(In)equalities in PISA 2012 mathematics achievement, socio-economic gradient and mathematics-related attitudes of students in Slovenia, Canada, Germany and the United States

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Introduction

The associations of student's socio-economic background with their educational achievement have long been well established (e.g. Duru-Bellat, 2004). For decades, international large-scale assessments such as the Programme for International Student Assessment (PISA) discovered significant relationships between the family background and student's performance. For example, the international PISA report on equity in schools describes that "socio-economically advantaged students and schools tend to outscore their disadvantaged peers by larger margins than between any other two groups of students" (OECD 2013a, p. 34). However, PISA also showed that higher achievement is not necessarily at the expense of equality: "Many countries and economies that have seen improvements in their mean performance on PISA have also managed to weaken the link between the socio-economic status and performance, sometimes resulting from a narrowing of the gap in performance between advantaged and disadvantaged students" (ibid, p.35).

There is evidence of the impact of socio-economic background on mathematics achievement in Slovene schools as well. In addition to the results that can be observed from large-scale international assessment, for Slovenia, Žakelj and Grmek (2010) demonstrated associations between students' socio-economic status and their achievement in the National Assessment of Knowledge (National Examinations Centre 2014), conducted every year at the end of compulsory education. Also, Štraus and Markelj (2011) showed that the choices students make from academic, technical and vocational upper secondary educational programs tend to parallel social lines. This warrants further studies into the relationship between students' socio-economic background and achievement in Slovenia.

However, socio-economic status is not the only factor influencing achievement. How students feel and think about themselves is an important predictor of how they act and decide when challenged by tasks and situations (Bandura 1977). There is vast research on students' attitudinal factors influencing mathematics achievement (e.g. Lamb and Fullarton 2001, Ma and Bradley 2004, Pang and Rogers 2013, Suan 2014). These factors can originate in students' home or school environment, or stem from their own perceptions.

The aim of this article is to examine to what extent students' attitudinal factors additionally explain the relationship between socio-economic background and achievement. In the study, mathematics achievement is taken into consideration, as it was the major domain in the latest cycle of PISA, in 2012, and it is one of the core subjects assessed in the National Assessment of Knowledge every year. In order to investigate the relationship between family background and student achievement, Willms (2003, 2006) introduced a concept of socio-economic gradient. PISA uses a composite measure of students' economic, social and cultural background derived from the highest occupational status and educational level of parents and home wealth, cultural and educational possessions (e.g. OECD 2013b). The socio-economic gradient is used to describe the quality of educational outcomes as well as the equality of outcomes for students from differing socio-economic backgrounds.

During PISA assessment, students are given a questionnaire including questions about their perceptions that are conceptualized in PISA to be relevant in explaining differences in their achievement (OECD 2012). Some of these data describe students' current school environment, for example sense of belonging to school or students' views of teacher behaviour. In Slovenia, this is a school environment in which students have generally only been part of for a few months – over 90% of 15-year-olds in Slovenia are in Year 1 of upper secondary school (Statistical Office of the Republic of, 2014a, 2014b). As such, these data are not likely to describe the context of the students' learning development in the previous years. Rather, inclusion of the indicators on current school environment in the model of factors relating to mathematics achievement in Slovenia could possibly mask other, more subtle factors from previous development. As described, the choices students make for their upper secondary programs parallel their social status and their responses to questions about their current school environment may, to a large extent, reflect this phenomenon.

The focus of analysis in this article is therefore limited to the constructs that more likely pertain to the students' background during a longer period. Such constructs are, for instance, self-concept in mathematics, anxiety about mathematics or perseverance. Such student-level constructs from the attitudinal domain generally play a two-fold role in educational assessments. First, they are seen as the pre-conditions for success in subject domains, and, second, they themselves may be judged as educational goals (Rychen and Salgalnik, 2003). The constructs of interest in this study are taken from Ajzen's (1991, taken from OECD 2012, p.185) theory of planned behaviour which states that by manipulating attitudes and subjective norms as pre-determinants of volitional behaviour, the chances that the person will intend to do a desired action can be increased which, in turn, can increase the likelihood of the behaviour actually occurring. By introducing attitudinal constructs in the model of relationship of socio-economic background and mathematics achievement, we try to investigate further the interplay of these constructs with achievement.

To provide a perspective or a reference point for the results of proposed investigations, other countries are included in the analysis. It is known from PISA (and other international studies) that there is a strong relationship between the students' family background and their achievement in all participating countries, however, there are possible differences in the factors that play a role in explaining this relationship in one country and not another. A comparative perspective therefore seems useful. The countries selected for comparisons are Canada, Germany and the United States. While it is obvious that the choice of countries is based on the content of the present thematic issue having guest authors from these three countries, it also gives a good framework for interpreting the results for Slovenia. From the educational policy perspective, international comparisons of Slovene students' achievements are an important indicator of educational quality. According to PISA 2012 international reports, mathematics achievement in Canada and Germany is higher than in Slovenia and in the United States it is lower (OECD, 2013c). At the same time socio-economic status of students varies among the countries; it is highest in Canada, similar between Germany and the United States and lowest in Slovenia[1]. Contextually, all three countries are major world economies and Germany is the strongest economic partner of Slovenia (Observatory of Economic Complexity, 2014). So these countries present different viewpoints from which results for Slovenia can be interpreted.

