Beating the Odds: Trees to Success in Different Countries

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A recursive partitioning model approach in the form of classification and regression trees (CART) was used with 2012 PISA data for five countries (Canada, Finland, Germany, Singapore-China, and the Unites States). The objective of the study was to determine demographic and educational variables that differentiated between low SES student that were overachieving or not and to explore the differences across countries. A review of the decision trees indicated contextual differences across countries, suggesting that a universal approach to facilitate overachievement for low SES students is not appropriate. Countries should look to efforts specific to their country and culture and the nature of their students when considering policies and programs for low SES students.

In the United States, educational researchers spent decades trying to identify generic effective teaching behaviors (Muijs et al., 2014). Eventually the effort lost steam. In part due to the fact that pretty much every behavior had been thoroughly investigated; but more important was the movement to focus on different situations. Pedagogical content knowledge suggested that teaching and learning is a highly-contextualized endeavor (Shulman, 1986). What works in one situation with certain students may not work in a different situation with different students. Theoretically the same is true, if not more so, internationally. The complex interaction of variables leading to achievement takes place within a cultural context that is likely to influence the learning process. However, efforts to determine general ways of improving achievement for low-performing students across countries persist (OECD, 2016).

Study goals

The primary goal of this study was to ascertain what demographic and educational variables, or combinations of variables, differentiate low income students who achieve at rates higher than those that would be predicted given their socioeconomic status (SES) from individuals in poverty who do not overachieve. In addition, it was of interest to determine whether the pattern of relationships among these variables and overachievement (or not) vary across nations.

Method

This study used a complex data analysis process to consider an array of variables to determine factors that yield "over-achievement" in low SES students in five different countries: A Scandinavian country (Finland), a European country (Germany), an Asian country (Singapore-China), and Canada and the United States of America.

Participants

Data for this study came from the Programme for International Student Assessment (PISA) 2012 test administration (OECD, 2012). The test measures achievement in reading, mathematics, and science in 15-year olds in 65 countries. The study participants had family SES of more than one standard deviation below mean SES for their nation, previously defined as relative poverty (Marchant & Finch, 2016). These individuals were then classified as being either overachievers or not. Each individual in the sample had a predicted achievement score that was obtained from a regression model in which the independent variable was family SES. Overachievers were those with an actual achievement score that was one standard deviation, or more, greater than their predicted score.

Factors

The factors in the study included demographic variables of gender, family structure, immigration status, and home language; teacher variables of formative assessment, student orientation, teacher-directed instruction, teacher support, and cognitive activation; classroom variables of disciplinary climate and management, class time and out-of-school study time (learning time was excluded because it was a combination of class time and out-of-school study time); and student characteristics of perseverance, openness for problem solving, perceived control, and attitude toward school (see Appendix for all variables, scales, and scale items).

Data Analysis

In order to address the primary research goals of the study, a recursive partitioning model approach in the form of classification and regression trees (CART) was used. CART is a nonparametric technique that makes no assumptions about the functional form of the model linking the dependent and independent variables, nor the distributions of the variables themselves (Williams, Lee, Fisher & Dickerman, 1999). Therefore, it is able to identify interactions of the predictor variables in an automated fashion, thereby making it a very flexible tool for understanding complex relationships in the data (Hothorn, Hornik, & Zeileis, 2006).

CART works by building a decision tree based upon binary splits from among the set of predictor variables. In order to explain the manner in which CART works, we can consider Figure 1. In this example the dependent variable is whether a study participant met the standard on a year-end reading assessment (yes/no), and the predictors included student gender, as well as scores on 5 formative reading tests. The CART algorithm begins by placing all subjects into a single grouping, called the root node, at the top of the tree. It then searches the entire set of predictors to find the value for one of those by which it can divide the study participants into two new child nodes so that their values on the dependent variable are as homogeneous as possible; e.g., the chosen split is the one that creates two child nodes that are

as similar as possible with respect to students passing (or not) the reading assessment. In this example, the CART algorithm assessed every possible split for each of subtest and found that splitting the sample at a score of 202 on formative test 5 yielded the most homogeneous child nodes. Thus, all individuals in the sample with a test 5 score less than or equal to 202 were moved to the left side of the tree, while those with scores greater than 202 were moved to the right side. To continue with the current example, individuals who had formative test 5 scores less than or equal to 202 (those in the left side child node) were again split on test 5, with those having scores less than or equal to 185 going to the left and those with scores higher than 185 (but less than or equal to 202 based on the earlier split) going to the right. For those on the left, the sample was split on test 3, where individuals with scores of less than or equal to 166 were placed to the left and those with test 3 scores greater than 166 were placed to the right. Finally, individuals with subtest scores less than 166 were again split, this time on test 2, with those having scores less than or equal to 176 going to the left, and those with scores greater than 176 going to the right. No further splits were made for these individuals. A similar tracing of each set of splits could be made across the entire tree.

At the base of the tree lay the final groupings of individuals in what are called "terminal nodes." For each of these terminal nodes frequency bar charts showing the proportion of individuals in the target outcome (i.e. those passing the year-end reading assessment) are included. An examination of the two bar charts at the far left of the tree reveals that for both of the terminal nodes that we have tracked, the probability of passing the reading assessment was approximately 0.1 and 0.25, respectively. Thus, individuals in these nodes were unlikely to be reading proficient, given that the majority of individuals in each had this category of the outcome variable. Conversely, individuals on the far right hand side of the tree, who had higher scores on the formative tests used for splitting, were likely to attain a proficient year-end reading score. Finally, note that predictor variables not included in Figure 1 never yielded the optimal split for any node, and thus did not play a role in determining the final form of the tree.

The exact determination of which variable to split where is made based upon a score statistic, which is distributed as a Chi-square. In a given node, score statistic values are calculated for every possible split of each predictor Splits are made only for values of the score statistic that are significant ($p < 0.05$). When multiple potential splits have a significant score statistic, the one with the largest score value is selected. This approach to creating the tree has been found to control the Type I error rate at the nominal 0.05 level because it is based on a series of conditional splits where tests further down the tree are conditional on the significance of the earlier tests (Strobl, Malley, & Tutz, 2009). The algorithm stops splitting nodes when no further statistically significant Chi-square values exist within that node.

