Comparison of student Positive Attitudes Towards Science (PATS) with students' results in Australia, England, Norway and Sweden.

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Abstract

This study investigates the relationship between student achievement in science and students positive attitude towards science according to the results collected in TIMSS 2007. Four countries with some similarities and differences in the school system and science education were selected. The students' results have a strong correlation to the index PATS in all four countries, but there are some differences between Sweden in particular to the other three countries. In Sweden the students have answered questions particularly to Biology, Chemistry, Physics and Geography and the other countries questions to science as one subject. The conclusions from the study is that the differences in TIMSS points when students' PATS is regresses against students results as plausible values in science compared to the countries mean is that this measure in Sweden is approximate half a standard deviation in TIMSS points. Differences in students' PATS regresses against students results as plausible values in science compared to the countries mean for the three other countries in this study are approximate half of the same measure of Swedish students, and even lower for Norway. Some tentative explanations for this difference are discussed in this paper, with focus of countries difference of curriculum structure, assessment habits and school culture.

Keywords: Science curriculum, assessments, attitudes to science, student achievements

Purpose

The main purpose of this study is to investigate the relationship between achievement and students' PATS, according to the results collected in the TIMSS 2007. Four countries were selected; Australia, England, Norway, and Sweden. According to TIMSS 2007 the proportion of students in Norway and Australia with high PATS have increased slightly since 1995. In England there is high decrease of students with high PATS (-15 percent from 1995 and -21 percent from 1999). The number of Swedish students with high PATS have decreased with -8 percent since 1995 (Martin, Mullins, & Foy, 2008).

In Sweden both high achieving girls and boys are less positive to all three subjects in 2007 compared to 1995 according a special study of this (Adolfsson, 2009). According to the same study the decrease of positive attitudes are largest for high achieving boys. Low achieving students, especially girls in physics and chemistry, is found liking science better

2007 than in 1995. During the same time students results in science in Sweden have gone down dramatically according to TIMSS results (Karlsson, Kjaernsli, Lie, & Åström, 2006).

Students in England have shifted from a large group having high PATS to having lower PATS. It is not the case in Australia, Norway and Sweden to that same amount. The secondary purpose of this study is to investigate and discuss some possible systemic similarities and difference between the four countries selected in the study in the light of the changing student attitude toward science.

Educational and academic significance of the study

An aim of this study is to compare four countries that bear similarities and differences in school systems to find if the correlation between students PATS illustrates some important feature of how students attains the curriculum. This study illustrates some differences between four countries with also much similarity. Swedish and Norwegian curricula have some resemblances in school system that is not found between the Finnish and Danish curricula (Lavonen, et al., 2009). One thing that is similar between Sweden and Norwegian is that there has not been high stake Science testing for admission to higher education until recently entered at national level in Sweden (Utbildningsdepartementet, 2008). England and Australia share common history of structure of the curriculum. There have been high stake testing for higher admission entry for long time both on national and on state level (Hafner, 2006; Millar, 2007). The importance of the school subject for future work and study possibilities could be one factor of enhancing the importance and stress around the school situation.

All four countries have had some renewal of the curriculum during the period from 1995 to 2007 when the two TIMSS measurements were done. During the time period Sweden have had mainly a goal oriented curriculum system in resemblance of Norway. The Norwegian system from 1990 had themes cutting across the traditional subjects of science like “manifolds of nature”, “body and health”, “the world”, “phenomena and materials” and “technology and design”. The Swedish science system from 1994 is divided into three main theme concerning human and nature, the scientific process and applications of science. The three themes have a manifold of goals to achieve for the students to pass to accomplish the course (in compulsory school). England and Australia had curriculum system with standards at key levels for students to pass. In the new national curriculum of Australia that should be implemented recently there are key terms to learn about, content strands that describes scientific skills that should be acquired and science areas to be covered. There are unifying ideas that cuts across the traditional science disciplines like energy, sustainability, equilibrium and interdependence, form and function, evidence, models, explanations and theories. In the English system from 2007 there are key concepts and processes to be learned, like scientific thinking, applications

and implications of science, cultural understanding and collaboration, practical and enquiry skills, critical understanding of evidence and communication. The content ranges energy, electricity and forces, chemical and material behaviour, organisms, behaviour and health, the environment, earth and universe. Thus, all four countries work with science courses that have differing amount of thematic and traditional science content, with the Nordic countries more supporting the thematic content since longer time ago, with the English speaking countries coming from a traditional science content going towards a higher proportion of thematic content in the compulsory curriculum.

One difference between Norway and Sweden on one hand and Australia and England on the other is the boys and girls results in science (Martin, et al., 2008). The Nordic countries do not show difference between boys and girls results, while Australia and England shows significant difference between girls and boys results in TIMSS 2007 for eight grade students. An indication is that interest in science could be a factor of concern according to boys and girls different interests profiles (Schreiner, 2006).

