, there has been a common and strong commitment in all of the Nordic countries toward equal opportunity for all. There have been frequent educational reforms in the last decades, which have mutually influenced each other, so that we may speak of a “Nordic” educational policy. Characteristic features are compulsory schooling until the age of 16 with no ability-based streaming, free upper secondary schools covering both academic and more vocational lines of study, and a relatively late start to formal schooling at age 7. (The only exception has, until recently, been Iceland where schooling starts at age 6. After the reform of 1997 schooling now starts at age 6 in Norway also.) Furthermore, there are also similarities concerning curricular emphases in science and mathematics. One may summarize the situation by stating that, seen from an international perspective, the focus has been more on important daily-life aspects of science and mathematics than on more advanced and abstract concepts. In mathematics, algebra and geometry have received relatively little emphasis up to age 13. On the other hand, topics like measurement, estimation, and data presentation, and interpretation have been emphasized. The similarities in the results for mathematics have been shown to be so strong that one may speak of a “Nordic profile of mathematics education” (Lie et al. 1997).

The situation for science is somewhat similar. Topics such as the concepts of cells, atoms, and molecules have received relatively little attention compared to the more daily-life aspects. Student experiments play a central role in science instruction. The focus is more on visualization for conceptual understanding and on engagement and motivation, whereas relatively little emphasis has been given to the formal aspects of scientific investigation as a logical means of creating scientific knowledge.

Science in Norway differs from that in other Nordic countries in one important respect. Up to Grade 10, science is taught as an integrated subject, whereas courses at the lower secondary level are organized in the form of separate science courses in each of the other countries. While Norway follows the English (and other English-speaking countries’) tradition, their Nordic peers follow a general continental European tradition.

Norway and Iceland took part in all three populations. In Population 3 both did the mathematics and science literacy test, and Norway also the physics test for advanced students. Denmark and Sweden participated in Population 2 and all three tests (literacy, physics, and mathematics) in Population 3.

SCIENCE ACHIEVEMENT AS A FUNCTION OF AGE

We begin our discussion of the TIMSS data by looking at over-all science results for all populations, then focus on school effects and gender differences. Finally, we examine in more depth similarities and differences between countries regarding profiles of achievement across science topics and across test items.

First, we focus on trends in the science achievement scores from Population 1 to Population 3 (generalists). Figure 1 summarizes changes in science achievement across age groups for selected countries. What is shown for each country and grade level is the science score above (+) or below (–) the mean for the 12 countries that participated in all three populations. Note that all the mean values are for the same set of countries, namely those which participated in all populations, and that these averages therefore are somewhat different from the international means for *all countries* which is published in the international TIMSS reports (Beaton et al. 1996, Martin et al. 1997, Mullis et al. 1998) and used elsewhere in this chapter. The lines between the points of measurement have no meaning except as a means of simplifying the tracking of each country’s changes.