From the above discussion, the following research question is formulated: *To what extent does variation in mathematics-related attitudes of students, in addition to their socio-economic background, contribute to explaining their mathematics achievement and how do these relationships compare between Slovenia, Canada, Germany and the United States?*

1 These data are presented in more detail later in this article.

This research question proposes studying the distribution of mathematics achievement by student-level socio-economic and attitudinal factors in Slovenia and three other countries. It needs to be noted that the PISA assessment measures a broad set of skills and knowledge in mathematics, called mathematical literacy of 15-years-old students enrolled in formal education (OECD, 2012). Therefore, it is not an assessment of what students learned in mathematics classes during their previous year, or during their lower secondary education. It is an assessment of the cumulative development of learning that has occurred throughout education or elsewhere.

The next section describes constructs, data and methods used in this article. Then, results of comparisons of socio-economic gradients in mathematics achievement in Slovenia with the other three countries will be given, followed by the results of analyses of socio-economic background's interrelationships with students' attitudes in describing mathematics achievement of 15-years-old students. These results are discussed in the final section.

Data and Methods

The latest PISA data collection was conducted in 2012 with mathematics literacy as the major domain. The majority of items in achievement tests therefore covered mathematics and the questionnaire items asked about constructs conceptualized in PISA to be related to mathematics achievement. These data will be used in the present study.

Samples of Students

The PISA data collection included large nationally representative samples of 15-years-old students, consistent with the requirements for the international study (OECD, 2013cI). Furthermore, PISA 2012 introduced a rotation design for the student questionnaire, similar to the design for cognitive items. This means that questionnaire items, organized in item packages, were distributed over three forms of questionnaire booklets, named Form A, Form B and Form C. Each student was allocated one of these booklets, and thus received a limited number of questionnaire items, while the booklets taken together covered a larger, "universal" pool of questionnaire items. Like the cognitive booklets, the questionnaire booklets were randomly rotated among students within each school to make sure representative samples of students took each of the questionnaire forms (OECD forthcoming). Each form was therefore allocated to approximately a third of students in the PISA sample in a particular country.

Table 1: Differences in sample sizes and population estimates based on full PISA 2012 samples and Form B Questionnaire subsamples[2]

	Slovenia	Germany	Canada	United States
Number of students in full PISA 2012 sample	5911	5001	21544	4978
Number of students in Form B subsample	1896	1654	7173	1665
Mean achievement based on full PISA sample	501 (1.3)	514 (2.9)	518 (1.8)	481 (3.6)
Mean achievement based on Form B subsample	505 (2.6)	518 (3.2)	519 (2.4)	484 (4.0)

Due to this rotation, not all students provided responses for all of the attitudinal factors to be used in this study. Data on the full set of items of interest was collected through Form B of PISA 2012 student questionnaire only. In order to analyse the factors derived from these items within a single model, we therefore used data from subsamples of 15-years-old students that were given Form B during the PISA assessment from each country. Consequently, population estimates based on these subsamples may slightly differ from the estimates obtained from full PISA samples that are available in PISA international reports. The two sets of estimates are presented in Table 1 for comparison. The differences between the full sample and the Form B-subsample estimates for Germany and Slovenia are somewhat larger due to the fact that in these two countries, small subgroups of students were given a shorter version of the cognitive assessment as well as the questionnaire, named UH (une heure) instruments. Such versions are available in PISA for students with special educational needs that otherwise could not participate in the PISA assessment. This version of instruments was given to 3% of students in Germany and 1% of students in Slovenia. Exclusion of these students from the calculations of the mean achievement in a country generally results in an increased estimate. However, UH instruments did not collect data on any of the factors selected for the present study, except for the index of socio-economic and cultural status, so students that were given these instruments would not be included in the analysis in any case. As none of the four differences between full-sample mean estimates and the Form B subsample estimates

2 In the whole article, standard errors are given in parentheses. The standard errors indicate the accuracy of the estimates. For example, if one imagines that the PISA study had been repeated a number of times with the same sample sizes for each country, then in about 95% of cases, the estimates of the means would have fallen within the double range indicated by the standard errors

are significant[3], the data from Form B subsamples were deemed of sufficient quality to be used for the present investigation. From here on, it is only these data that are included in the analysis.

