What Works Where? The Relationship Between Instructional Variables and Student Achievement in Mathematics and Science in Low-, Medium- and High-Achieving Countries

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Abstract

Hierarchical multilevel regression analysis was employed to explore the relationship between the frequency of using a set of instructional variables and the average score of schools in mathematics and science. The models specified for this analysis were two-level models of schools nested in countries (49) that participated in TIMSS-2007. The regression coefficient of a set of instructional variables on the mean score of schools in mathematics and science in three groups of countries grouped according to level of achievement provides us with an answer to the research question – whether or not frequent use of these modes of instruction is similarly associated with learning outcomes in low-, medium-, and high-achieving countries. A similar association might support a generalization regarding an instructional theory about "what works" and "what does not work" in education.

Findings of this study show that frequent implementation of constructivist modes of instruction were found to be positively associated with learning outcomes in high- and medium-achieving countries, but negatively associated with learning outcomes in low-achieving countries.

These findings confirm conclusions reached in other studies that replacing teacher-led (traditional) practices with more student-led (constructivist) practices does not necessarily result in more learning for all. Evaluating the differential effect of teacher practices in different countries grouped according to achievement level can help to shape effective pedagogical practices and also have implications for teacher training in different countries.

Purpose

The association between modes of instruction in mathematics and science and student achievements in these subject areas in countries that differ in their academic attainments is the focus of this study. The study not only looks at teaching practices "that work" (positively associated with achievement), but also investigates whether they "work" similarly in all groups of countries.

Perspective

The founders of the IEA considered the idea of assessing the strengths and weaknesses of educational practices in a worldwide "educational laboratory." It was expected that such a worldwide laboratory would enable arriving at valid international generalizations regarding what works in education (Husen, 1973).

Facing an educational reality in which variability exceeds similarity, the goal of constructing a comprehensive educational theory was relinquished, and instead of searching for similarities, researchers favored examining the differences that distinguished one country from anotherusually using data from only a few selected countries and delineate the differences or similarities among them (e.g., House, 2005; House & Telese, 2008; Le et al., 2006; Stevenson et al., 1987; Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999). Attempts to follow this line using data from **all** participating countries focused mainly on differentiating among them using descriptive measures of different variables such ascurriculum, students' backgrounds and attitudes, classroom practices, school climate, students' responses to test items, and other contextual or outcome variables (e.g., Desimone, Smith, Baker, & Ueno, 2005; Dudits & Elijio, 2008; Houang, Schmidt & Gogan, 2004: Grønmo, Kjaernsli & Lie, 2004; Japeli-Pavesic & Korenjak-Cerne, 2004; Rutkowski & Rutkowski, 2009; Schmidt, Wung, & Logan, 2001, and Zabulionis, 2001).

The variability revealed in these studies led the researchers to conclude that teaching is not culturally independent (Fuller & Clarke, 1994). These conclusions were in line with findings drawn from other studies (Dale, 2000; Dale & Robertson, 2002), which provided evidence for regional similarities and argued for three regions of harmonized curricula and instruction: Europe, Asia, and America.

Adopting this view led me, in the early stages of the present study, to classify countries a-priori according to cultural and geographical similarities and to look for typical modes of instruction that characterize each of these groups of countries. The variability found in implementing instructional practices in the grouped countries, together with the similarities found in the teaching practices used in countries belonging to different groups, led me, in later stages of the study, to seek another classifying principle – the actual level of attainment. Cutting countries' average score distribution in mathematics and science into three equally-sized parts allowed me to define three groups of countries: low-, medium-, and high-achieving countries.

At this stage, the focus of the study also shifted from distinguishing between the groups of countries according to the frequency of use of instructional practices to distinguishing between them according to their relationship with schools' learning outcomes, and the research question was whether or not this association is similar in all groups of countries. This research question links the study to the literature that deals with instructional effectiveness.