For the current study, the outcome variable was overachiever status (yes/no), and the predictors were as listed above. Due to the complex nature of the analysis, reading, mathematics, and science were combined for achievement and class time. Terminal nodes were considered overachieving if over 50 percent of the students in the node were overachievers. All analyses were conducted using the student level weight, and were done using the ctree function in the `party` package of the R software system, version 3.1.1 (R Development Core Team, 2015).

Results

Country Comparisons for Low SES Students

Although the crux of this study were the factors related to overachievement for low SES students within each country, a comparison of countries based on the sample for this study merits some attention. For the countries considered, Singapore (average rank 2.67), Finland (average rank 7.67), Canada (average rank 10.33), Germany (average rank 16), and the United States (average rank 29.33), the order for the low SES students mirrored their average rank with the exception of the United States' students doing better than Germany's in terms of score, percentage of overachievers, and average score for overachievers (see Table 1). Singapore was by far the leader in low SES student achievement and over achievement with twice the percentage of overachievers, overachieving by three times as much, as the United States. There was a great deal of variation among the variables across countries. Amount of class time ranged from a low of 113 hours per week for Singapore to 206 for Canada, and out of school study time ranged from less than five hours a week for Finland to more than 13 hours a week for Singapore.

Country Trees

Canada

The CART analysis yielded 19 terminal nodes (see Figure 2). Of these, there were seven overachiever nodes. Each of the seven overachiever nodes were gender specific with five male nodes and two female nodes (see Table 2). Class time was a split for all of the overachiever nodes with six of the seven nodes having more class time. When there is less class time for males, a higher disciplinary climate lead to more over-achievement (Nodes 3, 6, and 7 compared to Node 8). Surprisingly, less teacher student orientation was a factor for five out of six of the nodes (see Table 3 for descriptive statistics).

Finland

Of the seven terminal nodes, there were three overachiever nodes (see Figure 3). With the exception of one node with an immigrant status of native, all of the splits were related to teachers (see Table 4). With less teacher student orientation and more cognitive activation the node with native Fins had the highest achievement, the highest overachievement, and the greatest percentage of over achievers (see Table 5). The other two overachiever nodes had more teacher student orientation and either more teacher support or more teacher directed instruction.

Germany

Only one of the Germany overachiever nodes was gender specific (see Table 6). This node had more out-of-school study time, more teacher support, and more of a student orientation and better management. The other over-achiever nodes were an interesting mix of some factors off-setting other factors (e.g., more teacher student-orientation (Node 7, the highest achieving node, see Table 7), more teacher support (Node 10 and 11), more outside study hours and more Teacher Directed Instruction (Nodes 22 and 24).

Singapore

Singapore was by far the leader in overachievement among the countries investigated (see Table 1). More out of school learning time was a significant node for five of the seven

terminal nodes (see Table 8). Node 24 had the highest score, the highest score for over-achievers, and the highest percentage of overachievers (see Table 9). More out-of-school learning time, and better disciplinary climate and management characterized this terminal node.

United States of America

Gender was the first split node for the United States (see Figure 6), and therefore a factor in all of the over-achiever nodes (see Table 10). For the female over-achiever nodes, out-of-school learning time and classroom management were significant split nodes. The highest scoring female node had less out-of-school time and better classroom management (see Table 11). The highest achieving male node had more teacher student-orientation and more teacher support.

Country Node Comparisons

A review of the significant split nodes across countries suggested contextual differences associated with over-achievement (see Table 1). Although there are some shared factors related to over achievement, the path to overachievement is different for each country and for different students within each country. For example, the profile for over-achievers based on split nodes is very different for Finland and Germany. Gender and family structure play more of a role in overachievement in Canada and the United States than Finland and Singapore. This suggested that poverty and its impact on achievement functions differently in different countries.

Conclusion

The quest for a generic path to overachievement for low SES students appears to be an exercise in futility. As might be expected, student achievement is a complex context specific matter. Low SES students are the most vulnerable to failure in any country, but the path to achieving above expectation is a tricky endeavor. This study illustrated the need to consider success within rather than across countries. Also, many factors that would be considered "obvious" positive factors related to achievement, were unrelated or negatively related to overachievement. This was the case for teacher student-orientation and teacher formative assessment.

References

Hothorn, T., Hornik, K., & Zeileis, A. (2006). Unbiased recursive partitioning: A conditional inference framework. *Journal of Computational and Graphical Statistics, 15,* 651-674.

Marchant, G. J., & Finch, W. H. (2016). Does a rising tide lift all boats? International relative and absolute SES and achievement. *Journal of Global Research in Education and Social Science. 7*(3), 168-174.

Muijs, D., Kyriakides, L., van der Werf, G., Creemers, B. Timperley, H., & Earl, L. (2014). State of the art-teacher effectiveness and professional learning. *School Effectiveness and School Improvement, 25*, 231-256. Retrieved from http://dx.doi.org.proxy.bsu.edu/10.1080/09243453.2014.885451

OECD (2016). *Low-performing students why they fall behind and how to help them succeed*.PISA, OECD: Paris. http://www.oecd.org/edu/low-performing-students-9789264250246-en.htm.

R Development Core Team (2015). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4- 31.

Strobl, C., Malley, J., & Tutz, G. (2009). An introduction to recursive partitioning: Rationale, application, and characteristics of Classification and Regression Trees, Bagging, and Random Forests. *Psychological Methods, 14(4),* 323-348.

Table 1.

Descriptive Statistics for Achievement, SES, and All Significant Nodes by Country for Students One Standard Deviation Below Country (Relative) SES Mean.