Mathematics-related Constructs

Table 2: Structure of blocks and indices of students' mathematics-related attitudes and opinions

Block 1 Socio-economic background	
Index of socio-economic and cultural status (ESCS)	Constructed index based on students' responses about their parents' education and occupation and home possessions
Block 2 Mathematics self-beliefs and participation in mathematics-related activities	
Index of mathematics self-efficacy	Constructed index based on students' responses about their perceived ability to solve a range of pure and applied mathematics problems
Index of mathematics self-concept	Constructed index based on students' responses about their perceived competence in mathematics
Index of mathematics anxiety	Constructed index based on students' responses about feelings of stress and helplessness when dealing with mathematics
Index of subjective norms in mathematics	Constructed index based on students' responses about whether they intend to use mathematics in their future and whether students' parents and peers enjoy and value mathematics
Block 3 Students' drive and motivation	
Index of perseverance	Constructed index based on students' responses about their willingness to work on problems that are difficult, even when they encounter problems
Index of openness to problem solving	Constructed index based on students' responses about their willingness to engage with problems
Index of perceived self-responsibility for failing in mathematics	Constructed index based on students' responses about whether they attribute failure in mathematics tests to themselves or to others
Index of intrinsic motivation to learn mathematics	Constructed index based on students' responses about whether they enjoy mathematics and work hard in mathematics because they enjoy the subject
Index of instrumental motivation to learn science	Constructed index based on students' responses about whether they believe mathematics is important for their future studies and careers

In PISA 2012, background data was collected with the aim to portray important aspects of the affective domain, such as valuing mathematics and being confident in doing mathematics. From the data that were collected via student questionnaires, interval-scaled statistical indices were derived to capture the major constructs related to mathematics achievement.

3 Tested following the procedures in OECD (2009).

There is a set of indices given in the PISA 2012 database from which it is possible to select the indices that basically capture the major aspects in Ajzen's (1991) theory of planned behaviour. The indices selected for the present study are organized in three blocks; the first block comprises of a single index of socio-economic and cultural status, the second block comprises of indices of students' mathematics-related self-beliefs and the third block of indices of their drive and motivation in mathematics. Descriptions of these indices are presented in Table 2. Concrete items in the PISA 2012 student questionnaires that were used to collect data for the selected indices and data for these items are detailed in OECD (2013b).

A statistical index in the PISA database is constructed in a way that for all students in the OECD countries the mean is 0 and the standard deviation 1 (in computing the mean and standard deviation an equal weight is given to each of the participating countries) (OECD, 2013b and OECD forthcoming). Negative values of the index in the international database therefore do not imply that students responded negatively to the underlying questions, but rather that they responded less positively (or more negatively) than the average response across OECD countries. Likewise, positive values imply more positive (or less negative) responses than the average response in OECD countries.

Socio-economic Gradient

Willms (2003) describes that socio-economic gradients comprise of three components, mean level, mean slope and the strength of the relationship between the outcome variable and socio-economic background. The *level* of the gradient is defined as the expected score on the outcome measure for a student with average socio-economic status. The level of a gradient for a country is an indication of its overall performance, after taking into account the students' socio-economic status. The *slope* of the gradient is an indication of the extent of inequality attributable to socio-economic status. Steeper gradients indicate a greater impact of socio-economic status on student performance (greater inequality) while gradual gradients indicate lower impact of socio-economic status (less inequality). The *strength* of the gradient refers to how much individual scores vary above and below the gradient line. If the relationship is strong, then a considerable amount of the variation in the outcome measure is associated with socio-economic status, whereas a weak relationship indicates that relatively little of the variation is associated with socio-economic status. The most common measure of the strength of the relationship is a statistic called R-squared, which is the proportion of variance in the outcome measure explained by the predictor variable.

Statistical Analyses

The main analytical approach for the investigation in this article is linear regression analysis, conducted in a sequence of steps. First we estimate socio-economic gradient using a simple one-predictor model for each of the four countries. Then the model is extended with factors capturing various aspects of students' mathematics-related attitudes. The appropriate structure of these factors for the final model is derived from preliminary exploratory analyses. For all four countries the same final model is used.

Due to the clustering structure of the PISA data – students being sampled within previously sampled schools – the question whether hierarchical modelling needs to be used should be addressed. Since only student-level variables are investigated in our study separately for each of the four countries, it remains to be considered whether the variance of these variables shared between the schools is of interest. The impact of clustering on sampling variance is controlled for by Bootstrap procedures of computation.

As mentioned, the majority of 15-year-old students in Slovenia attend the first year of their upper secondary education segregated to different educational programs and that the students' selection of these programs tends to parallel their socio-economic background. Therefore it seems self-evident that the proportion of variance in mathematics achievement as well as other variables between schools is relatively large. The linear regression coefficient of socio-economic background on the student achievement provides an estimate of the overall difference in performance due to socio-economic background while multilevel regression model estimates the difference in performance after accounting for the differential attendance to schools. The multilevel regression coefficients on socio-economic background may therefore substantially differ from the linear regression coefficients, especially in highly tracked systems. Having four different education systems in our study, the primary interest are the overall differences in the populations of students while differences between schools are left aside. For this reason, the linear regression is used.

IBM SPSS 22.0 software is used for the analyses, with the addition of the syntax macros prepared through the IDB Analyzer software (IEA, 2014), which enables calculations of population estimates and standard errors with the use of suitable sample weights and all five plausible values of achievement in the PISA database. Throughout the article, significance of differences in mean estimates or in estimates of regression coefficients between countries is tested using the foundations in OECD (2009). Testing is carried out at 0.05 level of statistical significance between results for Slovenia and each of other countries.