Review and meta/mega analyses carried out on the many studies of this type (Brophy & Good, 1986; Creemers, 1994; Fraser, Walberg, Welch, & Hattie, 1987, Scheerens, 2000a, 2000b; Scheerens & Bosker, 1997; Seidel & Shavelson, 2007; Stallings, 1985; Walberg, 1984; Wang, Haertal & Walberg, 1993) highlighted a number of instructional components associated with achievement with highest effect sizes, such as time on task, structured direct teaching, opportunity to learn, feedback and monitoring student progress procedures, and other variables that were later included in what Scheerens (2004) refers to as "traditional instruction".

The change that occurred in the last decade in learning and teaching theories, due to the new epistemological paradigm of constructivism, introduced new instructional components into the instructional effectiveness framework in line with constructivist modes of instruction (for detailed description and references, see Seidel and Shavelson (2007, p. 459-460).

The mixture of both traditional and constructivist instructional components also occurs in the case of mathematics and science. In both subject areas, there is a debate as to whether the more constructivist approaches promote achievements of all students, or help only the brightest ones (Desimone et al., 2005; Le et al., 2006; Lee & Luyks, 2005; Tomlinson et al., 2003). Data on instructional practices obtained from large scale studies such as those carried out by IEA provide an opportunity to address this issue.

Methods, Statistical Techniques, and Data Source

The data that served this study were obtained from the TIMSS 2007 database. For each of the 49 participating countries, it provided estimated proficiency (achievement) scores in mathematics and science and extensive data on contextual variables—social as well as educational.

Hierarchical multi-level regression analysis using HLM 6 software was adopted to explore the relationship between the frequency of using a set of instructional variables and a school's mean score in mathematics and science.

The models specified for this analysis were two-level models of schools (7201) nested in 48 countries.

The school (class) level was decided upon as the appropriate lower level of the analysis as this is the level where our target variables—the instructional practices—operate and the aim of the study as defined was to explore the association of their frequent use with the average score of the school.

On the school level, the specified models included two aggregated student level variables that described students' background: Aspiration to complete higher levels of education (HFG) and the number of books at home (book). Another variable specified on this level described our target variable—the school (class) mean of students' perceptions of the frequency of being exposed to one of several modes of instruction.

On the country level, dummy variables were used to indicate the schools' affiliation to one of the three equally sized groups of countries established. The medium-achieving group was chosen to serve as the comparison group to which estimated regression coefficients for high- and low-achieving countries were compared.

In addition to the base models used to partition the total variance in schools' average achievement scores in mathematics and science, to "between-schools" and "between-countries" components, and a model that only included the school-aggregated student background variables. Three alternative models were specified for each of the instructional variables that were studied (17 in mathematics and 16 in science). The first model also included the school-aggregated student perceptions of the frequency of implementing a specific instructional mode. The second also contained the dummy variable indicating the schools' affiliation with either the high- or low-achieving groups of countries and the third model also included an interaction term between the relevant instructional variables and the variable describing the schools' affiliation.

The regression coefficient (B) of the relevant instructional variable obtained from the third model indicated the size and direction of change in the mean achievement score of schools as a result of a one-unit change on the frequency scale of implementing that instructional variable in the medium-achieving group of countries.

The regression coefficient (B) of the interaction term indicated similar changes in high- and low-achieving countries compared to that in the medium-achieving countries.

This last model was meant to provide an answer to the research question: Is the association between frequent use of certain instructional practices and the mean achievement score of schools in mathematics and science similar in all three groups of countries or does it differ from high- to mid- to low-achieving countries?

Results

The following tables show the regression coefficients of the different instructional modes used in mathematics or science classrooms on schools' mathematics or science mean scores in low-, medium-, and high-achieving countries (in bold in the table). The values appearing in the table were obtained from separate analyses carried out for each instructional variable. The tables also presents the regression coefficients of the interaction terms (in brackets) between the instructional variables and the affiliation of schools to either the low- or high-achieving group of countries.

a) *The Relationship between Frequent Use of Mathematics Instructional Modes and Mathematics Achievement*

Student perception of the frequency of using 17 modes of instruction common in mathematics classrooms were aggregated on the school level. These practices were classified into three groups: those that focus on developing computational skills; those that represent traditional, mostly teacher-led, instructional practices; and those that represent conceptual, more constructivist practices. This classification echoes the distinction between traditional and constructivist modes of instruction discussed earlier in this paper.

