

The relationship between principals' perceptions of school practices and student achievement in science: The implicit ethical meaning of the TIMSS

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Abstract

The aim of this study was to explore principals' perceptions of school practices that have ethical meaning through a transnational perspective based on the 8th grade TIMSS 2015 international assessment. The sample comprised 8353 principals from 8353 different schools and 280,130 students that participated in the TIMSS 2015 survey. We used principals' ranking procedure and Mplus for exploratory and confirmatory analyses, multilevel confirmatory analysis, and multiple group comparison. The results indicated that principals' perceptions include three main dimensions with an ethical meaning: 'caring for students' learning', 'respecting the rules amongst students and teachers' and 'parents' and students' involvement in schooling'. These dimensions broaden the meaning of existing dimensions describing ethical practices in school leadership. In addition, they were found to positively predict students' science achievements. The novelty of this study is reflected by the results, leading to the understanding that the TIMSS principals' questionnaire has an additional meaning, which goes beyond its original parameters. The findings may lead to a better understanding of the importance of the role of educational leaders in promoting ethical school practices. This study set out to elicit a new transnational measure, which may warrant an exploration of the similarities and differences between countries.

Keywords

Transnational perspective, ethics, school practices, principals, educational leaders, science achievement, TIMSS 2015

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Introduction

It is increasingly important to examine principals' perceptions of school practices that have ethical meaning through a transnational perspective, since we are aware that ethics constitute an integral component of educational leadership (Gross and Shapiro, 2015; Hammersley-Fletcher, 2015; Kimber and Campbell, 2014). By learning from the successes and failures of others, by means of transnational studies in educational leadership, we can significantly improve comparable educational systems (Leithwood and Hallinger, 2012; Marfan and Pascual, 2018). The TIMSS 8th grade international assessment helps describe educational systems in each country by providing information reflecting the practices in schools as submitted by the responding principals to a set of questionnaires (Mullis et al., 2016).

Therefore, in this study, we focus on principals' questionnaires in the 8th grade TIMSS 2015 international assessment conducted across 45 countries in order to examine whether ethical practices can be elicited from principals' descriptions of school practices and what the main characteristics of these practices are.

Since ethics are an integral part of school leadership, this study had three primary goals: (a) to explore whether shared ethical meanings emerge from school practices as perceived by principals' responses to TIMSS questionnaires across the participating countries. If shared perceptions of ethical meanings were to be found, then our subsequent goals would be: (b) to find the meaning of these shared perceptions based on school practices; and (c) to investigate the effect of these school practices on students' science achievements in the countries participating in TIMSS 2015.

This study focuses particularly on student achievement in science, due to the importance of the subject of science in every country's development. According to Mullis and Martin (2014), students' science knowledge has the potential to make a substantial contribution, as it can improve medical, housing and transportation conditions, as well as enhance the management of environmental protection and maintenance of a country's economic health and stability.

Our motivation for finding a *shared* ethical meaning in principals' perceptions of school practices across countries relates to international assessments in education, such as the TIMSS, which focus on the existence of shared ethical values in participating countries, such as equity and quality (Mullis et al., 2016). Therefore, in this study, we chose to focus on countries that participated in the TIMSS 2015, because for the last 20 years TIMSS reports have revealed international ethical values such as identifying gaps in resources, opportunities, and inequity and equity issues (Mullis et al., 2016), which are ethical values that affect educational leadership in schools all over the world (Brooks and Normore, 2010; Shapiro and Stefkovich, 2016).

The research hypothesis is that across countries and cultures, there is a shared meaning of ethical school practices, as ascertained from principals' TIMSS questionnaires reports. Therefore, first we used 10 principals' rankings of TIMSS items, which reflect ethical school practices. Then, by using correlational and factor analyses, we determined the dimensions of ethical school practices. Following this, we used multilevel confirmatory analysis to examine whether these dimensions appear on the school and country level. After that, multiple group analysis was conducted in order to assess whether these dimensions are similar across countries. Finally, we used the multilevel approach for schools at level one and countries at level two in order to examine the relationships between principals' reports on ethical school practices and student achievement in science.

In the following section, we present the theoretical background that supports this study. First, we describe the transnational context of this study, followed by a description of ethical aspects in educational leadership. We conclude with the role of ethics in leading school practices.