A final note of caution is in order. When interpreting the results of investigations in this article, it should be taken into consideration that the indices used in the analyses have been derived from students' responses to questions in the background questionnaire and not from, for example, independent observations or other types of objective measurements. This means that students' answers depended on the way students understood and responded to questions.

Results

International Comparisons of Slovene Students' Mathematics Achievement and its Socio-economic Gradient

From PISA 2012 data, we can derive basic comparisons of mathematics achievement and its socio-economic gradient between Slovenia, Canada, Germany and the United States. While these indicators are available in the PISA initial reports (e.g. OECD, 2013a), it is important to repeat that this study uses subsamples of the original PISA samples within the selected countries and, consequently, some of the indicators in Table 3 slightly differ from the initial reports.

Table 3: Data on socio-economic gradient in mathematical literacy for Slovenia, Germany, Canada and the United States in PISA 2012

	Slovenia	Germany	Canada	United States
Mean socio-economic and cultural status	0.07 (0.03)	0.21 (0.03)	0.41 (0.02)	0.16 (0.04)
Mean score in mathematical literacy	505 (2.6)	518 (3.2)	519 (2.4)	484 (4.0)
Level of socio-economic gradient1	501 (2.4)	521 (3.6)	515 (2.4)	489 (3.3)
Slope of socio-economic gradient2	45 (2.6)	42 (3.3)	34 (2.1)	36 (2.6)
Strength of socio-economic gradient3	16.1 (1.7)	13.8 (1.9)	10.2 (1.1)	14.3 (1.9)

Notes: 1 Level of socioeconomic gradient is the mean score in mathematical literacy adjusted for the mean socio-economic and cultural status (ESCS). Adjusting for socio-economic and cultural status takes into account only mean achievement of groups of students with socio-economic and cultural status equal to OECD average in each country.
2 Slope of socio-economic gradient is the score-point change in achievement associated with one-unit increase in socio-economic and cultural status.
3 Strength of socio-economic gradient is the strength of the relationship between mathematical literacy and socio-economic and cultural status (ESCS) as the percentage of variance in mathematics performance explained by the socio-economic and cultural status.

First, Table 3 shows differences between the four countries in average socio-economic and cultural status. Average socio-economic and cultural status of Slovene 15-years-old students (value 0.07) is slightly above the OECD average (which is 0[4]), however, it is the lowest value of the four countries. Socio-economic and cultural status of 15-years-old students in Canada is the highest (value 0.41) and the values for Germany and the United States are in-between (values 0.21 and 0.16, respectively).

The values of mean scores in mathematical literacy show a different pattern. The scores for Germany and Canada are similar, the score for the United States is the lowest and the score for Slovenia is in-between. This shows that the socio-economic and cultural status itself does not determine the level of mathematics achievement in a particular country. Furthermore, while one could try to argue that the level of achievement in Slovenia is understandably lower than in Canada and Germany due to lower socio-economic and cultural status of Slovenian students, this is not supported by the level of socio-economic gradient in Table 3. It can be observed that differences between Slovenia and the other countries still exist even when mathematics achievement is adjusted for students' socio-economic and cultural status. These comparisons show that the levels of socio-economic gradients indeed vary between the four countries.

Another element of the socio-economic gradient, the slope, also varies between the countries. One can observe that the slopes of socio-economic gradients in Slovenia and Germany are the two highest (45 and 42 points, respectively) and in Canada and the United States the two lowest (34 and 36 points, respectively). In other words, in Slovenia and Germany a one-unit increase in socio-economic and cultural status is associated with a somewhat higher increase in mathematics achievement than in Canada and the United States. It is interesting that, even though both, average socio-economic status as well as average mathematics achievement of Canadian students are different from these characteristics of the United States' students, the slopes of the socio-economic gradients are similar between the two countries. The same can be observed for Slovenia and Germany. The percentage of variance in mathematics achievement explained by socio-economic and cultural status is the lowest in Canada indicating the weakest gradient among the four countries. In Slovenia, the socio-economic gradient seems to be the strongest. However, given the relatively small percentages of variance in mathematics achievement explained by socio-economic and cultural status in all four countries, it seems reasonable to expect that there are other factors accounting for the variance in mathematics achievement of students in the selected countries. Some of these factors are investigated in the next section.

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4 For all indices, OECD average is 0. See section on data and methods.

Socio-economic Gradient Together with Self-related Beliefs in Mathematics

In this section, we present the structure of (some of) the underlying factors associated with mathematics achievement in Slovenia in comparison with Canada, Germany and the United States. The model for socio-economic gradient is extended with mathematics-related attitudinal factors. First, descriptive data on these factors are presented in Table 4. As explained, all factors are derived on an interval scale with a mean value 0 for OECD countries and standard deviation of 1. Values presented in Table 4 are therefore readily comparable.

