Interest in science: evidence from TIMSS Italian data

Fabio Alivernini * 

Abstract

There is a strong interest in acquiring a better understanding of what influences interest in science since it is supposed to be related to pupils’ future scientific skills and studies. The aim of this study is to examine, for the Italian Trends in International Mathematics and Science Study (TIMSS) 2007 data, the relationship between contextual factors, at school level and at pupil level, and the students’ interest in science. A multilevel analysis is conducted considering the home/student level nested under the school/teacher level. Results and implications for future studies are discussed.

Keywords: multilevel regression model; TIMSS 2007; interest in science

1. Introduction

In many countries there is concern about the decline of interest in scientific studies (OECD, 2008), while the demand for scientific graduates grows. The analysis of the aspects related to interest in science from the earliest years in school is particularly valuable in order to discover the possible factors motivating young people to embark on scientific studies. The Trends in International Mathematics and Science Study (TIMSS; Martin, Mullis, Foy, 2008) concerning fourth grade pupils offers a precious opportunity to investigate this issue. TIMSS 2007 collected, along with data on pupils’ science performance, also information regarding a series of student, teacher and school variables. Fostering positive interest toward science is often an important goal of a science curriculum (Martin et al., 2008) and TIMSS 2007 developed the Index of Students’ Positive Affect Toward Science (Olson, Martin, Mullis, 2008) to summarizes information about students’ self-reported pleasure in studying science. Italian results from TIMSS 2007 showed that fourth grade students generally had a positive attitude toward science, with 77 percent of students at the high level of the index, 12 percent at the medium level and 11 percent at the low level. Unfortunately, TIMMS 20007 results did not clarify which factors, at different levels, were related to student’s scientific interest in the Italian context. According to TIMSS 2007 assessment framework (Mullis, Martin, Ruddock, O’Sullivan, Arora, Eberber, 2005), the structure of these factors should be a multilevel and a multidimensional one.

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1.1. Purpose of the study

The aim of this study is to examine, for the Italian Trends in International Mathematics and Science Study (TIMSS) 2007 data, the relationship between contextual factors at the school level and at the pupil level and the students’ interest in science.

2. Methods

2.1. Participants and procedures

Data is based on the answers of 4470 pupils in Grade 4 (48.7% girls and 51.3% boys), as well as those of the teachers and principals of the 170 schools which took part in the TIMSS 2007 study in Italy. The data was collected in the classes during the second periods of an ordinary school day.

2.2. Variables

Measurements were taken at home/student level and at school/teacher level. The dependent variable of the analysis was the TIMSS Index of Students’ Positive Affect Toward Science (Olson et al., 2008) which is based on students’ agreement with three statements about science: “I enjoy learning science”, “Science is boring” (reverse coded) and “I like science”. The Cronbach's alpha of the index in the Italian context was 0.81. The independent variables were the TIMSS international indices and variables which were supposed (Mullis et al., 2005) to be theoretically related to interest in science. TIMSS international indices (Olson et al., 2008) are based on questionnaire responses from students, teachers and principals. Only indices with an acceptable reliability in terms of internal consistency in the Italian context (Cronbach’s alpha above .60) were taken into consideration for the analysis.

The independent variables at the school and teacher level were:
- Index of teacher reports on teaching science classes with few or no limitations. The index was based on teacher’s perceptions about the instructional impact of some characteristics of their students (e.g. differing academic abilities, students with special needs, disruptive students). The Cronbach's alpha of the index in the Italian context was 0.64.
- Index of teachers’ perception of school climate. The index was based on teacher’s reports about the climate of their school in terms of an environment supportive of learning (e.g. teachers’ job satisfaction, parental support for student achievement, and students’ regard for school property). The Cronbach's alpha of the index in the Italian context was 0.85.
- Index of science teachers’ adequate working conditions. The index was based on teachers’ reports on physical aspects of the school environment that impact their working conditions and capacity to provide effective science instruction. The Cronbach's alpha of the index in the Italian context was 0.62.

The independent variables at the student level were:
- Gender (scored 1/0).
- Students’ reports about homes literacy resources (number of books at home).
- Index of students’ self-confidence in learning science. This index was based on students’ responses to four statements about their science ability (e.g. “I usually do well in science”; “I learn things quickly in science”). The Cronbach's alpha of the index in the Italian context was 0.62.

2.3. Data analysis

A multilevel analysis (Hox, 2002) was conducted using two levels, the home/student level and the school/teacher level.