Theoretical background

A transnational perspective in educational leadership and management

Previous studies (Hallinger and Chen, 2015; Marfan and Pascual, 2018) have described the importance of transnational research in the educational leadership and management fields, showing that such studies promote a wider perspective and present a holistic and integrative approach that infuses new meanings into research in the field of educational leadership and management (Lumby and Foskett, 2016). This study ponders the power of globalisation as manifested in principals' perceptions of school practices with ethical meaning across countries in order to strengthen the potential transferability of these concepts. This will facilitate exploring the meaning of these shared ethical practices in different countries, while paving the way for change and development in light of each country's unique context.

Ethical dilemmas in leading school practices

Educational leaders often face challenges which call for solving ethical dilemmas and making moral judgements (Kimber and Campbell, 2014). They often confront tasks related to ethical questions (Hammersley-Fletcher, 2015). For example, they deal with problems that arise when their staff members do not conduct themselves in accordance with ethical principles (Dennis et al., 2019; Waheed et al., 2018). These leaders often have to deal with parents who are highly critical of the teachers and the school's extracurricular programmes (Addi-Raccah and Grinshtain, 2018).

Norberg and Johansson (2014) raise a number of dilemmas concerning educational leaders' practice. For example, what is the ethical way to act: to provide more resources for weak students or, alternatively, for gifted students? When it comes to issues that entail majority versus minority opinions, what side do they take? The literature points to a prevailing tension between the ethical principle of caring for the other (e.g. students, teachers, administration) and the need to follow formal, standardised rules (e.g. school regulations, professional standards) (Shapiro et al., 2014). Another type of challenging ethical dilemma occurs when the educational leader has an educational agenda, and the student and his/her family do not concur on this agenda (Grootenboer and Hardy, 2017). Moreover, ethical dilemmas also often appear when interested parties hold different ideas about what is 'good', leading to disagreements about whose viewpoint should be accepted (Berkovich and Eyal, 2018).

Educational leadership and ethical practices

Educational leaders operate in often difficult and fluctuating ethical circumstances, while all along being expected by society to arrive at ethical decisions (Kimber and Campbell, 2014). Thus, educational leadership is deeply rooted in ethical practices that are embedded in a social context. According to Elliott (2015), research into leadership practices creates an opportunity for an ethical and practical perspective among leadership practitioners. Studies have shown that both parents and teachers expect educational leaders to utilise ethical decision-making processes in their work and when operating with others in teams, which is how the majority of contemporary school leadership activities are conducted (Branson and Gross, 2014; Grootenboer and Hardy, 2017; Shapiro and Stefkovich, 2016).

Moreover, principals are perceived as those who are ultimately accountable for what occurs in the confines of the school (Grootenboer and Hardy, 2017). Nonetheless, several studies have shown that principals lack awareness of the ethical meaning of school practices and the impact of their behaviours (e.g. Bogotch, 2000; Marshall and Oliva, 2017).

Previous transnational studies have discussed three primary dimensions that may characterise ethical practices in school leadership. The first dimension, *caring for teachers' and students' learning*, refers to principals who utilise a range of high standards, strategies and assessments in their schools in order to support their teachers' development which, in turn, helps them to augment student achievement (Haiyan et al., 2017; van der Vyver et al., 2014). In addition to augmenting student achievement, teachers in a caring environment know their students and establish a robust rapport with them, thus inspiring and supporting their academic growth and development (Collinson et al., 1999).

These principals also encourage their teachers to participate in continuous professional training programmes so that they are better able to teach up-to-date subjects (Li et al., 2016). In this way, such principals express concern for their students through their teachers, striving to ensure the highest quality of learning for their students. They also take care to foster a positive learning environment (Sun and Leithwood, 2015) by ensuring a safe physical and emotional environment, providing fair and equitable treatment for each student (Louis et al., 2016). This, in turn, serves to advance student achievement and excellence.

The second dimension, *respecting school regulations, and teachers' and students' rights*, emphasises the fact that school rules are designed to safeguard the human rights and dignity of all students and all teachers; therefore, principals are well aware of the importance of conforming to these rules (Norberg and Johansson, 2014). As conflicts occur, principals are expected to seek ways to resolve the discrepancies between teachers' and students' beliefs and school regulations and guidelines (Anderson, 2016; Murphy and Louis, 2018).