Table 4: Mean values of factors[5]

	Slovenia	Germany	Canada	United States
Mathematics-related self-beliefs				
Index of mathematics self-efficacy	0,33 (0.03)	0,33 (0.03)	0,13 (0.02)	0,17 (0.03)
Index of mathematics self-concept	-0,02 (0.03)	0,10 (0.03)	0,20 (0.02)	0,31 (0.03)
Index of subjective norms in mathematics	-0,23 (0.03)	-0,12 (0.03)	0,36 (0.02)	0,28 (0.03)
Index of mathematics anxiety	0,13 (0.02)	-0,20 (0.03)	0,06 (0.02)	-0,04 (0.03)
Students' drive and motivation				
Index of perseverance	0,07 (0.03)	-0,02 (0.03)	0,19 (0.02)	0,38 (0.03)
Index of openness to problem solving	0,11 (0.03)	0,18 (0.03)	0,14 (0.02)	0,24 (0.04)
Index of self-responsibility for failing in mathematics	0,21 (0.03)	0,16 (0.03)	-0,22 (0.02)	-0,40 (0.03)
Index of intrinsic motivation to learn mathematics	-0,21 (0.03)	-0,18 (0.03)	0,01 (0.02)	0,12 (0.03)
Index of instrumental motivation to learn science	-0,31 (0.03)	-0,24 (0.03)	0,14 (0.02)	0,08 (0.02)

The average values of indices of students' attitudes and opinions about mathematics vary between the four countries. The levels of self-efficacy in mathematics show an interesting distinction between the countries. In Slovenia and Germany, students express high levels of conviction about their capability to cope with certain mathematics tasks (values of 0.33 in both countries), while students in Canada and the United States seem to be less convinced in their capabilities (values 0.13 and 0.17, respectively). This finding seems to be in contrast with the result that Canadian

5 Testing of statistical significance of differences in this article is carried out between results for Slovenia and each of other countries. For brevity, interpretations of comparisons between other countries are made more generally without testing for significance. This testing can be carried out using standard errors provided with each estimate. Due to estimates being based on Form B subsamples only, standard errors are somewhat larger and less significant differences can be established. Interpretations are made as indications of results for which further, more detailed investigations seem warranted.

students achieve the highest scores in mathematics among the four countries. However, perhaps the more important question is how does self-efficacy relate to achievement within individual countries. This will be presented later in this section.

A somewhat broader sense of the overall perception of students' personal attributes in mathematics, the mathematics-related self-concept, also varies between the countries, although rankings changed. Slovene students report the lowest self-concept, around the OECD average (value -0.02). German students report slightly higher values than the OECD average (value 0.10), with Canadian students reporting also higher (value 0.20), and the highest reports coming from students in the United States (value 0.31). Given that achievement in the United States is the lowest among the four countries, it is difficult to imagine this factor to be positively related to student achievement. However, it needs to be kept in mind that these are average values per country and that there is variation within individual countries in achievement as well as in the background factors. Again, this is examined later in this article.

A few additional indices portray clustering of values for Slovenia and Germany together on one side and of values for Canada and the United States on the other. The index of subjective norms captures the beliefs of student that specific individuals or groups think they should perform well in mathematics and students' motivation to comply with these groups. German and Slovene students expressed lower than average levels of such beliefs (values -0.12 and -0.23, respectively), and students from Canada and the United States well above average beliefs (values 0.36 and 0.28, respectively). The valuing of mathematics in the students' environment, as measured through the index of subjective norms, as well as intrinsic and instrumental motivation to learn mathematics are therefore relatively low in Slovenia and Germany and relatively high in Canada and the United States.

The index of self-responsibility for failing in mathematics reflects students' perceptions of their personal responsibility for failure in mathematics. Students with high values on this index tend to attribute the responsibility for failure to solve mathematics problems to themselves while students with low values on this index are more likely to see other individuals or factors as responsible. While students in Slovenia and Germany report relatively high levels of self-responsibility for failing in mathematics, students' reports show lower levels of this responsibility in Canada and the United States. Similarly, students in Slovenia and Germany report around average levels of perseverance, but students in Canada and the United States report higher perseverance. It is only for the openness for problem solving that students in all four counties give closer reports, all of them above average. The index that most stands out from this pattern is mathematics anxiety. While students in Canada and the United States report around average levels of anxiety (values 0.06 and -0.04, respectively), German students report relatively low anxiety (value -0.20) but Slovene students report the highest levels of mathematics anxiety among the four countries (value 0.13).

In summary, among the four countries, Slovene students express the lowest self-concept in mathematics, the lowest intrinsic as well as instrumental motivation to learn mathematics and the lowest level of beliefs that their parents and peers think they should perform well in mathematics. At the same time they express the highest level of self-responsibility for failing in mathematics and the highest mathematics anxiety. This in itself is an important message about Slovene mathematics education.

Preliminary Regression Analysis

In the preliminary analysis, it was first explored which factors, individually or as blocks, explain most variance in mathematics achievement.[6] The results of this analysis showed that for all countries, self-efficacy explains more variance in mathematics achievement than socio-economic and cultural status[7]. When blocks of indices were entered into the model separately, it was found that a larger amount of variance is explained by the block of mathematics-related self-beliefs (between 28 and 36 percent for the four countries) than by the block of indices on drive and motivation (between 7 and 19 percent for the four countries). Furthermore, when both blocks were entered, the amount of variance explained was nearly the same as the amount of variance, explained only by the block of indices of mathematics-related self-beliefs[8]. From this, it was decided to use only the block of mathematics-related self-beliefs in the regression model.