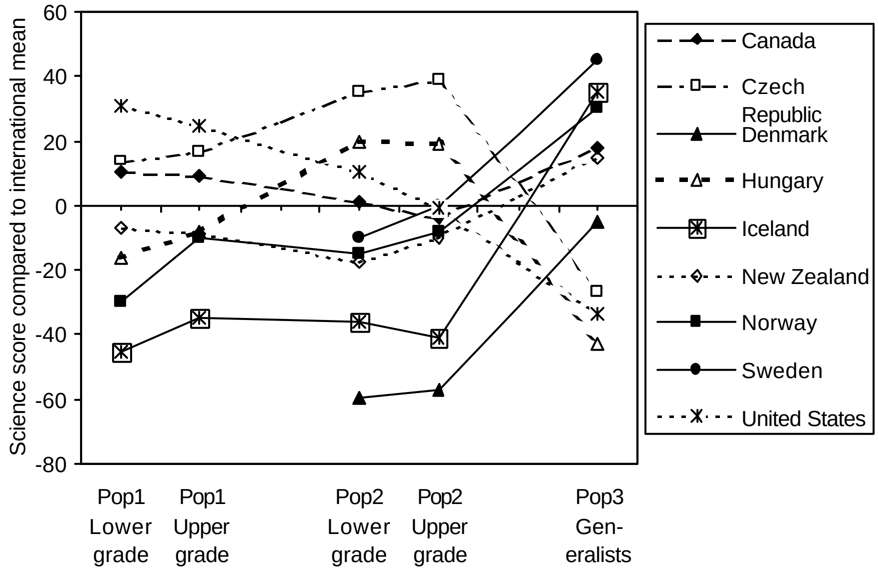

Figure 1. Science achievement in all three populations

In Figure 1 we have, in addition to the Norwegian and Icelandic results, also displayed the results also for Denmark and Sweden even though they did not participate in all three populations. Furthermore, by including some other countries, we want to illustrate examples of some typical trends. It appears that all four Nordic countries did score relatively poorly in Populations 1 and 2. Even Sweden, as the highest-scoring country of the three groups, is below or at the mean. (It should be mentioned that Finland in the repeat of TIMSS in 1999, scored higher than its Nordic counterparts did in 1995 (see Martin et al. 2000). From the point of view of the Nordic countries, however, the main message is very clear. Nordic students tend to score relatively higher as they grow older. The results for Canada and New Zealand show a similar upward trend, but not as pronounced. Also, results from the Netherlands show a weak upward trend, but substantial reference to this country has been avoided here due to its extremely low participation rate in all populations (Martin et al. 1997; Beaton et al. 1996; Mullis et al. 1998). The Eastern European countries, Hungary and the Czech Republic, both have a strong downward trend from Population 2 to Population 3, a common feature also for the Russian Federation and Slovenia (Mullis et al. 1998), but not shown here. For the United States we see that the downward trend is continuous and very pronounced.

When discussing results for the generalists of Population 3 it is important to have in mind that the samples are not easily comparable across countries. Both students' ages and the coverage of the age cohort vary from country to country (Mullis et al. 1998). However, particularly for Norway and Sweden, where more than 70 percent of the age cohort is covered by the sample, the high level of average achievement seems to be well established by the present data.

A similar trend of higher relative achievements by age for the Nordic countries may be found in the parallel results for mathematics (Mullis et al.

1998), albeit with somewhat lower Nordic results (except for Denmark). The results for the physics specialists are remarkable from a Nordic point of view. Norway, Sweden, and Denmark all rank among the four highest-scoring countries (Mullis et al. 1998). Again, since the age cohort coverage varies greatly from country to country, depending on the country's definition of a physics specialist, the rank order of countries should not be taken at face value. However, taken together, the high overall achievement level in science for the Nordic countries at the end of schooling seems to be a valid finding. It should be noted, however, that the Nordic students are older than their international peers (Mullis et al. 1998).

There are essentially two types of cultural explanations that have been put forward in relation to the results discussed here. One focuses on the Nordic emphasis on education for all, with high school-participation rates even at the upper secondary level, above 90 percent. Furthermore, theoretical subjects do play an increasing role even within the more vocational lines of study. It is well worth mentioning that students within what may be regarded as vocational lines of study in all four Nordic countries score at or above the international mean for all students (Mullis et al. 1998). The national reports for each of the Scandinavian countries discuss this point thoroughly (Allerup et al. 1998, Chapter 7; Angell et al. 1999; Skolverket, 1998) and draw attention to this positive effect of schooling for all. In particular, the Swedish (Skolverket, 1998) and Norwegian (Angell et al. 1999) national reports tend to interpret the results as an indication of an educational policy that in this respect has been fruitful.

The second type of explanation has to do with a view of childhood. There is a common tradition in Nordic countries to "let children be children" in the sense that little educational (and other) pressure is put upon them at an early age. The late start of schooling and relatively few classes per day during the first years are examples. Even more significant probably is the fact that formal marks are not given in the primary school at all. Furthermore, repeating grades does not occur in the compulsory school (primary and lower secondary).

