# INFLUENCE OF CONTEXTUAL FACTORS ON STUDENT ACHIEVEMENTS IN MATHEMATICS, SCIENCE AND CIVIC KNOWLEDGE IN LATVIA

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## Abstract

The aim of this paper is to determine to what extent student achievements in civic knowledge and in science and mathematics correlate, and to see whether the influence of contextual factors on student achievements in these different subjects varies. Such knowledge would improve understanding of the learning process and suggest better ways for teaching, especially crucial for the teaching of civic knowledge in Latvia. In 1999 Latvia was involved in two IEA research studies: TIMSS and CIVED. 1355 fourteen-year-old students from 71 schools participated in both projects. Different contextual factors influencing student achievements in the above-mentioned fields of knowledge are analysed in the paper. Structural equation modelling and two software programs - Streams 2.5 and Amos 4.0 - were used as methodological and technical means.

## INTRODUCTION

In Latvia, two IEA studies, the Third International Mathematics and Science Study (TIMSS-R) and the Civic Education Study (CIVED), were conducted in 1999, such that a certain number of the 8th grade students participated in both studies. As CIVED was conducted in both the Latvian and Russian language, but TIMSS was only in Latvian, the 1355 Latvian speaking students sat both tests. Our investigation concerns this sample of students.

Previous research studies (Geske 1999, Geske 2001), have shown that Latvian students' achievements in Mathematics, Science and Civic knowledge strongly depend on contextual factors of education, especially family. Figure 1 shows achievement's dependence on the Family Cultural Capital Index. This index was created from students' responses to a subset of three questions: number of books at home (over 200, the index is 1, less 0); mothers' level of education (if

university, index is increased by 1, if not 0); fathers' level of education (same rule as for mother, +1 or 0). Considering students' responses to these 3 questions there are four possible values for the index: 0, 1, 2 and 3. Figure 1 shows a strong correlation between student achievement and Family Cultural Capital Index.

Achievements in Mathematics, Science and Civic knowledge strongly correlate indicating that they are influenced by common factors. Figure 2 shows the correlation between student achievements in Mathematics and Civic knowledge on class level - each point on the diagram corresponds to the average achievement of one class.

The aim of this paper is to assess whether there are any discrepancies in contextual indicators' impact on achievements in Mathematics, Science and Civic knowledge, and if "yes" - what are they?

*Figure 1: Achievements in Civic knowledge, Mathematics and Science depending on family cultural capital index. Civic achievements recalculated according to math and science scale (international mean 500, standard deviation 100)*

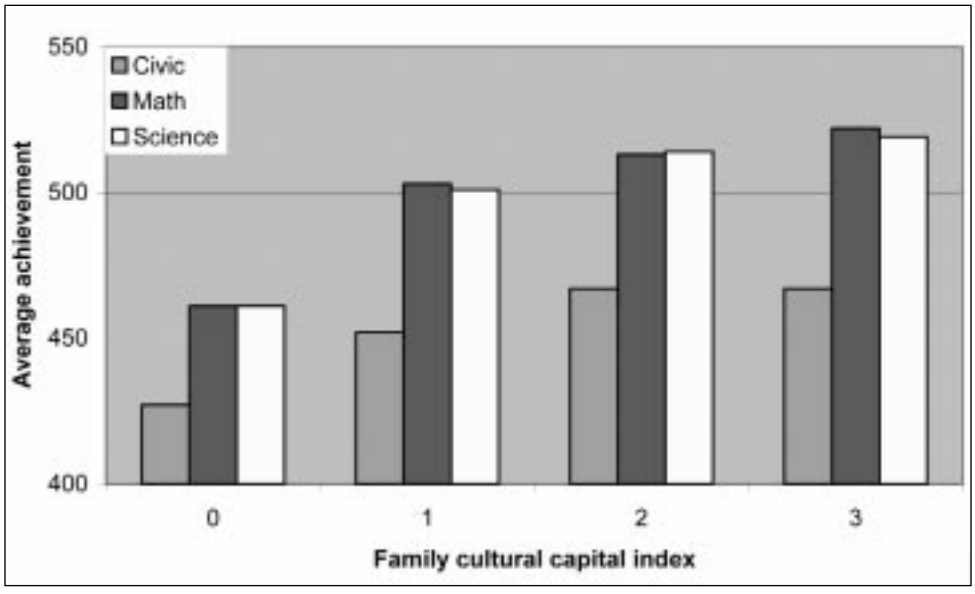
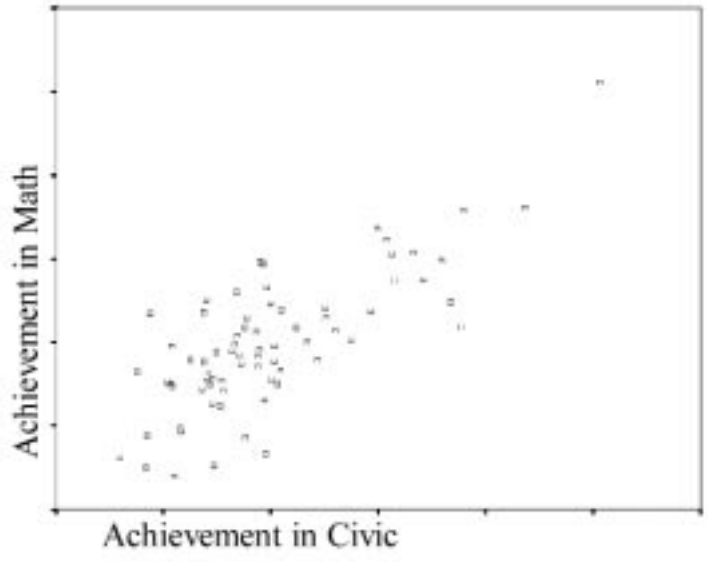