In addition, issues of multicollinearity of the factors in the block of self-beliefs were tested. It was found that there are relatively large (negative) correlations between self-concept and anxiety (from -0.76 in the United States to -0.61 in Slovenia). Due to self-concept having larger (positive) correlations with self-efficacy than anxiety (from 0.39 in Slovenia to 0.55 in Canada), it was decided that anxiety is kept as the predictor

6 This was explored using a stepwise procedure for linear regression analysis in SPSS. Also other preliminary analyses were carried out in SPSS.

7 In a single-predictor model, socio-economic and cultural status explained between 10 and 17 percent of variance and mathematics self-efficacy explained between 20 and 30 percent of variance for the four countries.

8 The largest increase in amount of variance explained by adding both blocks of indices into the model was 2.5 percent.

while self-concept is dropped. Correlation analysis of the remaining factors showed that they correlate weakly or moderately (-0.47 < r < 0.29). Additionally, variance inflation factors (VIF) were significantly below 10 (1.017 < VIF < 1.42). Other research, however, shows that these concepts are different (Ferla et al. 2009) and have differential impacts on achievement across countries (Morony et al. 2012).

Results of Regression Analysis

A linear model[9] was set up in order to investigate differences in the impacts of selected factors on student mathematics achievement between the four countries. The results of regression analysis based on this model are presented in Table 5.

Table 5: Relationship between mathematical literacy, socio-economic and cultural status and mathematics-related self-beliefs[10]

Slovenia	b	□	t(b)	t(□)	R^2	R^{2*}
constant	495 (2.3)		219.6			
ESCS	31 (2.8)	0.30 (0.02)	11.0	12.1		
MATHEFF	31 (2.8)	0.35 (0.03)	11.1	13.1		
SUBNORM	-8 (2.5)	-0.09 (0.03)	-3.3	-3.4		
ANXMAT	-19 (2.8)	-0.20 (0.03)	-6.8	-7.1	0.34	0.34
Germany	b	□	t(b)	t(□)	R^2	R^{2*}
constant	502 (2.4)		207.0			
ESCS	27 (2.1)	0.27 (0.02)	13.1	13.9		
MATHEFF	39 (2.9)	0.40 (0.03)	13.6	15.6		
SUBNORM	-14 (2.3)	-0.14 (0.02)	-6.0	-6.1		
ANXMAT	-16 (2.1)	-0.19 (0.03)	-7.3	-7.3	0.41	0.41
Canada	b	□	t(b)	t(□)	R^2	R^{2*}
constant	512 (1.9)		276.0			
ESCS	21 (1.7)	0.21 (0.02)	12.8	12.6		
MATHEFF	37 (1.4)	0.43 (0.02)	26.1	28.8		
SUBNORM	-5 (1.4)	-0.06 (0.02)	-3.6	-3.6		
ANXMAT	-17 (1.5)	-0.19 (0.02)	-11.3	-12.1	0.38	0.38

9 The names used are the following ESCS = Index of socio-economic and cultural status; MATHEFF = Index of mathematics self-efficacy; SUBNORM = Index of subjective norms in mathematics; ANXMAT = Index of mathematics anxiety. The final model has the equation $MATH\_ACHIEVEMENT = a + b_1 \times ESCS + b_2 \times MATHEFF + b_3 \times SUBNORM + b_4 \times ANXMAT + error$

10 Coefficients presented in this table are all significant.

United States	b	□	t(b)	t(□)	R^2	R^{2*}
constant	479 (2.7)		180.5			
ESCS	23 (2.0)	0.26 (0.02)	11.5	11.3		
MATHEFF	35 (2.8)	0.40 (0.03)	12.7	13.7		
SUBNORM	-14 (1.9)	-0.16 (0.02)	-7.4	-7.4		
ANXMAT	-21 (2.5)	-0.24 (0.03)	-8.4	-8.4	0.41	0.41

With the model, it was possible to explain from 34 to 41 percent of variance in mathematics achievement in the four countries, seemingly the least in Slovenia[11]. In all countries, the mean achievements adjusted by the four predictors are closer together than the unadjusted means but the ranking of countries is the same. If four average students with regard to socio-economic and the selected attitudinal factors are taken from each of the countries, than the expected mathematics score is the highest for the Canadian student, 512 points, for the German student 502 points, for the Slovenian student 495 points and for the student from the United States 479 points. Also, by controlling the factors of the students' self-beliefs in the model, the socio-economic gradient becomes more gradual in all countries. For example, while the socio-economic gradient in mathematics achievement in Slovenia is 45 points (see Table 3), controlling for students' self-beliefs reduces the gradient to 31 points. This gradient indicates that if two groups of Slovene students with the same self-beliefs but one with a one-unit higher socio-economic and cultural status are compared than the higher-status group has on average 31 points higher mathematics achievement. Or in other words, even though students may have the same high or low mathematics-related self-beliefs, the ones with higher socio-economic and cultural status are, on average, expected to achieve higher in mathematics. The order of the reduced socio-economic gradients in the regression model remains the same as is the order of gradients obtained from the single-predictor model (see Table 3). The reduced gradients in Slovenia and Germany are the two steepest and in Canada and the United States the two most gradual of the four gradients.