The East Asian countries Singapore, Japan, and Korea dominate the TIMSS league tables for Populations 1 and 2. (None of these countries participated in Population 3). In these countries there is a tradition of putting strong pressure upon children to do their best at school. This strong pressure is embedded in the culture and seems to give a general explanation of the strong results for these countries. We believe that, insofar as views on childhood are concerned, the Nordic countries are at the opposite extreme. Some contextual TIMSS data may shed light upon this matter. The responses to two questions in the TIMSS Population 2 questionnaire are particularly relevant here. Students were asked about how important it was for them to do well in science and to have time for fun.

In Table 1 we present the mean response for each of the Nordic countries together with the international mean. Country means have been calculated from the Likert scale responses on a scale from "Strongly disagree" (1) to "Strongly agree" (4) that the topic is important for them. The message from the table is clear. In their judgment, Nordic students seem to regard success in school science to be somewhat less important and time for fun to be clearly more important than their international peers.

Table 1. Population 2 responses to questions on importance

Country	*Do well in science*	*Time to have fun*
Denmark	3.21	3.85
Iceland	3.32	3.71
Norway	3.27	3.81
Sweden	3.07	3.77
International mean	3.30	3.58

On some other items for Population 2, students were asked how much time was used before or after school on certain activities on a normal day. Again, it is typical for Nordic students to spend a lot of time with friends (Denmark and Norway, together with Germany, at the top) and doing other non-academic activities, whereas homework takes very little of their out-of-school time (Denmark at the very bottom), see Beaton et al. 1996).

WITHIN- AND BETWEEN-SCHOOL VARIANCES

As described earlier, the Nordic countries are rather homogenous societies. This is also true for their education systems, and TIMSS data throw some light on this point. Countries vary as to how "similar" students are in the same school or classroom. Obviously, relatively low similarities between classrooms will occur in countries with a streamed system, i.e. where high and low achievers attend different classes or different schools. The opposite will happen in countries with no within or between-school streaming. If, in addition, the society is relatively homogeneous, each classroom could mirror the whole population. Generally, at Population 1 the streaming effects are very small, and at Population 3 they are dominant. In the following we discuss some data for science achievement at Population 2, upper grade. Here we expect to find the largest differences between countries. Since almost all of the countries sampled only one intact (mathematics) classroom per sampled school, one cannot partition the within-school variances into within-class and between-class components. This should be kept in mind when we discuss the within-school and between-school components of the variances in the following.

The percentages of the total variance in science achievement that occurs between schools (or rather is associated with the combined between-schools and between-classrooms-within-schools effects) are given in Martin et al. (2000). While the international average is 23 percent, all four Nordic countries appear among the eight countries with 10 percent or less of the total variance occurring between schools. (Due to shortcomings in the Danish sampling procedure, the value for Denmark is not shown in (Martin et al. 2000), but the actual value is below 10 percent). The other countries with similarly high homogeneity are Japan, Korea, Slovenia, and Cyprus. On the other extreme, more than 40 percent of the variance is associated with schools in Romania, the United States, Germany, and Singapore.

Thus, from an international perspective, science achievement in the Nordic countries appears as rather school-independent. Differences between schools seem to be relatively small, both between urban and rural areas and between high- and low-socioeconomic localities. This in itself does not mean that home background factors are not important predictors of science achievement, neither does this provide any clear explanation of the rather dramatic increase in student achievement with age for the Nordic countries discussed in the former section. But the findings can be interpreted to indicate that an important educational goal of equal opportunity for all in the Nordic countries seems to some extent to have been fulfilled.

Achievement Differences between Science and Mathematics

If we compare the TIMSS science and mathematics achievement scores for the same countries, it is striking that for all three populations the league tables for the two subject areas look quite similar. However, a closer look reveals some characteristic differences, as we can define certain countries as "mathematics countries" and others as "science countries" according to the difference between the country's science and mathematics mean score. An interesting pattern emerges if we investigate this further and combine results for all three populations. In general, the most pronounced "mathematics countries" are the East Asian countries (Hong Kong, Japan, Korea, and Singapore) together with the French-speaking countries (France and French-speaking Belgium). On the other hand, England and most of the other English-speaking countries appear to be "science countries," and consistently so across populations.