*Figure 2: Student achievements in Mathematics and Civic knowledge (class level)*




## METHODOLOGY

The influence of contextual factors on student achievements was analysed using trek diagrams and structural equation modelling. Models were generated by the software programme "Streams 2.5", but equations were solved iteravely with "AMOS 4.0". Approximate model calculations were performed using the maximum likelihood method. The conformity of the model with the data was assessed by two criteria - $x^2$ ratio of freedom degrees, as well as RMSEA criterion (Steinger's Root Mean Square Error of Approximation) (Loehlin, 1998).

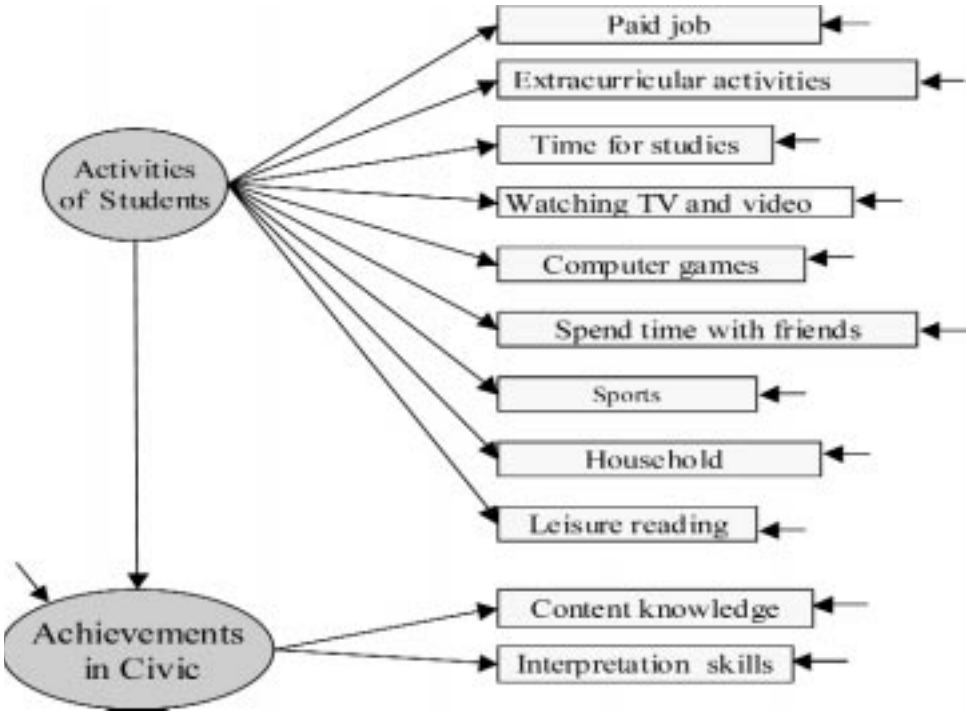
In our study, the performance of 1355 students in Mathematics, Science and Civic knowledge was analysed along with their opinions and attitudes. The number of students selected for analysis is sufficient for the chosen method. Other possible sources of data - Teachers' or Principals questionnaires - were not included in this study.

## PROCEDURE

A unitary data file was first produced from student results Mathematics, Science and Civic knowledge. The chosen model did not seem applicable for joint achievements with one variable, so student achievements in separate contextual or cognitive groups were used instead. Achievements in Mathematics were composed of achievement in solitary context fields: Algebra; Geometry; Fractions and number sense; Data representation, analysis, and probability, Measurement. Achievements in Science were composed of achievement in the following context fields: Life science; Physics, Chemistry, Environment and resource issues; Earth science, Scientific inquiry and the nature of science. Achievements in Civic were composed of achievement in fields of content knowledge and interpretation skills.