One study done of student experiences of school science as a cross country study of Sweden, England and Australia concludes that students' experiences of school science in those countries have some relation to the declining interest and enrolment in high school and university science courses (Lyons, 2006). Another theoretical study argues for a research focus on students' attitudes to science to understand the nature of the decline of numbers choosing the study science (Osborne, 2003). An early meta-analysis of the relationship between science achievement and science attitude concludes that, according to their data, small children's successful achievement in science will cause positive attitude toward school science later on (Willson, 1983).

Perspective

The Norwegian curriculum has been described as thematic and poetic (Fensham, 2008), the Swedish as thematic (Strömdahl, 2006). Centralized assessment system bears resemblance between the two countries. In Sweden there have not been national assessments in compulsory science education until spring 2009 (Nyström & Åström, 2008; Åström, 2009). Norway does not have national science assessment in compulsory school but have a finishing assessment in upper secondary school. The emphasis on assessment during compulsory school has been low in science subjects.

Comparing the English system with the Australian an equal amount of assessments seem to occur in both countries (Hafner, 2006). England has a history of high stake assessment as the foundation of admission to higher education (Millar, 2007). In Australia the states have been

deciding about assessments, and also assessments have been held by teachers (Hafner, 2006). Australia and England have similar curriculum with key concept and processes. In Australia the students have an integrated science curriculum with mainly chemistry and physics (National Curriculum Board, 2009). In England students take one integrated science curriculum, but can choose additional science that is studied as specific subjects (Millar, 2007).

Sweden and Norway usually show similar results in international studies (Olsen, 2005a, 2005b). In Norway the curriculum is compulsory structured in an integrated manner where in Sweden it is possible to choose to work integrated or subject specific (Skolverket, 2001). Approximate 20 percent of schools in Sweden uses that opportunity (Åström & Karlsson, 2007). Studies in Sweden have shown that students with integrated science have a more positive attitude towards science but the enrolment in further science studies are lower from the group of students that have taken integrated science in contrary to subject specific science (Andersson, 1994). In the three countries of England, Australia and Norway the students answered the TIMSS student questionnaire with integrated science and in Sweden the students answered the TIMSS student questionnaire with subject science.

Methods of inquiry

Since there are two versions of questionnaire in TIMSS 2007, one for countries having integrated science and one for countries having subjects of biology, chemistry and physics there were a choice for the countries to answer either one student questionnaire for mathematics and science or one student questionnaire for maths and biology, chemistry, physics and earth science. Sweden had the subject divided student questionnaire and the three other countries in this study had the science questionnaire. Since earth science is not studied as a subject of its own in Swedish schools at grade eight the students answer on that questions are disregarded in this study. The variables in the database of TIMSS 2007 are described below and were selected and analysed with the IDB analyser provided from the IEA/ETS Research Institute in Hamburg. Correlations were calculated between students' results and the indexes for the four countries. Regressions were calculated between students' results and the indexes for the four countries with the IDB analyser. This gave a result of TIMSS points for students of high PATS for each country and index. Differences between the TIMSS points for students with high PATS and the country TIMSS mean were calculated for each country. In Sweden the difference between each single subject TIMSS points for the different subject indexes and the country mean were calculated.

Data sources

The data used in the analysis is from TIMSS 2007, for eighth graders. The variables are

combined in the index PATS are “I enjoy learning science”, “Science is boring” and “I like science”. Response options were “Agree a lot” to “Disagree a lot” on a four grade likert scale, with the variable of “science is boring” having a reverse scale. The student questionnaire Swedish student answered consisted of four specific subject items, with science substituted for the four science subjects. In this study the questions about earth science are disregarded since that subject is not studied as a single subject of students in eighth grade in Sweden. The index is computed by averaging the student responses with a scaling method described in the technical report of TIMSS 2007 (Olson, Martin, & Mullins, 2008, pp. 282-283).

Results

Correlations between students’ results (as plausible values in science) and PATS are lowest in Norway, 0,13. In Sweden the correlation between students results and PATS are 0,17, 0,21 and 0,21 for biology, chemistry and physics respectively. In Australia the correlation is 0,22 and in England it is highest with 0,26. Calculated correlations from each country divided on sex with standard estimates can be found in table 1.

[Take in Table 1 about here]

There are stronger relationships between the variables of positive attitude towards science and students results as plausible values of science for Australia, England and Sweden than for Norway. Calculating the regression shows significance when t-tested at 0,005 level for high PATS in Norway, Australia and England. In Sweden significance was shown when t-tested at 0,005 level of physics PATS, chemistry PATS and Biology PATS was significant for boys and girls. Students in all countries with high PATS have higher TIMSS points than countries mean. The regression values in TIMSS point for girls and boys divided on countries and in the case of Sweden also divided into different subjects are shown in table 2.

[Take in Table 2 about here]

Calculating the difference between the regression mean for high PATS and the mean science result in the countries shows in Norway the difference as 8 TIMSS points, in Australia the difference were 15 and 19 TIMSS points (differing on sex), in England the difference were 22 and 15 TIMSS points (differing on sex). In Sweden the differences were between 48 and 58 TIMSS points depending on subject and sex.