Now, let us look at the Nordic countries from this perspective. In Table 2 we have shown the difference between the mean science and mathematics scores for the Nordic countries together with the international extremes ("Maximum" being the most pronounced "science country," and "Minimum" as the most pronounced "mathematics country"). Norway, Sweden, and Iceland all appear consistently above the average line as "science countries." On the other hand, Denmark's results are clearly and consistently different from their Nordic counterparts, and one may speculate as to why this is so. Denmark seems, as a "mathematics country," to put relatively more emphasis on mathematics; or, formulated alternatively, relatively less focus on science. A similar picture emerges even when one compares the results of the mathematics and physics specialists in Population 3 (Mullis et al. 1998; Angell et al. 1999).

Table 2. Differences between science and mathematics mean scores

Country	*Population 1*	*Population 2*	*Population 3*
Denmark	n/a	–24	–38
Iceland	31	7	15
Norway	28	24	16
Sweden	n/a	17	7
Maximum	39 (England)	46 (England)	21 (Czech Rep.)
Minimum	–78 (Singapore)	–66 (Hong Kong)	–38 (Denmark)

There is no easy explanation for why countries differ along this science-mathematics dimension. Obviously, different traditions regarding structure, emphasis, and content of the curriculum may play important roles; traditions that in turn may have deep cultural antecedents. Such cultural factors may be instrumental if one tries to understand what makes English-speaking countries "science countries" and French-speaking and East Asian countries "mathematics countries." However, concerning the difference among the Nordic countries, a more "local" explanation is called for, due to the otherwise close similarities in cultural traditions (Allerup et al. 1998; Lie et al. 1997). Geographical factors may have some influence on what is considered important and therefore emphasized in school. Wilderness in the form of forests, mountains, lakes, or coastlines is within close reach for essentially all Norwegian, Swedish, and Icelandic (as well as Finnish) people. A common extensive right for everybody to go wherever you want (except gardens and fields during the summer) exists in these countries. By using nature for all sorts of purposes, students in these countries may well have learnt some science outside school that has helped them to solve TIMSS items. In this respect Denmark is somewhat different with its high population density and more cultivated landscapes. It should be noted here that from the results of TIMSS–99, Finland also appears to be a "science country," with a science-mathematics difference of 15 score points (see Martin et al. 2000 and Mullis et al. 2000).

GENDER DIFFERENCES

As an important part of the struggle for equal opportunity, gender equity has been given high priority in Nordic education and in the Nordic societies in general. For many years the Nordic countries have had the reputation of being the part of the world where gender equity has come the farthest. This picture may well represent one important part of the situation, in particular when it comes to strict laws against discrimination or to the number of females in the parliament or in the government. Also, a female prime minister (Norway) and female presidents (Iceland and Finland) have received international attention. In the *Human Development Report* published by the United Nations Development Program (UNDP, 2000), the five Nordic countries came out as the first five in a list of 150 countries regarding their scores on indices of gender equity.

Within science and mathematics education, it has been an important international aim to provide equal opportunities for both sexes. However, young women are generally under-represented both within higher education and in jobs that involve these subject areas, in particular mathematics and physics. The situation in the Nordic countries is not any better than in most other countries. The fact that gender equity in general has been given such high priority makes it particularly troublesome that mathematics and the "hard" sciences still have such a masculine image.

Internationally, gender related issues in science education have been the focus of much research and a number of anthologies have been published (e.g. Wilson, 1992; Parker et al. 1996). Since the early eighties there have also been held a number of GASAT ("Gender and Science and Technology") international conferences on the topic (e.g. GASAT 8, 1996). IEA studies are very well suited for a closer inspection of gender differences, as they provide valid and reliable data on achievement as well as attitudes. The IEA First International Science Survey was the basis for an extensive discussion on gender differences (Kelly, 1981). Results from the Second International Science Study (SISS) and TIMSS have provided important data for gender-related in-depth studies (e.g. Parker et al. 1996; Mullis et al. 2000).