The initial data contained all variables from the student questionnaires in CIVED and TIMSS studies. Even after exclusion of some variables (equal or very much alike in both studies), the number exceeded 100. It was therefore impossible to randomly select a model to accommodate all variables. The final model was designed step-by-step starting with a mini model, i.e., a fragment of the model with two latent variables, one of which was achievements, the other was one of the factors influencing it. One such mini model is shown in Figure 3. The latent variables in this case are "Achievements in civic knowledge" and "Activities of students" (marked by ovals). Manifest variables (marked by rectangles), causal relationship indicating treks (arrows linking variables) and residuals (small arrows) are related to these latent variables. Figure 3 represents a model of achievements in Civic knowledge, but mini models were also computed for achievements in Mathematics (five respective manifest variables) and in Science (six respective manifest variables).

*Figure 3: Mini model with latent variables "Achievements in civic" and "Activities of students" and respective manifest variables. Small arrows represent residuals.*



The complete model was comprised of eight mini models: *Student's activities, Family, Home educational resources, Mother's pressure, Friends' pressure, Self-concept, Microclimate in class, School.* Each is discussed separately below.

1. *Student's extracurricular activities* (before or after lessons at school). The initial model is represented in Figure 3. The manifest variables are the time dedicated to studies, leisure reading, watching TV and video, computer games, friends, sports, household work, paid job, and other out-of-school activities. Calculating the model parameters it was found that the time dedicated to household work, paid job and out-of-school activities was not adequate for this mini model (small correlation coefficient with latent variable and poor conformity with the data - high RMSEA). Thus, in this mini model the latent variable is linked to five manifest variables - time dedicated to studies, leisure reading, watching TV and video, friends and sports, with causal relationship treks. Of course, the last three variables are encoded opposite the first two - the less time students dedicate to TV and video, friends and sports, the higher are their achievements. Its worth mentioning that correlation of these three variables is much higher than the previous two - studies and leisure reading. It is not surprising, of course, as previous analysis indicated a nonlinear correlation between time dedicated to studies and student achievements - students with higher abilities spend less time on homework.

2. *Family.* There was an attempt to include in the model student responses to questions about their parents' birthplace (Was your mother born in Latvia? Was your father born in Latvia?), on structure and size of family (Do you live together with mother? Do you live together with father? Do you live together with your grandparents? How many are you living together in your family?), and on parents' education. Only the questions on parents' education fit the model.

3. *Home educational resources.* Initially this latent variable was linked to such variables as number of books, availability of computer, calculator, encyclopaedia at home, newspapers bought (subscribed) every day, access to Internet at home, access to Internet anywhere else, study desk. Four variables were kept for modelling: Internet access at home, access to Internet anywhere else, number of books, and one integrated variable that included availability of computer, study desk and encyclopaedia. The availability of Internet access anywhere else variable was included in home educational resources, as usually it is at the parents' workplace or parents have secured it somewhere else.

4. *Mother's views.* Responses to four questions were included: Does your mother believe that you should do well in Science? Does your mother believe that you should do well in Mathematics? Does your mother believe that you should do well in Latvian to succeed? Does your mother believe that you have leisure time?

5. *Friends' views.* Questions on friends' views were similar to the above-mentioned ones, only the opinion of friends and not mother was essential. Analysis of this mini model indicated that the question on sports doesn't fit it.

But interpretation of these results is interesting: the more students report the importance of studying well according to the opinion of their friends, the lower are their achievements. The influence of friends is exactly opposite the influence of the mother.

6. *Self-concept.* There was an attempt to create a mini model considering student responses to questions and statements on necessity of studies, on expectations of finishing school. (I have to succeed in Mathematics/Science to enter the desired secondary school or higher educational establishment ... I have to succeed in Mathematics/Science to get the desired job ... I have to succeed in Mathematics/Science to have fun ... I consider it important to do well in Science/Mathematics/Latvian ... What further education do you expect?) Unfortunately it was not possible to create such model, as the data fit was poor.

7. *Class microclimate.* In this case the microclimate in class indicates the security of students - how much are they threatened, what is the extent of thefts in class. Manifest variables are student responses to four questions on events occurring in class in the last month: Do you feel endangered? Does somebody abuse your friend? Were you hit? Was your friend hit? It has been shown (Geske, 2000) that the microclimate in the class is an essential factor facilitating achievement in Mathematics and Science.