Table 1 shows the regressions coefficients of these instructional modes on schools' mathematics mean scores in the three groups of countries and the coefficient of their interaction terms with the high and low achieving groups.

Insert Table 1 about here

Interpretation

Frequent use of three of the six instructional modes that aim at developing computational skills were found to be positively associated with the mean mathematics score of schools in all three groups of countries, although in varying strength. For two modes, "memorizing formulas and procedures" and "practicing the four arithmetical operations without using a calculator," this association is more profound in low- and medium-achieving countries, while for "writing equations and functions to represent relationships," the association is more profound in high- and medium-achieving countries. A one-unit increase on the frequency scale of these variables results in an increase of about 0.15 to 0.4 standard deviations of the distribution of schools' mean scores in the different groups of countries. Frequent use of other instructional modes of this type ("working on fractions and decimals," "interpreting data in tables, charts and graphs") were found to be negatively associated with achievement in low-performing countries.

In the case of traditional teacher-led modes of instruction, such as "reviewing homework" and "listening to teacher lecturing," a one-unit increase on their frequent use scale increases the mathematics mean scores by about 0.1 to 0.3 of the standard deviation of the distribution of schools' mean scores in the relevant group of countries. The positive association of "reviewing homework" with achievement is more profound in low- and medium-achieving countries, while that of "listening to teacher lecturing" is more profound in medium- and high-achieving countries. Some traditional activities, such as "having quizzes or tests" or "beginning to do homework in class," when occurring frequently, were found to be negatively associated with the average achievement of schools in all groups of countries. Frequent use of computers was also found to have a negative association with average mathematics achievement of schools in all groups of countries.

Among the more constructivist modes of instruction, only the practice that requires students to "explain their answers" was found to be highly associated with the average achievement of schools in all three groups of countries; more so in medium- and low-achieving countries. However, requiring students to "work out problems on their own" or to "decide on their own on procedures for solving complex problems" was found to be positively associated with the average achievement of schools in high- and medium-achieving countries, but negatively associated with achievement in low-achieving countries.

Generally speaking, it seems that practices that focus on computational skills and traditional teacher-led, more direct instruction that are positively associated with achievement in all groups of countries are more effective in low- or medium-achieving countries, while more challenging constructivist modes of instruction are more effective in medium- or high-achieving countries.

Plotting graphs of predicted schools' mean mathematics scores at two distal categories on the frequency scale of using these practices (1 and 4) makes it possible to visualize the association between frequent use of instructional practices and the schools' mean mathematics scores.

To give a feeling of these patterns of association, three plots are presented. Figure 1 illustrates the positive relationship between a traditional teacher-centered mode of instruction—LSP ("listen to teacher lecture") and schools' mean score, while Figure 2 illustrates a negative association, this time between another common practice, "working in small groups" (WSG) and schools' mean mathematics scores.

Figure 3 demonstrates the differential relationship between "students working out problems on their own," a more student-centered constructivist mode of instruction, and schools' mathematics mean scores. Here the relationship is positive in high- and medium-achieving countries and negative in low-achieving countries.

Predicted scores for each group of countries at the two distal categories on the frequency of use scale of the instructional practice make it possible to calculate the achievement gap between students exposed frequently to the practice and those who never engage in such practices. These gaps, when compared with the standard deviation of schools' mathematics mean scores, are considered large.

Insert Figures 1-3 about here

b) *The Relationship between Frequent Use of Science Instructional Modes and Achievement in Science*

Instructional practices in science classrooms were classified into two groups of practices: traditional teacher-led expository practices and the more inquiry-oriented, student-led, constructivist modes of instruction. Here, too, this classification echoes the "instructional components" that appear in school effectiveness literature discussed earlier.

Table 2 shows the regression coefficient of these instructional modes on schools' science mean score in the three groups of countries and the coefficient of their interaction terms with the high' and low-achieving groups.