The process of analysis was carried out in two stages:
1. A model with no explanatory variables (intercept-only model) was analyzed to estimate the school intra-class correlation.
2. The posited model was analyzed with all the variables taken into consideration in the present study.

3. Results

The intra-class correlation for the model was .03, meaning that only 3% of the variance of the scores for interest in science is attributable to school traits. Table 1 shows the results of the tested model.

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Coefficient</th>
<th>SE</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_{00}$</td>
<td>1.29</td>
<td>.1</td>
<td>118.59**</td>
</tr>
<tr>
<td>Teachers’ perception of school climate $\gamma_{01}$</td>
<td>.114</td>
<td>.028</td>
<td>.09</td>
</tr>
<tr>
<td>Teaching classes with few limitations $\gamma_{02}$</td>
<td>-.002</td>
<td>.02</td>
<td>-.1</td>
</tr>
<tr>
<td>Teachers’ adequate working conditions $\gamma_{03}$</td>
<td>-.001</td>
<td>.02</td>
<td>-.06</td>
</tr>
<tr>
<td>Home literacy resources $\beta_{ij}$</td>
<td>-.01</td>
<td>.01</td>
<td>-.12</td>
</tr>
<tr>
<td>Self-Confidence in Learning Science $\beta_{ij}$</td>
<td>.53</td>
<td>.02</td>
<td>25.99**</td>
</tr>
<tr>
<td>Gender $\beta_{ij}$</td>
<td>.02</td>
<td>.02</td>
<td>.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random effect</th>
<th>Variance component</th>
<th>df</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest in science $U_{ij}$</td>
<td>0.01</td>
<td>164</td>
<td>262.68**</td>
</tr>
</tbody>
</table>

* $p<.05$. ** $p<.001$

Results show that all the analyzed variables except for Students’ Self-Confidence in Learning were not significantly related to interest in science.

4. Discussion

This study was based on Italian data from TIMSS 2007 study and examined the relationship between contextual factors at the school level and at the pupil level and the students’ interest in science. This was done by means of multilevel regression modeling taking into account a set of variables, both at school and student levels.

Results at the student level showed that the only variable which was significantly related with student interest was students’ self-confidence in learning science. This result is consistent with the prediction from self-determination theory (SDT; Deci & Ryan, 2002). SDT claims that students’ interest is related to self-determination, an innate necessity connected to a number of basic psychological needs such as the need for autonomy and the need for competence. The need for autonomy refers to the need for individuals to perceive that their behaviour originates from personal choices. In other words, the person who implements a certain way of behaving needs to perceive an internal locus of causality (Deci, 1980). The need for competence refers to the human need to interact effectively with one’s environment and to be able to control it, to some degree at least, thereby producing desirable results and avoiding changes that are seen as harmful (Deci & Ryan 1985). According to SDT a high level of self-confidence should increase the level of perceived autonomy, which, in turn should increase the degree of interest.

Students’ Self-Confidence in Learning was the only student level variable, which was significantly related to student interest. Searching for other variables at this level, that could explain additional variance in students’ positive interest in science, one should take into consideration that research has shown that a parental modality which is supportive of autonomy as opposed to a controlling modality influences the motivation of pupils (Deci & Ryan, 1991). Parents whom external observers evaluated as being supportive of autonomy and more emotionally involved tended to have children who were more intrinsically motivated (Grolnick & Ryan, 1989). Within the
family the support of parents for autonomy is connected to their empathy, to being able to see things from the point of view of their children, to providing them with a choice on every occasion where this is possible, and to helping them to explore the world and to behave according to their own values and interests (Ryan, 1995). Unfortunately TIMSS 2007 instruments did not include a questionnaire for parents so, for the present study there was not the possibility to analyse a measure of parents support for autonomy.

As regard the school level, the results showed that only the 3% of the variance for interest in science was related to schools features and practices. Furthermore, none of the school level variables taken into consideration had a significant effect on student’s interest. Future studies and analyses will hopefully search for school level variables that can explain different differences between schools for interest in science. A possible direction could be to include, as a national option in TIMSS studies, a measure of teachers autonomy controlling behavior. As a matter of fact, several studies (e.g., Reeve, 2002; Assor, Kaplan, Kanat-Maymon, Roth, 2005) within a school context have revealed the negative effects on students’ interest in studying of teachers exhibiting various forms of controlling behaviors such as giving rigid directives, closely supervising and monitoring, or not allowing students the opportunity to express choices and opinions that differ from those proposed by an adult, compared to the positive effects of behaviors that support the autonomy of students such as providing possibilities of choice, listening and asking students for their points of view.

References