We start our inspection by focusing on gender differences as a function of age. In Figure 2 results in the form of differences between boys' and girls' mean science scores have been displayed for all the Nordic countries together with the international mean. These differences can be directly compared across populations due to the common metric for the standardized student scores (international mean = 500 and standard deviation = 100 for each population).

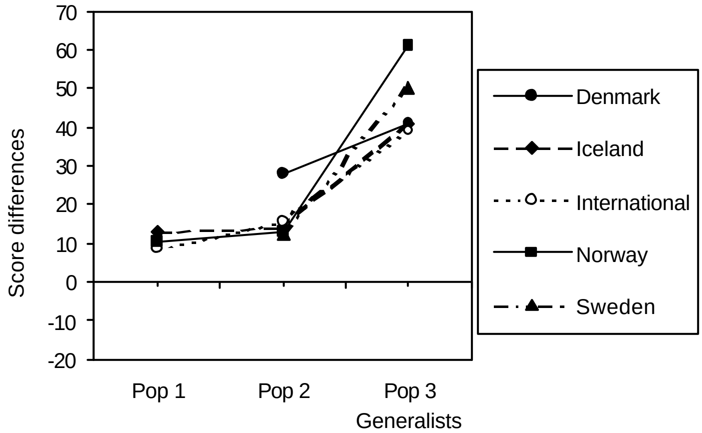

Figure 2. Science score differences in favor of boys

Let us first look at the results for the two lower populations (data are shown for the upper grades). For Iceland, Norway, and Sweden the gender differences are quite similar to the international situation. In all three countries boys score significantly, but not very much, higher than girls. The effect size of the gender differences, also called the standardized sex difference (SSD, difference divided by the pooled standard deviation) is of the order of 0.15. For Denmark, the gender gap is already rather wide at Population 2, in fact the widest of all the participating countries after Israel. Results for the TIMSS performance assessment component have not been included in the discussion so far, but it should be mentioned that no significant gender differences for the overall science part of this component were found in any of the participating countries, including Norway and Sweden (Harmon et al. 1997).

There are indications that internationally a remarkable decrease in the gender gap has occurred during the last decades. The above-mentioned SSD of 0.15 for TIMSS is much lower than that of the first IEA science study, which reported an SSD of 0.46 (Comber & Keeves, 1973) and the second science study, with an SSD of 0.36 (Postlethwaite & Wiley, 1992). Care must be taken not to draw simple conclusions from these numbers. The countries were not the same, and the Population 2 students in the earlier studies were somewhat (typically two years) older. But even among Population 1 students in the earlier studies, the SSD values were higher than 0.15 (0.23 in both studies).

When we move to science literacy for Population 3 it should be remembered that comparisons between countries must take into account which parts of the student age cohorts have been sampled. In particular, countries differ in the extent to which typical vocational lines of study have been included. Nevertheless, the general picture seems to be quite significant. Figure 2 displays a general dramatic increase in gender differences in favor of males when we go from Population 2 to science literacy in Population 3. This increase occurs in all countries (Mullis et al. 1998) and reflects, to a large extent, gender differences in curricular choices for Population 3 students. However, it is notable that, particularly for Norway, but also for Sweden, the gender gap is much wider than elsewhere. In fact, the Norwegian difference stands out as the very highest of all countries and amounts almost to an effect size of as much as 1.0 (gender difference equals the standard deviation). From Figure 2 the situation for Iceland and Denmark seems somewhat "better" than for their Nordic counterparts. However, for these two countries, the Population 3 literacy sample represented a considerably lower part of the age cohort (55 percent and 58 percent, respectively) than in many other countries. If more of the vocational lines of study had been included, one would likely have seen Danish and Icelandic gender differences more like those of Norway and Sweden. Similarly, the very high cohort coverage in Norway (84 percent) is a factor to take into account when interpreting the extreme gender difference for this country.