	Canada	Finland	Germany	Singapore	U.S.A.
Percent					
Overachievers	31	28	16	46	23
Gender (Female)	52	42	59	50	50
Native Status	42	75	50	91	30
Single-Parent Family	31	45	27	15	30
Means and Standard Deviations					
Achievement Score	1382.28	1342.03	1274.43	1468.06	1319.99
(Combined)	(242.23)	(259.07)	(240.66)	(286.22)	(224.56)
Overachievement	126.73	94.50	27.10	224.15	67.41
Amount	(243.41)	(248.58)	(234.79)	(276.69)	(227.32)
SES Index	-1.78	-1.85	-1.85	-1.89	-1.81
	(.46)	(.43)	(.41)	(.41)	(.37)
Teacher Student	.42	.14	.08	.07	.44
Orientation	(1.06)	(.93)	(1.20)	(1.00)	(.93)
Discipline Climate	13.83	13.17	13.73	14.06	14.34
	(3.86)	(3.31)	(3.55)	(4.08)	(4.01)
Class Time	206.33	143.16	144.38	113.18	195.35
	(41.60)	(29.00)	(33.41)	(31.56)	(72.96)
Teacher Direct	.40	.21	-.06	.07	.30
Instruction	(1.25)	(1.12)	(1.27)	(.92)	(1.16)
Student-Teacher	.33	-.16	-.34	.34	.30
Relationship	(1.14)	(.93)	(1.20)	(1.03)	(1.16)
Teacher Formative	.40	.27	-.12	.24	.27
Assessment	(1.25)	(.96)	(1.14)	(.99)	(1.38)
Out-of-School	7.39	4.74	8.26	13.40	8.46
Learning Time	(8.68)	(4.65)	(6.73)	(11.43)	(7.31)
Cognitive Activation	.29	-.12	-.36	.05	.29
	(.93)	(1.12)	(1.04)	(.92)	(1.07)
Teacher Support	.32	.14	-.46	.33	.19
	(1.11)	(.93)	(1.37)	(.97)	(1.02)
Classroom	11.50	11.78	11.75	11.94	11.72
Management	(2.09)	(1.88)	(1.39)	(1.66)	(1.68)

Note. Shaded areas represent significant split nodes.

Table 2.

Summary of Overachiever Nodes for CART Decision Tree for Canada.

	Nodes						
	8	29	34	17	26	16	37
Gender	Male	Female	Male	Male	Female	Male	Male
Family Structure					Single P		
Immigrant		2nd Gen.	2nd Gen.	1st Gen.	2nd Gen.	Native	2nd Gen.
Class Time	Less	More	More	More	More	More	More
T. Student Orient.		Higher	Lower	Lower	Lower	Lower	Higher
T. Formative Assess		Less					
St-T. Relationship			Better				
Discipline Climate	Better						

Table 3.

Descriptive Statistics for Overachieving Nodes and Total of All Nodes for CART Decision Tree for Canada.

	Nodes							
	8	29	34	17	26	16	37	Total*
Percent								
Overachieving	100	100	99	97	95	63	61	31
Language of Test	96	0	21	0	0	94	35	50
Immigration-100 %	Native	2nd Gen	2nd Gen	1st Gen	2nd Gen	Native	2nd Gen	42 Nat 24 1st G
Gender (Female)	0	100	0	0	100	0	0	52
Single-Parent Fam	0	0	18	62	100	36	33	31
Means and Standard Deviations								
Total PISA Score	1811.89	1705.97	1751.88	1663.62	1596.16	1464.36	1484.26	1382.28
	(84.57)	(110.81)	(172.76)	(113.41)	(85.00)	(227.44)	(227.43)	(242.23)
Over-Achieving by	534.95	474.83	471.38	432.24	359.91	262.88	242.28	126.73
	(64.97)	(95.90)	(165.69)	(106.60)	(97.52)	(247.21)	(229.15)	(243.42)
SES Index	-1.59	-2.00	-1.56	-2.00	-1.95	-2.26	-1.90	-1.78
	(.17)	(.13)	(.29)	(.36)	(.15)	(1.36)	(.36)	(.46)
Class Time	120.84	189.08	214.15	216.64	198.93	214.20	228.06	206.33
	(3.54)	(26.96)	(30.00)	(27.03)	(15.91)	(21.81)	(16.63)	(41.60)
Teacher Student	.29	.33	-.80	-.42	-1.14	-.67	1.19	.42
Orientation	(.27)	(.21)	(.65)	(.26)	(.51)	(.64)	(.82)	(1.06)
Teacher Formative	-.52	-2.19	.27	.66	-.78	-.72	.79	.40
Assess	(.32)	(.39)	(.86)	(1.13)	(.22)	(1.30)	(1.55)	(1.25)
Student-Teacher	-.37	-.69	1.06	-.46	.79	-.88	1.36	.33
Relationship	(.47)	(.41)	(.63)	(.44)	(1.06)	(1.51)	(.79)	(1.14)
Discipline Climate	17.06	6.87	15.12	13.37	13.74	14.72	13.88	13.83
	(.24)	(1.66)	(3.72)	(2.82)	(1.06)	(5.77)	(3.30)	(3.86)

Note. * All low SES student nodes, high and low achievers

Table 4.

Summary of Overachiever Nodes for CART Decision Tree for Finland.

	Nodes		
	5	11	13
Teacher Student Orientation	Less	More	More
Cognitive Activation	More		
Teacher Directed Instruction		Less	More
Immigrant	Native		
Teacher Support		More	

Table 5.

Descriptive Statistics for Overachieving Nodes and Total of All Nodes for CART Decision Tree for Finland.

	Nodes			
	5	11	13	Total*
Percent				
Overachieving	89	82	57	28
Immigration-Native	100	89	74	75
Means and Standard Deviations				
Total PISA Score	1600.52	1553.88	1457.81	1342.03
	(138.58)	(178.11)	(275.20)	(259.07)
Over-Achieving by	363.04	305.54	207.10	94.50
	(141.68)	(172.04)	(263.31)	(248.58)
SES Index	-1.94	-1.85	-1.83	-1.85
	(.38)	(.43)	(.47)	(43)
Teacher Student	-1.12	.11	.80	.14
Orientation	(.51)	(.16)	(.57)	(.93)
Teacher Directed	-.24	.09	2.28	.21
Instruction	(.72)	(.72)	(.45)	(1.12)
Teacher Support	-.16	1.34	.90	.10
	(.57)	(.37)	(.62)	(1.02)
Cognitive Activation	.44	-.03	.28	-.12
	(.48)	(.94)	(.82)	(1.12)

Note. * All low SES student nodes, high and low achievers

Table 6.