The third dimension, *respecting parents' and students' involvement in school*, refers to principals who are driven to collaborate with parents and students because of their shared interest in advancing learning opportunities and processes (Rapp and Duncan, 2012). Several research studies have shown that parents' and students' involvement, and the principal's collaboration with them, directly affect student achievement (Jeynes, 2015; Khalifa, 2012) and school effectiveness (Epstein, 2018).

These ethical dimensions drove us to analyse, transnationally, whether, and which, characteristics of ethical school practices are implicit in principals' TIMSS questionnaires, since these questionnaires reflect school practices, of which ethics are an integral part.

The section below will discuss the following questions:

1. Can we elicit a shared concept of ethical school practices across TIMSS-participating countries based on principals' responses to TIMSS questionnaires?

If the answer is positive, our follow-up questions are:

2. What dimensions does the concept of ethical school practices include?
3. Will we find any relationships between these ethical school practices and students' science achievements in the countries participating in TIMSS 2015? What characterises these relationships?

Method

Context and measurement

The TIMSS 2015 was the continuation of a 20-year-long international assessment of maths and sciences, conducted by the International Association for the Evaluation of Educational Achievement (IEA) amongst principals, teachers and students. The IEA is an independent international cooperative of national research institutions and government agencies. The current study focuses on the TIMSS 2015 principals' questionnaire in relation to 8th grade students' science achievements across 45 countries.

For this purpose, data were based on: (a) the principals' questionnaires, composed of an initial 49 items related to school practices, which were subsequently condensed to 22 items (these items are shown in Table 3) based on principals' ranking procedure (for further details, please see the results section). These items focused mainly on the *school's emphasis on academic success* (e.g. How would you characterise each of the following within your school: teachers working together to improve student achievement; teachers' ability to inspire students; parental support for student achievement; parental expectations for student achievement (very high/high/medium/low/very low)); *school discipline and safety* (e.g. To what degree is each of the following a problem amongst 8th grade students in your school: absenteeism (i.e. unjustified absences); classroom disturbance (not a problem/minor problem/moderate problem/serious problem)); and (b) student achievement based on questionnaires focusing on the 8th grade science curriculum aggregated into a school mean achievement. More specifically, the science achievement score was measured and imputed to generate five plausible values for each student (von Davier et al., 2009). We integrated these five scores by aggregating each plausible value at the school level (for further details, see the 'Plausible data' section).

Our analyses were based on a dataset available on the TIMSS website (IEA, 2014), where all the relevant items in the principals' and students' questionnaires are already coded.

Sample

Our sample comprised 8353 principals from 8353 different schools (one principal per school) and 280,130 8th grade students (the students' gender distribution was equal) who were represented in this study by mean achievement grade per school across 45 countries that participated in the TIMSS 2015 survey. Nearly half of the principals held a bachelor's degree or its equivalent (49.8%), and the others held a graduate degree (42.5% had completed a master's level; 4% had completed doctoral studies). The rest did not complete a bachelor's degree or its equivalent. Average management experience was 9.42 years ($SD = 7.79$). Principals were not asked to designate their gender; therefore, these statistics are not available. The majority of the students (88.9%) were born in the country in which the survey took place, while the rest (11.1%) were born in a different country and migrated to the surveyed country. We focused on the students' science scores, using the plausible value procedure (Foy, 2017).

Overview of pre-procedures and analyses

Approval of the research ethics committee was obtained from the authors' university. In our analyses, we used Mplus V.8.0 (Muthén and Muthén, 2017), which enables complex examinations

related to both the multilevel structure of the data and the possibility of constructing different latent factors, based on variant items in the sample (Brown, 2015).

Our main pre-procedures before dealing with the study hypotheses were as follows:

Missing values. Our preliminary analysis for missing values showed that 1% or less was missing. Although the number of observations was high, we imputed the missing values (Little and Rubin, 2014). For the imputation procedure, we used the Expectation Maximisation (EM) method, which improves the examined likelihood of the data in comparison to the known likelihood (Do and Batzoglou, 2008).