As a general finding, we conclude that the gender gap in science achievement increases by age in all countries, and that girls' underachievement is particularly distinct in the Nordic countries towards the end of the education system. It should also be mentioned that the international results show that the gap is particularly pronounced in physical and earth sciences (Mullis et al. 2000), this being an international and well-known trend.

In an analysis of the Norwegian data, Kjærnsli and Lie (2000) showed that there is a general tendency for boys to outperform girls, particularly in topic areas that are not commonly covered in formal school science. A comparison of marks given within the same school science courses revealed no or very small gender differences. Nevertheless, significant differences in favor of boys appeared on the TIMSS science scores. It seems that boys, to a much higher degree than girls, are interested in science and accordingly learn more from media and other out-of-school experiences. This difference in interest may be an important factor in understanding girls' underachievement despite more effort within the subject in school (Mullis et al. 2000).

The large gender gap for science achievement has caused considerable concern in the Nordic countries (e.g. Hoff, 1999; Kjærnsli & Lie, 2000). Why is it that science has an even more masculine image than in other parts of the world? From the discussion above, it seems essential to consider differences in attitudes towards the sciences.

Attitudes toward Science

In this section we draw attention to some TIMSS attitude data we consider relevant for the above discussion on gender differences. We regard attitudes at Population 2 level to be particularly crucial because these students have recently made, or (as in the Nordic countries) are within a year or two of making their first important curricular choices. In addition to achievement, students' attitudes towards the sciences obviously will have an effect on the selection, or non-selection, of science-related subjects and areas of study.

From the Population 2 questionnaire data a construct has been made based on the overall measure of students' responses on a four-point Likert scale to several items about how well they liked science and to what degree they would like a science-related job (Beaton et al. 1996). The focus here is not a comparison between countries' mean scores on this construct, but the score differences by gender. The data are somewhat complicated by the fact that these questions were included only in countries where science is taught as one integrated school subject. As explained earlier, among the Nordic countries this only applies to Norway. But the Norwegian data is very pronounced. Except for Japan, in none of the 22 countries in this category (of integrated science) was the gender difference as large as in Norway. The effect size of this difference amounts to 0.30, or about twice the magnitude of the achievement difference at the same grade level. From the point of view of gender equity we therefore regard this Norwegian "attitude gap" as more serious and having more consequences than the "achievement gap" at Population 2 (Kjærnsli & Lie, 2000).

Similarly, a comparison between countries with courses in the separate sciences reveals that, also in Denmark and Sweden, boys have a much more positive attitude towards science. However, no strong attitude gap appears in the Icelandic data. It should be noted that for all countries, gender gaps mainly appear in the physical sciences.

It appears from the data discussed here that the large gender gap in science achievement in Population 3 in the Nordic countries has an important prerequisite in the large attitude gap already existent by Population 2. It is not surprising that large differences in attitudes toward science influence both the tendency to choose science subjects in further education and also the degree to which some science is learned outside school. A recent international study on interests and experiences within science as well as images of science and scientists (Sjøberg, 2000), has reported quite similar to those discussed here. The situation in the Nordic countries regarding gender equity is described by Sjøberg as a paradox due to the particularly large gender differences in attitudes toward science in spite of the general high level of gender equity.

SIMILARITIES AND DIFFERENCES BETWEEN COUNTRIES

A View from Norway

Based on the similarities and common features mentioned in the introduction, one would expect the various TIMSS achievement results for Population 2, both overall and for individual items, to be rather similar for the Nordic countries. As has been described in another paper in this volume (Chapter 9), the results for Population 2 support this expectation concerning the item-by-item results that all the Nordic countries fall into the same ("Nordic") group based on patterns of responses to the science items. Furthermore, in order to investigate this from a Norwegian perspective, we calculated the correlation coefficients for *p*-value residuals (corrected for the international difficulty of each item and for overall science achievement for all countries) between Norway and all other Population 2 countries. The list of correlation coefficients can be interpreted as a list of countries sorted by the similarity of the science knowledge of the students compared to that of their Norwegian peers. Results are shown in Table 3.