Summary of Overachiever Nodes for CART Decision Tree for Germany.

	Nodes					
	7	10	18	22	24	30
Sex						Female
Out of School Study Time	Less	Less	More	More	More	More
Teacher Support	Less	More	More			More
Class Time	Less					
Immigrant	Nat&2nd					
Teacher Student Orientation	More		Less	Less	Less	More
Teacher Directed Instruct			Less	More	More	
Student-Teacher Relation			Less	Less		
Discipline Climate				Less	More	
Management						More
T. Formative Assessment						

Table 7.

Descriptive Statistics for Overachieving Nodes and Total of All Nodes for CART Decision Tree for Germany.

	Nodes						
	7	10	18	22	24	30	Total*
Percent							
Overachieving	100	100	100	100	100	55	16
Immigration-100 %	Native	2nd Gen	2nd Gen	1st Gen	2nd Gen	Native	42 Nat 24 1st G
Gender (Female)	100	100	0	0	100	0	52
Means and Standard Deviations							
Total PISA Score	1811.89	1705.97	1751.88	1663.62	1596.16	1464.36	1382.28
	(84.57)	(110.81)	(172.76)	(113.41)	(85.00)	(227.44)	(242.23)
Over-Achieving by	534.95	474.83	471.38	432.24	359.91	262.88	126.73
	(64.97)	(95.90)	(165.69)	(106.60)	(97.52)	(247.21)	(243.42)
SES Index	-1.59	-2.00	-1.56	-2.00	-1.95	-2.26	-1.78
	(.17)	(.13)	(.29)	(.36)	(.15)	(1.36)	(.46)
Class Time	120.84	189.08	214.15	216.64	198.93	214.20	206.33
	(3.54)	(26.96)	(30.00)	(27.03)	(15.91)	(21.81)	(41.60)
Teacher Student	.29	.33	-.80	-.42	-1.14	-.67	.42
Orientation	(.27)	(.21)	(.65)	(.26)	(.51)	(.64)	(1.06)
Teacher Formative	-.52	-2.19	.27	.66	-.78	-.72	.40
Assess	(.32)	(.39)	(.86)	(1.13)	(.22)	(1.30)	(1.25)
Student-Teacher	-.37	-.69	1.06	-.46	.79	-.88	.33
Relationship	(.47)	(.41)	(.63)	(.44)	(1.06)	(1.51)	(1.14)
Discipline Climate	17.06	6.87	15.12	13.37	13.74	14.72	13.83
	(.24)	(1.66)	(3.72)	(2.82)	(1.06)	(5.77)	(3.86)

Note. * All low SES student nodes, high and low achievers

Table 8.

Summary of Overachiever Nodes for CART Decision Tree for Singapore.

	Nodes						
	7	10	22	23	24	28	30
Out of School Study	Less	More	Less	More	More	More	More
Immigrant Status	1st&2nd						Native
T. Student Orientation	More		Less	Less	Less	More	More
St-Teacher Relation		More					
Cognitive Activation						More	
Discipline Climate	Less	Less	More	More	More	Less	More
Management			Less	Less	More		

Table 9.

Descriptive Statistics for Overachieving Nodes and Total of All Nodes for CART Decision Tree for Singapore.

	Nodes							
	7	10	22	23	24	28	30	Total*
Percent								
Overachieving	54	52	53	80	92	60	75	46
Immigration->70 %	1nd Gen	Native	Native	Native	Native	Native	Native	Native
Means and Standard Deviations								
Total PISA Score	1354.32	1484.35	1517.55	1652.76	1671.25	1594.56	1649.32	1468.06
	(339.57)	(331.86)	(258.89	(210.32)	(204.16)	(257.43)	(268.59)	(281.22)
Over-Achieving by	135.72	243.00	267.20	399.89	420.64	347.73	407.22	224.15
	(324.23)	(325.67)	(248.95)	(202.77)	(205.01)	(244.85)	(266.65)	(276.69)
SES Index	-2.11	-1.91	-1.83	-1.81	-1.83	-1.86	-1.90	-1.89
	(.41)	(.38)	(.35)	(.34)	(.30)	(.40)	(.31)	(.41)
Out ofSchool Study	6.58	26.17	10.95	25.53	16.31	21.87	23.13	13.40
	(2.54)	(14.16)	(2.55)	(7.56)	(8.87)	(14.69)	(15.44)	(11.47)
Teacher Student	1.14	1.12	-.54	-.69	-.51	.97 (.55)	.77 (.43)	.07
Orientation	(.21)	(.73)	(.59)	(73)	(.61)			(1.00)
Student-Teacher	.78 (.94)	.93 (.93)	.09 (.83)	.30 (.91)	.84	.65 (.94)	1.03	.34
Relationship					(1.05)		(.98)	(1.03)
Cognitive Activation	.05 (.35)	.15	.13 (.81)	.11 (.72)	.23 (.80)	.84 (.53)	.40 (.61)	.05 (.92)
		(1.36)						
Management	12.28	12.78	11.11	11.12	13.33	12.12	12.21	11.94
	(1.62)	(1.82)	(.96)	(.84)	(.58)	(1.84)	(1.15)	(1.66)
Discipline Climate	12.76	9.24	17.70	17.00	17.91	15.93	19.35	14.06
	(1.20)	(2.85)	(1.82)	(1.73)	(1.70)	(1.11)	(.48)	(4.08)

Note. * All low SES student nodes, high and low achievers

Table 10.

Summary of Overachiever Nodes for CART Decision Tree for the United States of America.