8. *School.* This mini model was designed in two different ways, after considerable reflection on the full model. In the first case the variable was location of the school (urbanisation factor), number of students in class and type of school (primary or secondary school). Considering three possibilities for the urbanisation factor - (1) Riga, cities, towns and rural areas, (2) Riga, cities and other community, (3) Riga and other community - the last one was the best fit for the model. The second case integrated school factors related to the closest neighbourhood inhabitants, i.e., students' parents were included. The first case was expanded to include average number of books at home, parents' education and access to Internet.

The full model presented was designed from the separate mini models. Figure 4 is a partial representation, comprising only latent variables and treks. Manifest variables and unaccountable share are not indicated, to make the figure more demonstrative. Corresponding trek coefficients a, b, c, ...g are listed in Table 1. The left part of the table represents the model corresponding to the school variable with urbanisation factor, number of students in class and school type (first model). The right part of table represents the model that includes the average socio-economic status of students in the school variable.

*Fig. 4: Full model in which student achievement depends on contextual factors (residuals are not shown).*

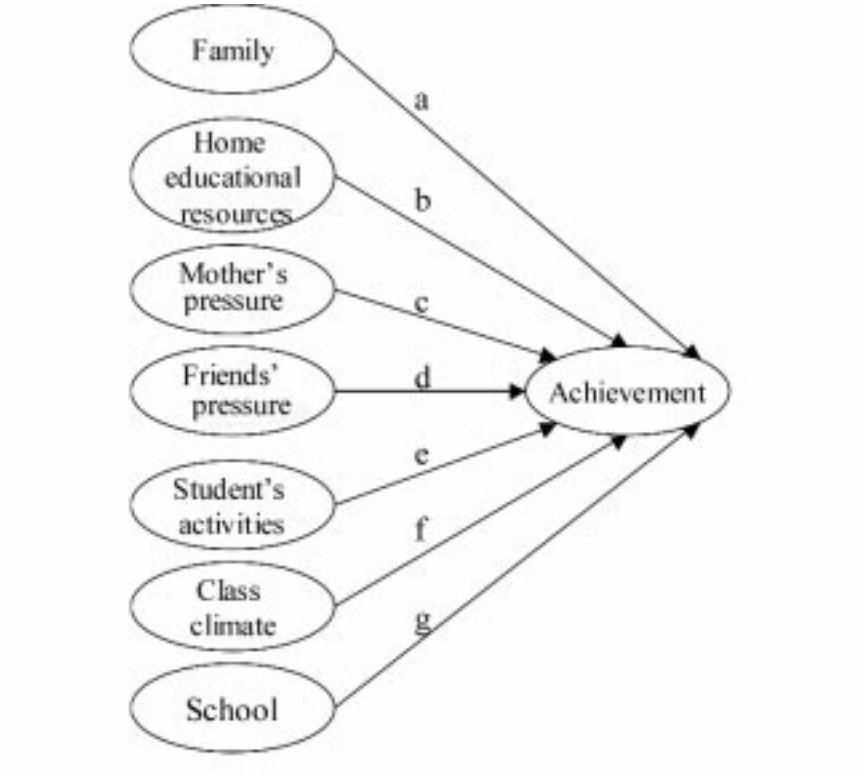



*Table 1: Full model treks coefficients linking contextual factors with students' achievements*

| *Trek* | *Model concerning school type and location* | | | *Model considering school socio-economic status* | | |
|---|---|---|---|---|---|---|
| | *Achievements in Civic* | *Achievements in Math* | *Achievements in Science* | *Achievements in Civic* | *Achievements in Math* | *Achievements in Science* |
| a | 0.10 | **0.15** | **0.16** | 0.07 | **0.12** | **0.12** |
| b | 0.25 | 0.24 | 0.25 | 0.12 | 0.13 | 0.15 |
| c | 0.05 | **0.12** | **0.13** | 0.08 | **0.14** | **0.14** |
| d | 0.15 | 0.18 | 0.13 | 0.13 | 0.16 | **0.21** |
| e | **0.29** | 0.15 | 0.16 | **0.23** | 0.11 | 0.12 |
| f | 0.09 | 0.10 | **0.16** | 0.10 | 0.12 | **0.17** |
| g | **0.27** | 0.20 | 0.12 | **0.43** | 0.33 | 0.28 |

## CONCLUSIONS

The results of these investigations showed:

- although there are great differences between Science and Civic knowledge, a strong correlation of student achievements in these subjects can be detected;
- family means for education, and influence of peers are approximately equally influential in all three subjects (Science, Mathematics, Civic knowledge);
- the education of parents and mother's influence are less significant for Civic knowledge than for Mathematics and Science;
- the intensity of students' involvement in all kinds of school activities and school life in general helps to improve achievements in Civic knowledge;
- class environment has more relation to Science achievement and less to Mathematics; but school life enhances performance more in Mathematics and less in natural Sciences.

## References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