Table 3. Correlation coefficients for p-value residuals between Norway and other countries

0.10 or higher	*0 to 0.09*	*-0.11 to 0*	*-0.17 or lower*
Sweden (0.54)	Spain (0.09)	Thailand (0.00)	Cyprus (-0.17)
Denmark (0.43)	Ireland (0.08)	Israel (-0.01)	South Africa (-0.17)
Iceland (0.31)	Belgium (Fr.) (0.08)	Slovenia (-0.05)	Kuwait (-0.17)
Switzerland (0.22)	Germany (0.06)	Latvia (-0.05)	Hungary (-0.18)
New Zealand (0.21)	Australia (0.06)	Portugal (-0.07)	Bulgaria (-0.19)
Canada (0.14)	France (0.05)	Korea (-0.08)	Lithuania (-0.19)
Belgium (Fl.) (0.12)	Japan (0.04)	Greece (-0.08)	Philippines (-0.20)
Scotland (0.12)	United States (0.03)	Singapore (-0.08)	Russian Fed. (-0.20)
Netherlands (0.10)	England (0.00)	Austria (-0.10)	Czech Rep. (-0.21)
		Slovakia (-0.10)	Hong Kong (0.22)
		Colombia (-0.11)	Iran (-0.26)
			Romania (-0.27)

As expected, Sweden, Denmark, and Iceland are clearly the top countries, and they are followed by Switzerland (0.22), New Zealand (0.21), and Canada (0.14). Seen from a Norwegian point of view, the other Nordic countries appear quite "close." Other pronounced features are that all English-speaking countries appear relatively close (at or above zero) and that all Eastern European countries appear "far away" (negative), features that may be interpreted as similar and very different emphases in science education, respectively.

Achievement Across Items and Content Areas

If we go into more detail concerning subject matter topics, or rather individual items, we can also demonstrate the similarity of student achievement among the Nordic countries. In Figure 3 we have, as an example, displayed the *p*-values for each individual physics item for Norway (solid line) compared to the international mean (heavy dotted line) and the highest- and the lowest-scoring country (weak dotted lines). The items are sorted in descending order of international mean. Also shown is the (shaded) area of variation that the other three Nordic countries cover for each item. The figure (Zabulionis, 1997) shows that the Norwegian results, with very few exceptions, vary within a Nordic "river" of *p*-values. Thus, we have another strong indication that Nordic students have more or less identical strengths and weaknesses across the different science topics.

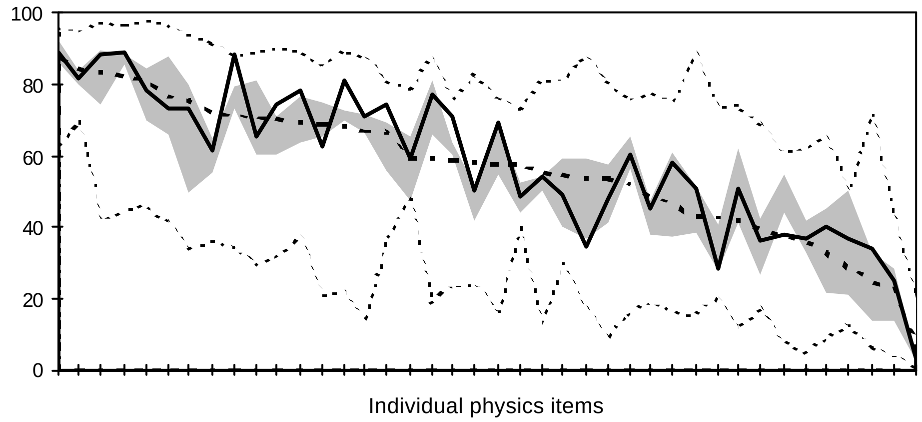

Figure 3. p-values for individual physics items, Population 2 upper grade

Achievement Across Content Areas

Finally we look more closely into what sorts of similarities one can find among the Nordic countries when it comes to student achievement across content areas, and how this relates to international means. Figure 4 shows the achievement in the form of *p*-values for each of the content domains in Population 2, upper grade. The difference between each country's *p*-value and the international mean is displayed. Data are given for each domain for the Nordic countries together with the highest- ("Max") and lowest-scoring ("Min") country for each domain.