Insert Table 2 about here

Interpretation

Despite the advocacy for inquiry-oriented student-centered modes of instruction, such as "make observations," "plan and conduct experiments," "work on experiments in small groups," and so on, the regression coefficients of such practices, even if showing a positive association with the average science score of the school, are small and in most cases statistically insignificant. The only student-led activity found to be positively and significantly associated with science achievement in schools in all groups of countries was that of students "providing their own explanations about what they study." A one-unit increase on the frequency scale of this activity increases the average school score in all groups of countries from about 0.27 to 0.45 of a standard deviation of the distribution of schools' mean scores in the relevant groups of countries. Another practice associated with constructivist notions of learning and recently used in science classrooms, "relating what is learned to daily life," also seems to be positively associated with achievement in all groups of countries. However, this association is weak. A one-unit increase on the frequency scale of this activity increases average school scores only from 0.1 to 0.24 of a standard deviation of the mean distribution of school scores in the relevant group of countries.

In contrast to the unfulfilled expectations of inquiry-oriented and constructivist modes of instruction, many traditional teacher-led practices in science classrooms, such as "listening to teacher lecturing," "memorizing facts and principles," "using formulas and laws to solve problems," "reading textbooks," and so on, were found to be positively associated with the mean science scores of schools in all groups of countries.

Some traditional practices, when frequently implemented, are more positively associated with the mean score of schools in low-achieving countries. Such is the case when students are often asked to "memorize science facts and principles" or to observe their "teacher demonstrating an experiment," but in other cases, such as "listening to teacher lecturing," "using scientific formulas and laws to solve problems," or "reading textbooks and other resource material," this positive association is more profound in high- and medium-achieving countries.

It is interesting to note that while frequent "reading of textbooks" is positively associated with the average science scores in schools in high- and medium- achieving countries, it is negatively associated with the average science scores in schools in low-achieving countries.

Some traditional practices, such as "beginning homework in class," "having quizzes or tests," and "using computers," when frequent, were found to be negatively and significantly associated with achievement in schools in all groups of countries.

Plotting a graph of predicted school mean science scores for the distal categories on the frequency scale of using some instructional variables shows that there are some that "work" similarly in all groups of countries, although with varying strengths, while others exhibit a differential effect in the different groups of countries. Three examples are shown below to demonstrate the patterns of association.

Figures 4 and 5 show a positive association between "listening to teacher lecturing" and "memorizing facts and principles" and the mean science score of schools. In contrast, Figure 6 displays the differential association between "students working out problems on their own" and the mean science score of schools.

Predicted scores in the two distal categories on the frequency scales of using the instructional practice make it possible to compute the achievement gap between students exposed during every lesson to the instructional practice and those who never engage in such a practice.

Insert Figures 4-6 about here

Conclusions

In both school subjects, some modes of instruction were found to be similarly associated with achievements in all three groups of countries (either positively or negatively), while others show a differential association.. In mathematics, instruction targeted at developing computational skills (practicing four operations without calculators, memorizing formulas and procedures, and writing equations and functions) and traditional modes of instruction (listening to teacher lecturing, and requiring students to explain their answers), were found to be positively and significantly associated with mathematics achievements in all groups of countries, though with varying strength. Usually, this association is much stronger in low-achieving countries.

Some instructional activities (frequent interpretation of data in tables or graphs, begin homework in class, frequent use of computers, frequent group work, and having tests or quizzes frequently), were found to be negatively and significantly associated with achievement in all groups of countries and often more so in low-achieving countries while interpreting graphs and charts, and the use of computers are regarded as more demanding modes of instruction. Frequent testing or frequent group work and frequently starting to do homework in class may be a symptom of low attainment and not its cause.