Weighting. We found that the distribution of schools in each country ranged from 48 schools (in Malta) to 477 schools (in the United Arab Emirates). The analyses required that the number of schools in each country be similar across all 45 countries. Therefore, we used the country sampling weight that equalised the number of schools across countries (Foy, 2017). The overall frequencies by country (Table 1) are presented in comparison to the weighted number of schools, whereby weight was calculated around the mean number of schools per country ($m = 186$). That is, when the number is lower, the weight inflates it to the mean, and when it is higher, the weight deflates it to the mean.

Fit indices and cut-off values used for evaluation in this study. In this study we used the following fit indices (below) which determine how well a prior **model** fits the sample data (McDonald and Ho, 2002), and provide an indication of how well the proposed theory fits the data.

Model chi-square (χ^2) value – a traditional measure for evaluating overall model fit that assesses the magnitude of discrepancy between the sample and fitted covariance matrices (Hu and Bentler, 1999). Due to the restrictiveness of the Model Chi-Square, researchers have sought alternative indices to assess model fit. There is no consensus regarding an acceptable value for this statistical measure.

Root mean square error of approximation (RMSEA) – this measure tells us how well the model, with unknown but optimally chosen parameter estimates, would fit the population's covariance matrix. Cut-off values close to .03 represent excellent fit (Hooper et al., 2008).

Standardised root mean square residual (SRMR) – the square root of the difference between the residuals of the sample covariance matrix and the hypothesised covariance model. Values for the SRMR range from 0 to 1.0 with well-fitting models obtaining values less than .05 (Diamantopoulos and Siguaw, 2000).

Tucker-Lewis index (TLI) – an index that prefers simpler models and assesses the model by comparing the χ^2 value of the model to the χ^2 of the null model. Hu and Bentler (1999) have suggested $TLI \geq 0.95$ as the threshold.

CFI (Comparative fit index) – this measure assumes that all latent variables are uncorrelated (null/independence model) and compares the sample covariance matrix with this null model. This statistic ranges between 0.0 and 1.0. A cut-off criterion of $CFI \geq 0.95$ is presently recognised as indicative of good fit (Hu and Bentler, 1999). Today this index is one of the most popularly reported fit indices due to being one of the measures least affected by sample size (Hooper et al., 2008).

Table 1. Unweighted and weighted school frequency.

Country code	Country name	Unweighted school frequency	Weighted school frequency
36	Australia	285	186
48	Bahrain	105	186
72	Botswana	159	186
124	Canada	276	186
152	Chile	171	186
158	Chinese Taipei	190	186
268	Georgia	153	186
344	Hong Kong, SAR	133	186
348	Hungary	144	186
364	Iran, Islamic Republic of	250	186
372	Ireland	149	186
376	Israel	198	186
380	Italy	161	186
392	Japan	147	186
398	Kazakhstan	172	186
400	Jordan	252	186
410	Korea, Republic of	150	186
414	Kuwait	168	186
422	Lebanon	138	186
440	Lithuania	208	186
458	Malaysia	207	186
470	Malta	48	186
504	Morocco	345	186
512	Oman	301	186
554	New Zealand	145	186
578	Norway (9)	143	186
634	Qatar	131	186
643	Russian Federation	204	186
682	Saudi Arabia	143	186
702	Singapore	167	186
705	Slovenia	148	186
710	South Africa	292	186
752	Sweden	150	186
764	Thailand	204	186
784	United Arab Emirates	477	186
792	Turkey	218	186
818	Egypt	211	186
840	United States	246	186
926	England	143	186
Benchmarking Participants			
5788	Norway (8)	142	186
7841	United Arab Emirates (Dubai)	135	186
7842	United Arab Emirates (Abu Dhabi)	156	186
9132	Canada (Ontario)	138	186
9133	Canada (Quebec)	122	186
32001	Argentina, Buenos Aires	128	186

Total 8353

Results

The study results are presented according to the following two main steps.