	Nodes								
	22	23	28	33	35	39	41	47	55
Gender	Female	Female	Female	Male	Male	Male	Male	Male	Male
Family Structure	Other	Other	Other						
Immigrant	2nd		2nd						
Out Hours	Less	Less	More						More
T Directed Instruct				Less	More			More	More
T. Student Orient.				Less	Less	More	Less		More
T. Formative Assess				Less	Less	Less	More	More	More
Teacher Support						More			
Management	Low	More	More					Less	
Discipline Climate				Less					

Table 11.

Descriptive Statistics for Overachieving Nodes and Total for CART Decision Tree for the United States.

	Nodes									
	22	23	28	33	35	39	41	47	55	Total*
Percent										
Overachieving	100	100	65	87	100	100	100	69	98	23
Immigration-> 85%	1st Gen	Native	1st Gen	Native	Native	Native	2nd Gen	Even	2nd Gen	30 Nat 47 2st G
Gender (Female)	100	100	100	0	0	0	0	0	0	50
Family > 85%	Other	Other	Other	Single	2 Par	Single	2 Par	2 Par	2 Par	31
Means and Standard Deviations										
Total PISA Score	1603.20	1772.17	1425.83	1534.51	1611.71	1825.93	1672.48	1519.87	1569.93	1319.94
	(.00)	(.00)	(228.64)	(171.08)	(.00)	(.00)	(.00)	(212.72	(78.97)	(224.56)
Over-Achieving by	339.56	510.78	153.16	304.09	314.38	535.33	465.00	285.41	345.47	67.41
	(.00)	(.00)	(242.68)	(104.14)	(.00)	(.00)	(.00)	(239.32)	(80.44)	(227.56)
SES Index	-1.71	-1.73	-1.63	-2.01	-1.41	-1.47	-2.21	-1.97	-2.06	-1.81
	(.00)	(.00)	(.13)	(.60)	(.00)	(.00)	(.00)	(.45)	(.09)	(.37)
Out hours	3.00	2.00	10.52	8.19	22.00	1.00	1.00	8.69	23.99	8.46
	(.00)	(.00)	(6.25)	(2.06)	(.00)	(.00)	(.00)	(3.18)	(6.00)	(7.31)
Teacher Student	-1.60	.21	.61	-1.60	-1.60	.22	-58	.23	1.64	.44 (.93)
Orientation	(.00)	(.00)	(.99)	(.00)	(.00)	(.00)	(.00)	(.87)	(.03)	
Teacher Directed	-.08	-.32	.65	-3.65	-.32	-1.67	-.08	.82	1.80	.30
Instruction	(.00)	(.00)	(.31)	(.00)	(.00)	(.00)	(.00)	(1.05)	(.75)	(1.12)
Teacher Formative	-.29	.76	1.08	-2.39	-.59	-1.46	-.59	.45	1.98	.27
Assess	(.00)	(.00)	(1.14)	(.00)	(.00)	(.00)	(.00)	(.66)	(.63)	(1.14)
Teacher Support	-.09	.61	.28	-2.92	.97	1.68	-.86	.36	1.01	.19
	(.00)	(.00)	(.51)	(.00)	(.00)	(.00)	(.00)	(.87)	(.67)	(1.02)
Management	10.00	16.00	13.70	9.19	12.00	9.00	8.00	9.69	13.41	11.72
	(.00)	(.00)	(.96)	(2.06)	(.00)	(.00)	(.00)	(.70	(.87)	(1.68)
Discipline Climate	19.00	19.00	16.57	5.00	18.00	17.00	5.00	14.42	13.02	14.34
	(.00)	(.00)	(.53)	(.00)	(.00)	(.00)	(.00)	(3.73)	(6.99)	(4.01)