In science, too, certain instructional variables were found to be similarly associated with achievement in all groups of countries. As in mathematics, variables that represent traditional expository modes of teaching (listening to teacher lecturing, and memorizing facts and principles) were found to be positively and significantly associated with science achievements in all three groups of countries. Here too, some types of instruction were found to be negatively associated with achievements in all groups of countries (frequent use of computers, frequent testing, frequently beginning to do homework in class). As in the case of mathematics instruction, the negative association of frequent use of computers with achievement can signal teachers' lack of digital pedagogies, which might explain the ineffectiveness of this mode of instruction. The habit of starting to do homework in class may indicate reduced instructional time, which may have a negative effect on achievement, or may signify weakness of the students that is, on its own, the reason for their low achievements. Similarly, the negative association of frequent testing with achievement may be the result of low performance of schools and not its cause.

On the other hand, in both school subjects, there are variables that do not exhibit similar association with achievement in all groups of countries. Most of these variables are those oriented toward more constructivist modes of instruction. Variables describing students working on problems on their own both in science and mathematics—designing or planning experiments in science, and deciding on ways to solve problems in mathematics, which are highly demanding modes of instruction—show a differential effect. Frequent implementation of these practices was found to be positively associated with learning outcomes in high- and medium-achieving countries but negatively associated with learning outcomes in low-achieving countries.

These findings confirm findings from other studies related to science and mathematics instruction (Le et al., 2006; von Secker, 2002; von Secker & Lissitz, 1999), which hold that replacing teacher-centered (traditional) practices with more student-centered (constructivist) practices will not necessarily result in more learning for all. Such student-centered, more demanding practices seem to be more beneficial for high-achieving students (more of whom can be found in high-achieving countries) and might be a waste of time for low-achieving students in low-achieving countries.

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Appendix

Table 1: Regression Coefficients of Instructional Variables on Schools' Mean Scores in Mathematics

(a) Instructional practices that focus on developing computational skills

Instructional Practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Practice four operations without using a calculator (ASAM)	**-11.4*** (13.4)*	**-24.8****	**-1.0** (23.8**)
Write equations and fractions (EFR)	**-7.8*** (3.6)	**-11.4****	**-14.3*** (-2.9)
Memorize formulas and procedures (FRR)	**-19.5***** (-1.9)	**-17.6***	**-8.9** (8.7)
Solve problems in geometry (GSA)	**2.3** (7.1)	**-4.8**	**-3.8** (1.0)
Interpret data in tables, charts and graphs (GCT)	**14.6*** (7.5)	**7.1**	**11.4*** (4.3)
Work on fractions and decimals (WFD)	**22.2***** (30.0***)	**-7.8**	**-3.0** (4.8)

(b) Traditional practices

Instructional Practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Review homework (ROH)	**-15.4*** (-4.3)	**-11.1***	**-5.7*** (5.3)
Listen to teacher lecture (LSP)	**-10.8** (7.4)	**-18.2***	**-12.7*** (5.5)
Begin homework in class (BHC)	**27.4***** (-22.9***)	**4.4**	**5.3** (0.9)
Have quizzes or tests (HQT)	**18.7**** (7.8)	**10.9**	**4.8** (-6.1)
Use computers (COM)	**41.5***** (18.3**)	**23.1*****	**16.9***** (-6.3)
Use calculators (CAL)	**4.6** (-5.9)	**10.5***	**-6.1** (-16.6*)

Table 1/cont.

Table 1 (cont.)

(c) Constructivist modes of instruction

Instructional practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Students work out problems on their own (WPO)	**12.7**** (44.5***)	**-31.8*****	**-28.5***** (3.3)
Students explain their answers (EXP)	**-26.1**** (6.0)	**-32.0*****	**-14.3**** (17.8)
Students decide on their own about procedures for solving problems (SCP)	**11.0*** (14.7)	**-3.6**	**-12.7*** (-9.0)
Work together in small groups (WSG)	**15.1**** (-0.3)	**15.4****	**11.1***** (-4.3)
Relate what is learned to daily life (MDL)	**9.2*** (5.5)	**3.7**	**1.9** (-1.8)

Note: In parentheses – regression coefficients of the instructional variable with school's affiliation with either low- or high-achieving groups of countries, compared to that in the medium-achieving group