First step: exploring whether, and which, shared reflections of school practices with ethical meaning emerged from the TIMSS questionnaires

Principals' ranking of ethical meaning. We used our ISSPP (International Successful School Principal Project) network, and sent emails to 11 randomly selected principals in the TIMSS participating countries (one principal from each country: Singapore, Ireland, United Kingdom, United States, Sweden, Israel, Australia, Italy, Norway, South Africa and New Zealand) and asked each principal to rank the 49 items from the TIMSS principal's questionnaire as reflecting school practices that have an ethical meaning. Specifically, the question was: 'Below are items reflecting principals' perceptions regarding school practices. Please rank each item on a scale of 1 (low ethical meaning) to 5 (high ethical meaning) as reflecting ethical meaning.'

Ten principals agreed to participate (91% response rate). The principals' rankings were then used to identify items which reflect ethical meaning in school practices. We followed a ranking procedure (Meyer and Booker, 2001), which considers high-ranking relevancy (4 or 5 on a Likert scale) for reflecting ethical school practices. Our final set of items included 22 out of 49 items in the TIMSS school principals' questionnaire (example of items excluded from the study: How would you characterise each of the following within your school: parental commitment to ensure that students are ready to learn; students' ability to reach school's academic goals; students' respect for classmates who excel in school (very high/high/medium/low/very low)?).

Correlations analysis. In order to ascertain the meaning of the interrelationships between the 22 items in the larger data set of principals ($n = 8,353$), correlations amongst these items were examined, including means and standard deviations. Table 2 shows that strong relationships exist amongst items BCBG15B–BCBG15 K (10 items) and that BCBG18A–BCBG18B (two items) elicited a shared meaning of respecting the rules amongst students and teachers; BCBG14F, BCBG14 H; BCBG14I, BCBG14 K; BCBG14 M (five items) elicited shared meaning of parents' and students' involvement in schooling; and BCBG14A–BCBG14E (five items) elicited shared meaning of caring for learning. Each group of items reflecting shared meaning is highlighted in grey.

Exploratory factor analysis. In order to justify the shared meaning between items elicited in Table 2, exploratory factor analysis was conducted. Table 3 shows the exploratory factor analysis that was conducted on approximately 36% of the total principals' data ($n = 3005$ principals). The final factors were classified according to their meaning, which elicited three main dimensions: 'respecting the rules amongst students and teachers' (39.6% explained variance), 'parents' and students' involvement in schooling' (18.5% explained variance) and 'caring for learning' (5.7% explained variance). These degrees of variance of each dimension justify continued focusing on these dimensions.

At the bottom of the table, we note the high internal consistency amongst the factor items (Cronbach's $\alpha > .80$). The shaded cells represent the final set of items for each factor. At this exploratory point, the multilevel structure of the data was ignored.

Table 2. Correlations, means, and standard deviations ($n = 8353$).