Note. * All low SES student nodes, high and low achievers

Figure 1. Example CART Tree

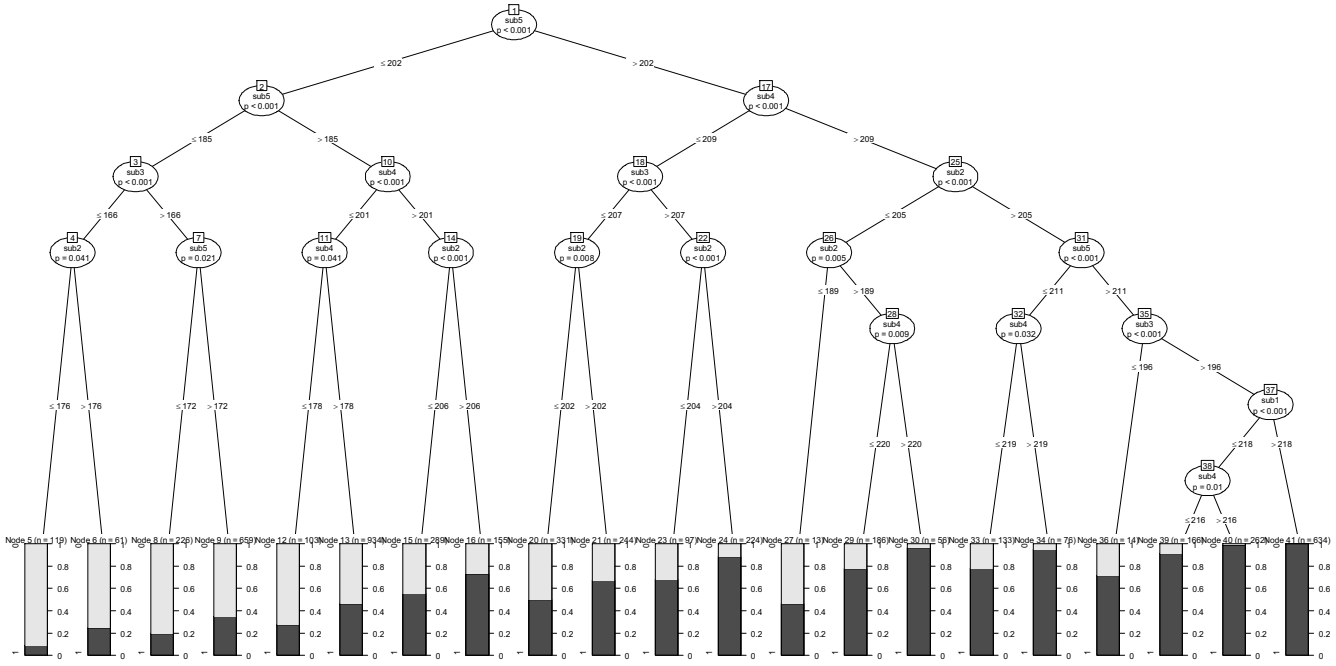


Figure 2. CART Decision Tree Nodes for Canada

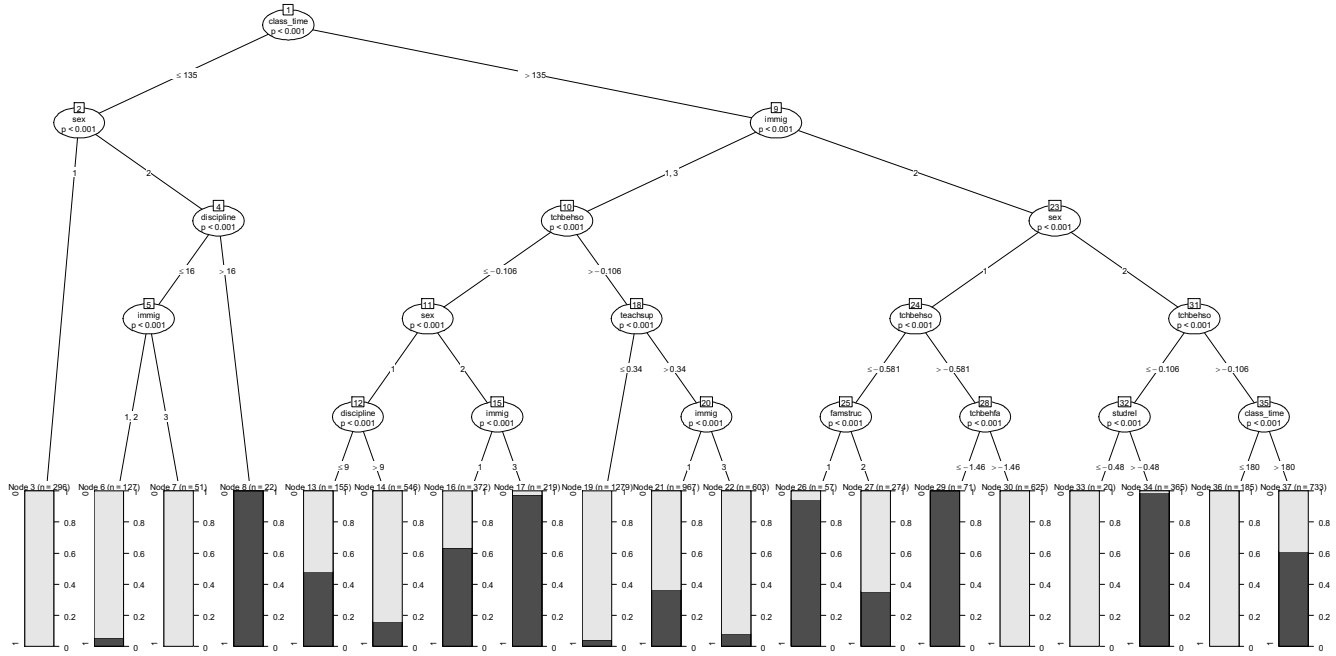


Figure 3. CART Decision Tree Nodes for Finland

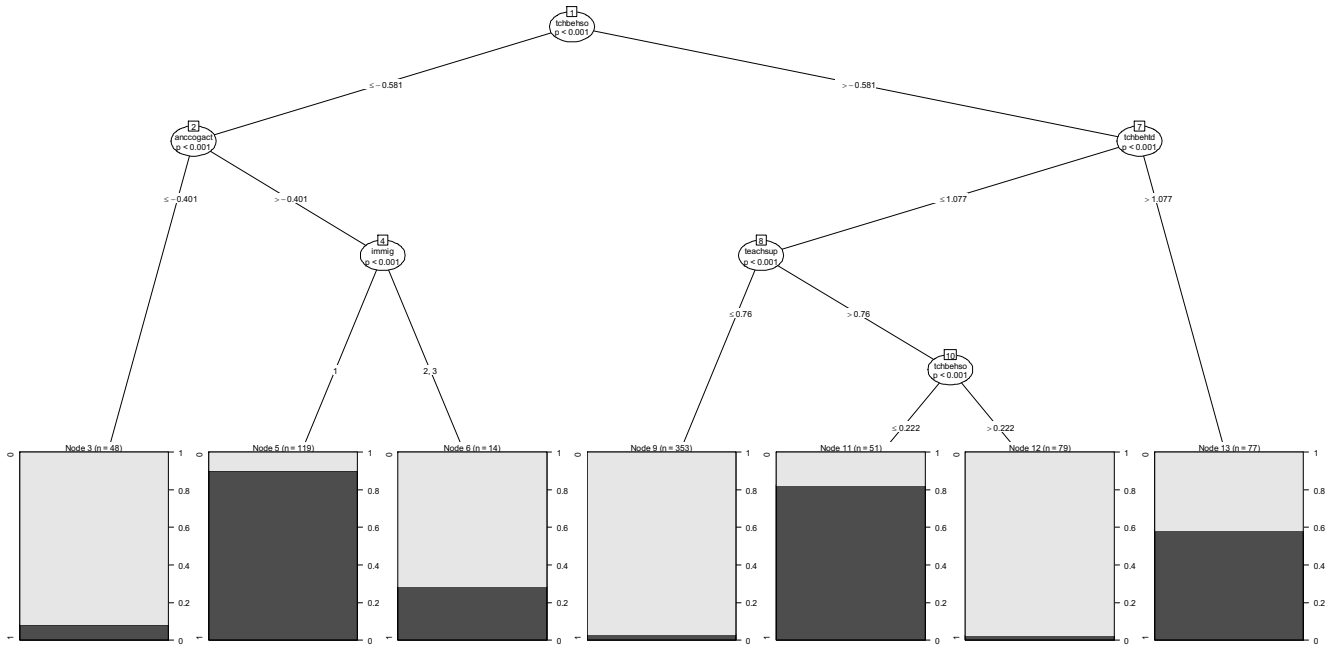


Figure 4. CART Decision Tree Nodes for Germany

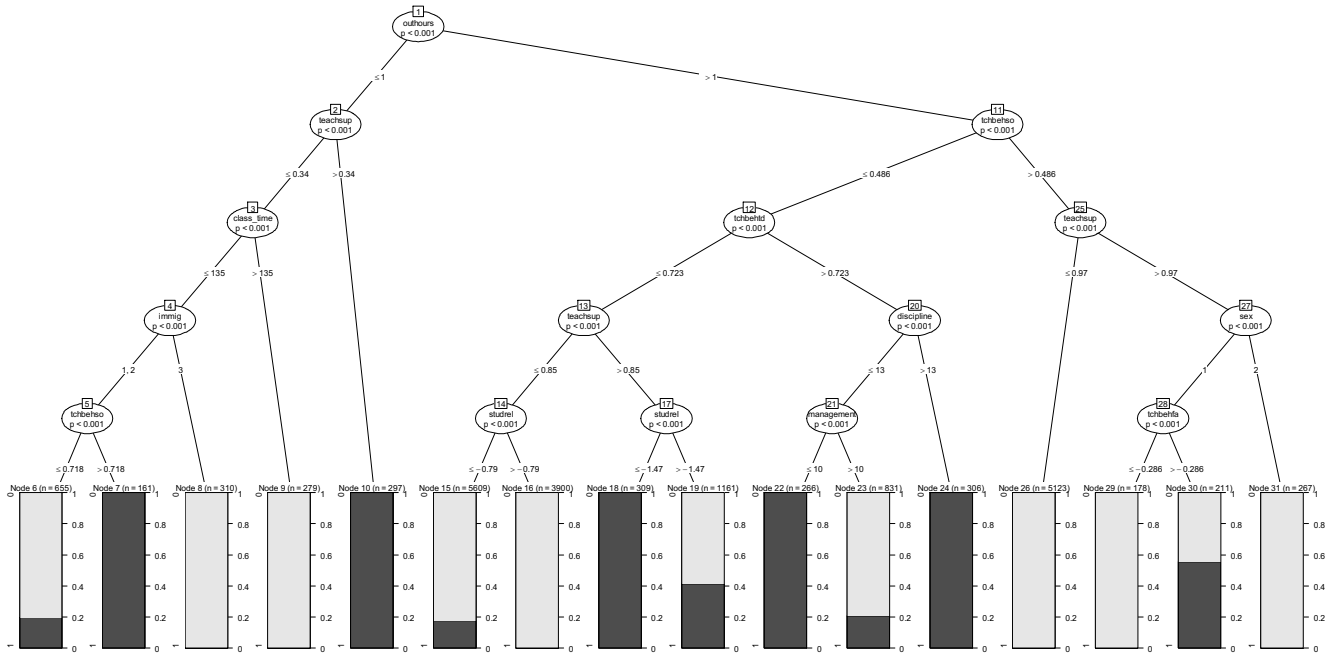


Figure 5. CART Decision Tree Nodes for Singapore

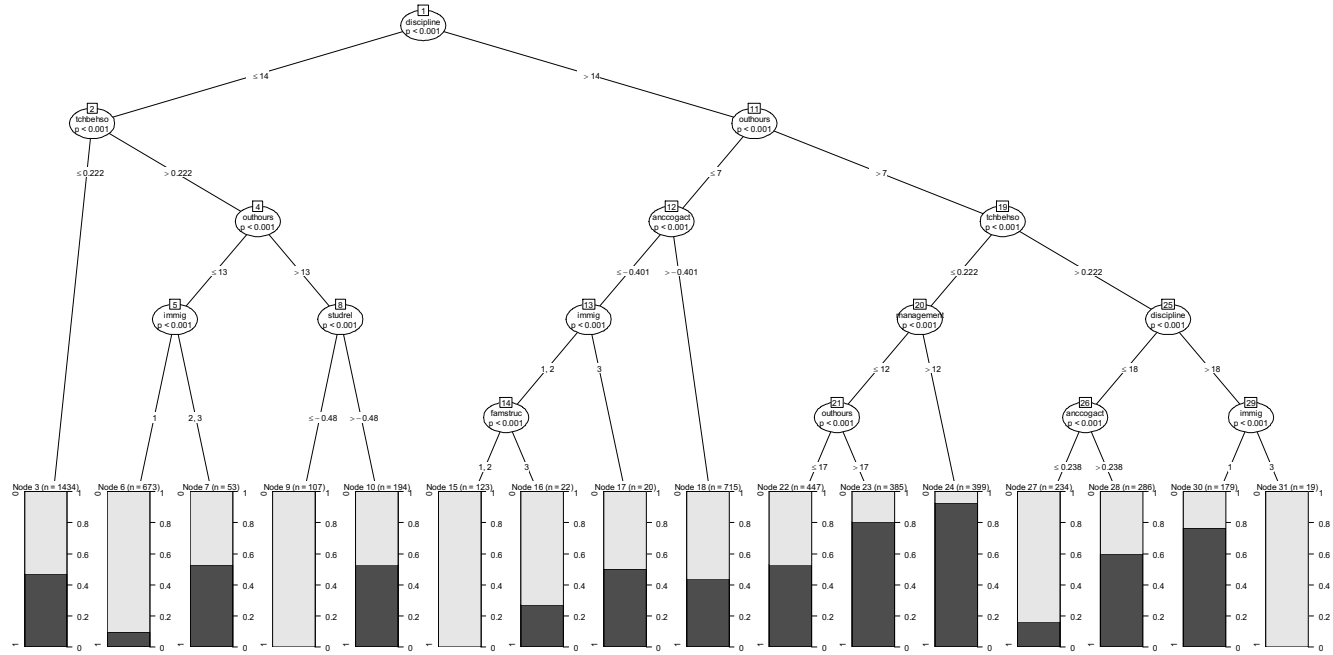
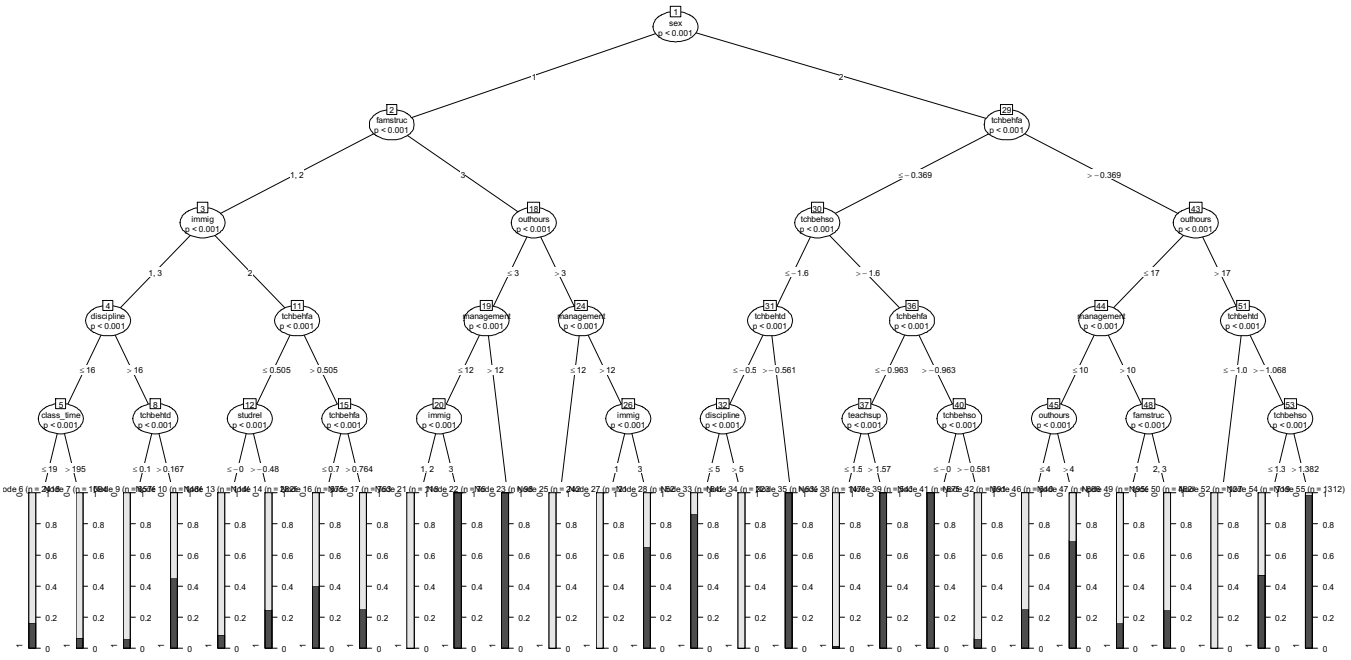


Figure 6. CART Decision Tree Nodes for the United States of America



Appendix

Class time (scheduled school class time)

Out-of-School Study Time Scale
- Homework
- Guided Homework
- Personal Tutor
- Commercial Company
- With Parent
- Computer

Teacher Behaviour:
- Formative Assessment
  - Gives Feedback
  - Gives Feedback on Strengths and Weaknesses
  - Informs about Expectations
  - Tells How to Get Better
- Student Orientation
  - Differentiates Between Students When Giving Tasks
  - Assigns Complex Projects
  - Has Students Work in Small Groups
  - Plans Classroom Activities