*** = $p \leq .000$; ** $p \leq = .01$; * $p \leq = .05$

Table 2: Regression Coefficients of Instructional Variables on Schools' Mean Scores in Science

(a) Traditional teacher-led instructional practices

Instructional Practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Listen to teacher lecture (LSP)	**-17.9*** (4.2)*	**-22.11****	**-25.6***** (-3.5)
Watch teacher demonstrate an experiment (DEI)	**-12.5*** (-5.3)	**-7.1***	**-0.1*** (7.0)
Memorize facts and principles (FAP)	**-26.3***** (-6.4)	**-19.8****	**-15.6**** (4.2)
Use scientific formulas and laws to solve problems (LAW)	**-8.2** (6.8)*	**-15.0***	**-13.4*** (1.6)
Review homework (ROH)	**-12.4** (-4.1)*	**-8.4***	**-4.9** (3.5)
Begin homework in class (BHC)	**36.0***** (15.4)	**20.6****	**11.1**** (-9.6)
Read science textbooks and other resource materials (TEX)	**17.7*** (33.0**)	**-15.3***	**-15.9***** (-0.6)
Have quizzes or tests (HQT)	**16.0**** (10.4)	**5.6***	**11.3*** (5.7)
Use computers (COM)	**48.3***** (32.9***)	**15.4****	**7.4**** (-8.0)

(b) Inquiry-oriented, constructivist student-centered practices

Instructional Practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Make observations and describe what is seen (OBS)	**6.2** (8.8)	**-2.6**	**-6.4*** (-3.8)
Conduct experiments (CEI)	**3.8** (7.9)	**-4.2**	**-6.9*** (-2.7)
Design or plan experiments (PEI)	**10.4**** (4.2)	**6.2**	**3.4** (-2.8)
Work in small groups on an experiment or investigation (WGO)	**3.6** (6.3))	**-2.7**	**-6.3** (-3.6)
Give explanation about what is studied (EOS)	**-16..5** (8.0))	**-24.5*****	**-16.8***** (7.7)
Work on problems on their own (WPO)	**22.6**** (22.3*)	**0.4**	**-9.8**** (-10.2)
Relate learning to daily life (MDL)	**-7.6** (5.5)	**-13.1***	**-8.6*** (4.5*)

Note: In parentheses – regression coefficients of the instructional variable with school's affiliation with either low- or high-achieving groups of countries, compared to that in the medium-achieving group

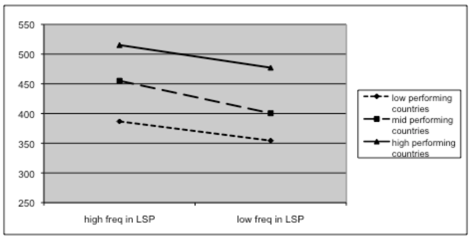
*** = $p \leq .00$; ** = $p \leq .01$; * = $p \leq .05$

Table 2 (cont.)

(b) Inquiry-oriented, constructivist student-centered practices

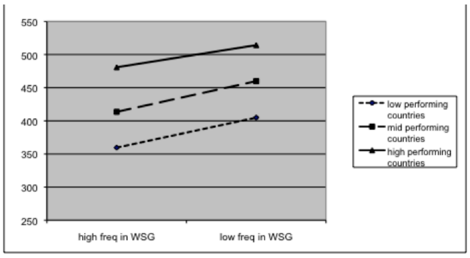
Instructional Practice	Regression Coefficient		
	Low-Achieving Countries	Medium-Achieving Countries	High-Achieving Countries
Make observations and describe what is seen (OBS)	**6.2** (8.8)	**-2.6**	**-6.4*** (-3.8)
Conduct experiments (CEI)	**3.8** (7.9)	**-4.2**	**-6.9*** (-2.7)
Design or plan experiments (PEI)	**10.4**** (4.2)	**6.2**	**3.4** (-2.8)
Work in small groups on an experiment or investigation (WGO)	**3.6** (6.3))	**-2.7**	**-6.3** (-3.6)
Give explanation about what is studied (EOS)	**-16..5** (8.0))	**-24.5*****	**-16.8***** (7.7)
Work on problems on their own (WPO)	**22.6**** (22.3*)	**0.4**	**-9.8**** (-10.2)
Relate learning to daily life (MDL)	**-7.6** (5.5)	**-13.1***	**-8.6*** (4.5*)