However, analysis showed that believing in one's own capability of solving certain mathematics tasks remains a factor of relatively high impact even when other factors are controlled. In Germany, Canada and the United States students with similar socio-economic and cultural background and similar levels of subjective norms and mathematics anxiety, but with a one-unit difference in the levels of mathematics self-efficacy have on average over 35 points different scores on PISA mathematics test;

11 No significant differences were established between estimated proportion of variance for Slovenia and Canada.

students with higher self-efficacy having higher scores. In Slovenia, the impact of self-efficacy seems to be somewhat smaller; 31 score points.[12]

Generally, the index on subjective norms in mathematics, that is, the students' beliefs that their parents and peers value mathematics, was conceptualized to act as a positive predictor in the sense that students with higher values on this index achieve at higher levels (OECD, 2012). Results in the international PISA reports show that for the overall impact of subjective norms on mathematics achievement, this is true in Canada and the United States where a one-unit increase in this index is associated with an 8-point average increase in mathematics achievement in Canada and a 4-point increase in achievement in the United States. In Slovenia, there is no significant association between subjective norms and achievement but in Germany a one-unit increase in the index of subjective norms is associated with a 13-point *decrease* in mathematics achievement (OECD, 2013b). German students reporting more valuing of mathematics in their personal environment have on average lower achievement.

When this index is included in the model in the present investigation, its impact on mathematics achievement when other factors are controlled, becomes negative in all four countries.[13] If two groups of students in these countries are compared, having similar socio-economic and cultural status and expressing similar self-efficacy, and mathematics anxiety, than the group reporting higher values of subjective norms have on average lower achievement.

Mathematics anxiety presents no surprise as a predictor in the model. As shown by the results in international PISA reports, it has, in general, a negative impact on the achievement of at least a 27-point decrease per one-unit of this index in the four countries considered here (OECD, 2013b). This impact reduces substantially when other factors in the model are controlled. The decrease in achievement per one-unit increase in anxiety when controlling for other factors is between 16 and 21 scale points[14].

Discussion and Conclusion

The goal of educational policy and reform in most countries is to raise levels of literacy skills, while reducing disparities among citizens from differing subgroups, like social classes and ethnic groups. In this article, we ad-

12 Significance of difference can be established between the results for Slovenia and Germany and the results for Slovenia and Canada.

13 The impacts of subjective norms and mathematics anxiety range from a 5 to 14 point decrease in achievement per one-unit increase of the factor. The significance of differences between Slovenia and any other individual country could not be established.

14 The significance of differences between Slovenia and any other individual country could not be established.

dressed the issue of social gradient in student mathematics achievement and mathematics-related attitudes in Slovenia in comparison to three other countries, Canada, Germany and the United States. The availability and quality of PISA data provided an opportunity to gain further understanding on how differences in socio-economic and cultural background of students along with students' mathematics-related self-beliefs affect student achievement in mathematics.

The international PISA reports showed that, of the four countries, Canada and Germany are top-achieving countries, with mean mathematics achievements significantly above the mean in Slovenia, and the United States with mean mathematics achievement significantly below Slovenia. An overview of data on socio-economic and cultural status and mathematics-related attitudes showed Slovene students' socio-economic and cultural status are the lowest among the four countries and that most indices of mathematics-related attitudes of Slovene students are similar to Germany and opposite to Canada and the United States. Standing out from this pattern is the level of mathematics anxiety that, by students' reports, is the highest in Slovenia, average in Canada and the United States and below average in Germany. This can be taken as an indication of the area that needs further research in Slovenia. Such research may reveal the background of the results observed in this study.

To investigate how these aspects of student background and attitudes relate to student achievement, we set up a linear model, first only investigating socio-economic gradient and later expanding the model with attitudinal factors. Besides being assessed as outcomes of mathematics education, these constructs can also assist in explaining differences in performance on the PISA mathematics assessment. It was presumed that some of the variation in mathematics achievement observed by socio-economic background may overlap with variation in students' self-beliefs about mathematics.

There are several interesting findings from the analysis in this study. With regard to socio-economic gradient, this study, as many previous studies, found that there are inequalities in performance in all four countries associated with students' family background. The results also show that the extent of these inequalities varies between the countries. The most gradual socio-economic gradient among the four countries is found in Canada, then the United States, and then Germany and Slovenia.[15] In a similar order, the socio-economic gradient is the weakest – that is, socio-economic and cultural background of students explains the smallest

15 No statistical significance between the results for Germany and Slovenia could be established.

percentage of variance in mathematics achievement – in Canada (11 percent), then United States and Germany (14 percent) and is strongest in Slovenia (16 percent).[16] For Slovenia, this indicates the importance of research in the area of equity in education, such as the present study, to further illuminate the background for the observed results.