From Figure 4 one can see very strong similarities among the Nordic patterns. In particular, Norway and Sweden follow each other closely and Denmark and Iceland even more so. The similar traditions in curricular emphases are clearly reflected, in particular the strong influence from Denmark to Iceland. There are also a few characteristic differences: Earth science seems to be more emphasized in Norway and Sweden than in the other two countries. And further, chemistry topics seem to be more emphasized in Sweden than in the Nordic counterparts, where traditionally chemistry has been given little emphasis at early age. In Norway, after the national curriculum reform of 1997, partly as a response to the TIMSS results, there is now more focus on chemistry than before.

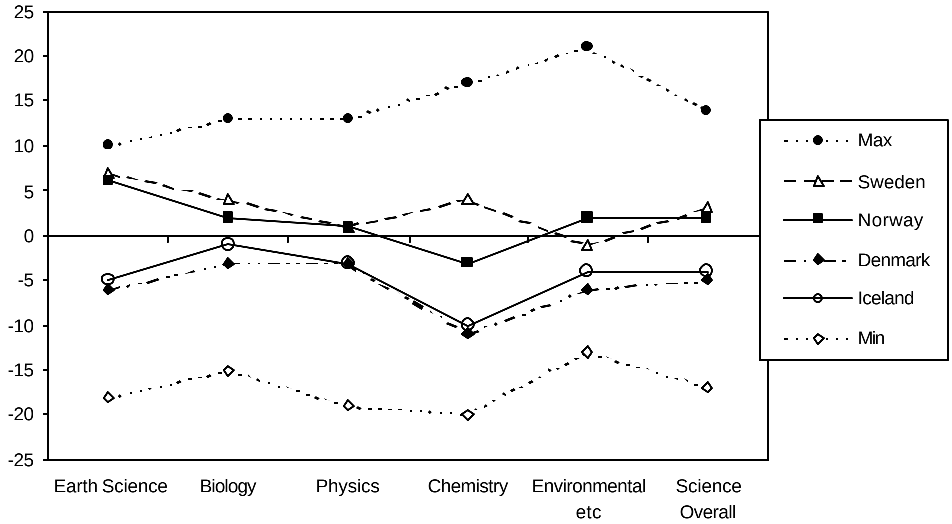

Figure 4. Achievement score above or below international mean within content areas, Population 2, upper grade

CONCLUSION

In this chapter we have analyzed the TIMSS science results seen from a Nordic point of view. We have focused on some characteristic features that have emerged from the data. The relatively low achievement level at Populations 1 and 2 in spite of the high level of expenditure has caused serious concerns in the Nordic countries. On the other hand, the upward trend of achievement by age has been positively received. The Population 3 data, taken as a whole and interpreted with care, indicate a relatively positive outcome for the Nordic education systems, taken as a whole. Further research may investigate what the crucial factors are for this accomplishment, and in particular how it is related to the Nordic tradition of putting low educational pressure on students at an early age, and strong emphasis on education for all.

Gender differences in science achievement have been shown to represent a particular problem for the Nordic countries, in spite of the high standard of gender equity more generally. Students' attitudes toward science have been discussed as a possible crucial factor in the development of gender gaps in achievement.

The last part of the chapter has focused on similarities and differences between countries regarding profiles of achievement across items and content areas. The striking similarities among the Nordic countries have been clearly demonstrated in various ways. It is also interesting to note that Nordic science education seems to be relatively "close" to the tradition in English-speaking countries, whereas Eastern European and Asian countries seem to have quite different emphases in their educational approaches.

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