The percentage of students with high positive attitude towards science is lowest in physics in Sweden where 37 percent of the students have graded high PATS. Swedish girls have lowest percentage on PATS in physics, with only 33 percent grading PATS high. Swedish boys have

higher percentage of high positive attitude towards physics (42 percent). Swedish students also have a low percentage for high PATS in chemistry (43 percent), with girls having even a lower percentage (40 percent) and boys having 46 percent high PATS in chemistry. Swedish students have 52 percent high PATS in biology, with girls having 58 percent and boys 48 percent high PATS in biology. The three other countries have a percentage of between 48 (Australia) and 59 percent (Norway) of the students having a high positive attitude towards science.

Conclusions

A question asked in this study is how students' positive attitude towards science is correlated to the students' science results in Australia, England, Norway and Sweden. There are correlation between students' results and students' positive attitude to science in all four countries in this study. In this study there is lowest correlation between students' results and positive attitude towards science for girls in Norway. The highest correlation between students' results and positive attitude towards science in this study is for girls in England.

In comparing the regression value in TIMSS points of PATS to the plausible values in science the following appears. In Sweden the regression value of PATS to plausible values in science compared to country mean is higher than the regression value of PATS to plausible values in the three other countries. The country with second highest value of regression value of PATS to plausible values is England where the differences were 15 and 22 TIMSS points, depending on sex. The country with lowest difference between the regression value of PATS to plausible and the mean science result in the countries is Norway that has only 8 TIMSS points as difference. One difference in collecting data is that students' questionnaire differs according to if science or subject specific science is questioned. Therefore it seems as students positive attitude towards science have a bigger influence on TIMSS science results in Sweden than in the other countries. Sweden has a rather undefined curriculum where students and teachers are able to choose much of what content they should work with and how deeply they works with the material (Utbildningsdepartementet, 1994). If teachers and students choices of content and extent differs this could be an explanation of why positive attitudes towards science have a bigger influence of the science results measured.

A comparison of students positive attitudes in Sweden 1995 and 2007 shows that low achieving students, especially girls, have more positive attitude towards chemistry and physics in 2007 than in 1995 but that high achieving students, especially boys, have got less positive attitude towards physics in 2007 (Adolfsson, 2009). That result are interesting and needs further investigations since Sweden implemented a new curriculum in 1994, therefore students in TIMSS 2007 studied according to the new curriculum, but students in 1995 had

studied according to a curriculum from 1980. Some differences of the two curricula are the amount of independence and choices made possible for students study. The curriculum content or attainment of the curriculum could perhaps give some implication of why low achieving students are more positive and high achieving students are less positive towards science.

Since students in Norway have the least and Sweden have the highest difference between the regression TIMSS value and the mean value of the countries in this study this raises some particular questions. Even if those two countries have similar structure of the curriculum and outcomes in international comparisons groups in similar clusters (Olsen, 2005a), how come that students attitudes towards science in relation to students' results differs as shown in this study? Is it a prerogative to have positive attitudes towards science in Sweden to get high results in TIMSS but not in Norway? Or could the differing results be explained with the amount of science studied in the current age of students in each country? If a positive attitude towards science comes from earlier positive achievements in education as implied (Willson, 1983) could it be that Norwegian students have studied less science and had less opportunity to evaluate their own results?

Another question is why students positive attitude towards science in England have gone down since the earlier TIMSS studies (in 1995 and 1999) and what factors in England's school system could be traced as explanations for this. The result of this study require some further investigations of curriculum structure, content and assessment habits of the different countries since the four countries in the study works different according to these variables as shown in the discussion above.

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Table 1.

Country	Gender	Subject	Correlation	S.E.
Australia	Girls	Science	-0,18	0,04
	Boys	Science	-0,25	0,03
England	Girls	Science	-0,28	0,03
	Boys	Science	-0,23	0,02
Norway	Girls	Science	-0,12	0,02
	Boys	Science	-0,15	0,03
Sweden	Girls	Biology	-0,16	0,03
	Boys		-0,18	0,03
	Girls	Chemistry	-0,18	0,03
	Boys		-0,24	0,03
	Girls	Physics	-0,20	0,03
	Boys		-0,22	0,03

Table 2.

Country	N	Gender	Subject	Plausible value	S.E.	t-test
Sweden	1640	Girls	Biology	563,96	3,19	-2,25
			Physics	560,59	2,77	-3,82
			Chemistry	564,53	2,44	-2,71
	1780	Boys	Biology	567,61	2,99	-2,16
			Physics	564,42	3,09	-3,12
			Chemistry	560,28	2,79	-4,95
Norway	2262	Girls	Science	495,23	2,00	-5,14
	2300	Boys	Science	495,33	2,81	-5,02
Australia	1803	Girls	Science	520,20	3,47	-4,49
	2167	Boys	Science	542,58	2,84	-8,49
England	2045	Girls	Science	559,39	2,70	-9,85
	1916	Boys	Science	561,43	2,96	-8,30