Note: In parentheses – regression coefficients of the instructional variable with school's affiliation with either low- or high-achieving groups of countries, compared to that in the medium-achieving group
*** = $p \leq .00$; ** = $p \leq .01$; * = $p \leq .05$



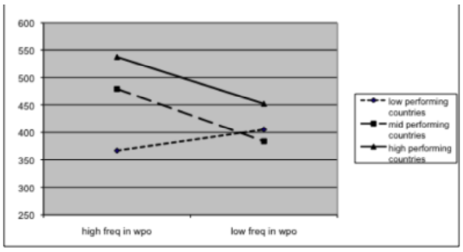
Countries	High Freq. in LSP	Low Freq. in LSP	Gap
Low performing	387	354	33
Mid performing	455	400	55
High performing	515	477	38

Figure 1: Achievement Gaps between High and Low Frequent Use of LSP (listen to teacher lecture)



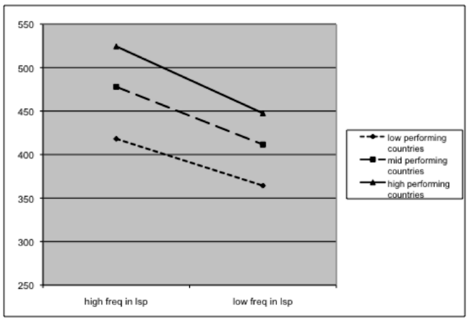
Countries	High Freq. in WSG	Low Freq. in WSG	Gap
Low performing	360	405	-45
Mid performing	414	460	-46
High performing	481	514	-33

Figure 2: Achievement Gaps between High and Low Frequent Use of WSG (work in small groups)



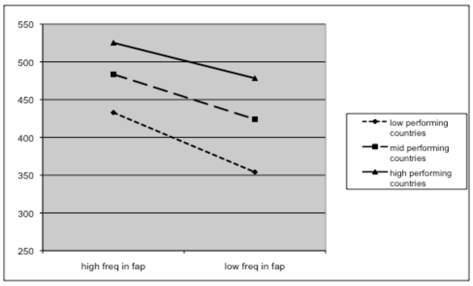
Countries	High Freq. in WPO	Low Freq. in WPO	Gap
Low performing	367	405	-38
Mid performing	479	384	95
High performing	537	452	85

Figure 3: Achievement Gaps between High and Low Frequent Use of WPO (students work out problems on their own)



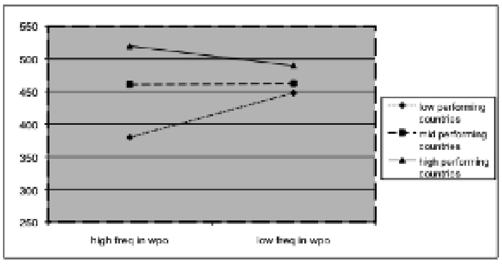
Countries	High Freq. in LSP	Low Freq. in LSP	Gap
Low performing	418	364	54
Mid performing	478	412	66
High performing	525	448	76

Figure 4: Achievement Gaps between High and Low Frequent Use of LSP (listen to teacher lecture)



Countries	High Freq. in FAP	Low Freq. in FAP	Gap
Low performing	433	354	79
Mid performing	484	424	60
High performing	525	478	47

Figure 5: Achievement Gaps between High and Low Frequent Use of FAP (memorize facts and principles)



Countries	High Freq. in WPO	Low Freq. in WPO	Gap
Low performing	380	448	-68
Mid performing	461	462	1
High performing	519	490	29

Figure 6: Achievement Gaps between High and Low Frequent Use of WPO (work on problems on their own)