A preliminary regression analysis showed that in all four countries the indices of mathematics-related self-beliefs of students, as a block, are meaningfully stronger predictors of mathematics achievement than the block of indices on drive and motivation. This was seen by a larger amount of variance explained by the block of mathematics-related self-beliefs than by the block of indices on drive and motivation. Furthermore, the single factor explaining the largest amount of variance in mathematics achievement is self-efficacy. This is in line with findings from other studies (e.g. Ferla et al., 2009). As founded by the work of Bandura (1997), this indicates that conviction of one's own capability to perform is closely connected to achievement, in a circular manner where stronger conviction leads to better performance and better performance reinforces convictions. In reverse, if students are not convinced in their abilities to accomplish particular academic tasks, they have a higher probability of underperforming, even though they may have the ability. This is because they may not put in the self-control and motivation needed to perform the tasks. Zimmerman (2000) showed that self-efficacy is an important predictor of common motivational outcomes, such as students' activity choices, effort, persistence, and emotional reactions, but that it is sensitive to subtle changes in students' performance context.

Our analysis showed that if socio-economic and other attitudinal factors in the model are controlled, mathematics-related self-efficacy is still a strong and important predictor of mathematics achievement. The analysis further showed that among the four countries, this predictor seems to have the least impact in Slovenia. In efforts to avoid the vicious cycle of self-fulfilling prophecy for students with low self-efficacy, further investigations of this phenomenon seem warranted. A plausible hypothesis about the reasons behind this phenomenon may be that Slovene students with relatively high efficacy do not perform as well or students with low efficacy perform better. Given that average efficacy is as high in Slovenia as is in Germany, it seems the first is more likely than the latter. Although this finding needs to be cross-checked with additional information, like policy documents or data from additional countries, it seems a reasonable hypothesis that one of the reasons for this phenomenon may

16 The significance of differences could be established between the results for Slovenia and Canada.

come from teachers' practices in giving feedback to students (Zupanc and Bren, 2010).

A finding from preliminary analysis is also that, next to self-efficacy, the strongest factor explaining most of the remaining variance in mathematics achievement in all four countries is socio-economic and cultural status. When the attitudinal factors in the model are controlled, the socio-economic gradient varies from 21 to 31 scale points, the two largest being in Slovenia and Germany.[17]

A notable finding is also that while other factors preserved their conceptualized positive or negative nature of impact on mathematics achievement in the model, the index of subjective norms changed to a negative impact in all four countries. The initial PISA results published in the international reports already indicated that the nature of this factor's impact on mathematics achievement varies between the countries; in 18 countries it is positive, in 30 negative and in 17 countries its impact is neutral (OECD, 2013b). The finding that the impact of this factor in our model is negative in all four countries may be interpreted that the students agreeing with items 'most of my friends do well in mathematics', 'most of my friends work hard at mathematics', 'my friends enjoy taking mathematics tests', 'my parents believe it's important for me to study mathematics', 'my parents believe that mathematics is important for my career' and 'my parents like mathematics' actually responded about the pressure they feel from parents and friends that they have to do well in mathematics. This interpretation is substantiated on the negative impact of this factor for students with otherwise similar levels of socio-economic and cultural status, self-efficacy, and anxiety. There may, however, be a reversed causality in this association; somewhat weaker students may feel more pressure than their more successful peers that are otherwise similar to them on other factors.

In conclusion, our study confirmed the influences of socio-economic background on student mathematics achievement reemphasizing the need for constant and more in-depth research in this area. It seems safe to say that research on equity in education is needed also in other achievement areas. Based on comparisons with the other countries this is even more important for Slovenia due to a somewhat stronger impact of socio-economic and cultural status and a weaker mediating impact of mathematics-related self-efficacy on student achievement.

There are, of course, limitations to generalizing the results of this study. As mentioned, all data are based on students' reports. This may in-

17 Gradients in Canada and the United States are significantly smaller than in Slovenia.

fluence objectivity and comparability of data across countries as well as within. Also, it is important to be careful in assuming causality from the models. It may well be that the outcome variable - mathematics achievement - influences the levels of predictors as well. For example, evidence of high achievement naturally increases one's conviction of their capability to solve mathematics tasks. Or, parents may exert less pressure for mathematics learning when their children are high achievers. Since the model included four predictors, the observed impacts of these factors may not only or not at all be direct effects but also due to effects of possible other hidden or unmeasured variables not included in the model. In addition, we assumed only linear relationships in the model while there may be curvilinear relationships between the factors as well as with the outcome variable and additional multilevel influences. However, the findings from this model seem reasonable and informative for future methodology of the national and international educational studies as well as for educational policy.

Further studies may explore the issues addressed in this article in several directions. First, other countries may be taken into account. This could show generalizability of the present results across different cultures and educational settings. Second, the outcomes in specific mathematical sub-domains could be considered. This could show generalizability of the results across different process and content-specific achievements, which were organized in PISA in process sub-scales formulating, employing and interpreting and content sub-scales change and relationships, space and shape, quantity, and uncertainty and data. Further, with a larger number of countries or additional factors other methods could be used, like multi-level modelling to explore the proportions of between-country variance explained by the selected predictors, or structural equation modelling to explore the possible causal interrelationships of the selected factors.

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