- Teacher-Directed Instruction
  - Sets Clear Goals
  - Informs about Learning Goals
  - Encourages Thinking and Reasoning
  - Checks Understanding
  - Summarizes Previous Lessons

Cognitive Activation
- Teacher Encourages to Reflect Problems
- Gives Problems that Require to Think
- Asks to Use Own Procedures
- Presents Problems with No Obvious Solutions
- Presents Problems in Different Contexts
- Helps Learn from Mistakes
- Asks for Explanations
- Apply What We Learned
- Problems with Multiple Solutions

Disciplinary Climate
- Students Don’t Listen
- Noise and Disorder

- Teacher Has to Wait Until its Quiet
- Students Don't Work Well
- Students Start Working Late

Teacher Support
- Lets Us Know We Have to Work Hard
- Provides Extra Help When Needed
- Helps Students with Learning
- Gives Opportunity to Express Opinions

Classroom Management
- Students Listen
- Teacher Keeps Class Orderly
- Teacher Starts On Time
- Wait Long to (quiet down)

Attributions to Failure
- Not Good at Math Problems
- Teacher Did Not Explain Well
- Bad Guesses
- Material Too Hard
- Teacher Didn't Get Students Interested
- Unlucky

Student-Teacher Relations
- Get Along with Teachers
- Teachers Are Interested
- Teachers Listen to Students
- Teachers Help Students
- Teachers Treat Students Fair

Sense of Belonging Scale
- Feel Like Outsider
- Make Friends Easily
- Belong at School
- Feel Awkward at School
- Liked by Other Students
- Feel Lonely at School
- Feel Happy at School
- Things Are Ideal at School
- Satisfied at School

Perseverance Scale
- Give up easily

- Put off difficult problems
- Remain interested
- Continue to perfection
- Exceed expectations

Openness for Problem Solving Scale

- Can Handle a Lot of Information
- Quick to Understand
- Seek Explanations
- Link Facts
- Like to Solve Complex Problems

Perceived Control Scale

- Can succeed with enough effort
- Doing well is completely up to me
- Family demands and problems
- Different teachers make me try harder
- If I wanted I could perform well
- Perform poorly regardless

Attitude towards School Scale

- Does little to prepare me for life
- Waste of time
- Gave me confidence
- Useful for job
- Helps to get a job
- Prepare for college
- Enjoy good grades
- Trying hard is important