	BCBG15G	BCBG15J	BCBG15K	BCBG15I	BCBG15F	BCBG15H	BCBG15E	BCBG15D	BCBG15C	BCBG18A	BCBG18B	BCBG15B	BCBG14I	BCBG14H	BCBG14K	BCBG14F	BCBG14M	BCBG14B	BCBG14A	BCBG14D	BCBG14E	BCBG14C
Respecting the rules:																						
BCBG15G	0.71	0.70	0.72	0.76	0.65	0.63	0.63	0.62	0.54	0.52	0.50	0.54	0.22	0.22	0.20	0.19	0.21	0.15	0.16	0.14	0.14	0.17
BCBG15J		0.81	0.75	0.66	0.67	0.62	0.57	0.56	0.49	0.49	0.50	0.50	0.20	0.21	0.17	0.18	0.18	0.12	0.14	0.12	0.13	0.18
BCBG15K			0.70	0.61	0.56	0.53	0.56	0.46	0.49	0.49	0.49	0.44	0.12	0.16	0.08	0.10	0.07	0.05	0.09	0.06	0.06	0.13
BCBG15I				0.72	0.70	0.66	0.60	0.60	0.49	0.50	0.50	0.54	0.24	0.24	0.21	0.22	0.21	0.16	0.18	0.16	0.17	0.21
BCBG15F					0.63	0.70	0.63	0.61	0.50	0.49	0.54	0.54	0.28	0.26	0.25	0.25	0.27	0.19	0.20	0.18	0.19	0.23
BCBG15H						0.65	0.52	0.59	0.41	0.42	0.50	0.21	0.20	0.22	0.21	0.27	0.17	0.18	0.18	0.21	0.18	
BCBG15E							0.63	0.66	0.43	0.42	0.53	0.28	0.26	0.26	0.26	0.26	0.28	0.22	0.20	0.21	0.23	0.26
BCBG15D								0.59	0.46	0.41	0.50	0.25	0.24	0.24	0.24	0.21	0.20	0.18	0.20	0.18	0.25	
BCBG15C									0.41	0.44	0.57	0.30	0.26	0.31	0.28	0.31	0.23	0.21	0.22	0.22	0.25	0.26
BCBG18A										0.71	0.44	0.22	0.22	0.18	0.18	0.20	0.16	0.19	0.22	0.20	0.19	0.21
BCBG18B											0.45	0.22	0.23	0.17	0.22	0.15	0.17	0.19	0.19	0.18	0.21	
BCBG15B												0.32	0.31	0.28	0.29	0.27	0.21	0.20	0.20	0.21	0.24	
Parents' and students' involvement in schooling																						
BCBG14I													0.65	0.61	0.57	0.65	0.47	0.43	0.39	0.42	0.45	0.49
BCBG14H																0.53	0.40	0.35	0.35	0.36	0.39	0.50
BCBG14K																0.48	0.57	0.45	0.40	0.44	0.48	0.50
BCBG14F																	0.40	0.38	0.36	0.40	0.46	0.43
BCBG14M																		0.40	0.37	0.42	0.44	0.37
Caring for learning:																						
BCBG14B																		0.69	0.58	0.60	0.58	
BCBG14A																			0.55	0.54	0.52	
BCBG14D																				0.67	0.57	
BCBG14E																					0.55	
BCBG14C																						
Means	4.44	4.55	4.75	4.37	4.29	4.09	4.10	4.29	3.93	4.41	4.24	3.95	3.15	3.62	3.52	2.92	3.78	3.93	4.11	3.89	3.77	3.87
STD	0.88	0.81	0.75	0.86	0.93	0.87	0.91	0.85	0.87	0.81	0.90	0.90	0.97	0.95	0.81	1.02	0.79	0.71	0.69	0.81	0.77	0.75

Note: Level 1; all correlations were found significant, $p < .001$.

Table 3. Exploratory factor analysis and factor loadings ($n = 3005$ principals).

	F1	F2	F3
Respecting the rules amongst students and teachers:			
BCBG15G Theft	0.88	-0.04	-0.02
BCBG15J Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.)	0.87	-0.05	-0.05
BCBG15K Physical injury to teachers or staff	0.87	-0.16	-0.06
BCBG15I Physical injury to other students	0.87	-0.02	-0.02
BCBG15F Vandalism	0.83	0.05	-0.02
BCBG15H Intimidation or verbal abuse amongst students (including texting, emailing, etc.)	0.74	0.05	-0.03
BCBG15E Profanity	0.73	0.15	-0.04
BCBG15D Cheating	0.70	-0.01	0.07
BCBG15C Classroom disturbance	0.67	0.18	-0.02
BCBG18A Arriving late or leaving early (teachers)	0.64	-0.13	0.17
BCBG18B Absenteeism (teachers)	0.62	-0.09	0.15
BCBG15B Absenteeism (i.e. unjustified absences)	0.59	0.19	-0.03
Parents' and students' involvement in schooling:			
BCBG14I Parental support for student achievement	-0.01	0.87	-0.04
BCBG14H Parental expectations for student achievement	0.01	0.78	-0.08
BCBG14K Students' desire to do well in school	-0.05	0.72	0.07
BCBG14F Parental involvement in school activities	-0.01	0.65	0.09
BCBG14M Students' respect for classmates who excel in school	0.03	0.51	0.12
Caring for learning:			
BCBG14B Teachers' degree of success in implementing the school's curriculum	0.02	-0.02	0.82
BCBG14A Teachers' understanding of the school's curricular goals	0.03	-0.07	0.80
BCBG14D Teachers working together to improve student achievement	-0.02	0.05	0.73
BCBG14E Teachers' ability to inspire students	-0.01	0.16	0.65
BCBG14C Teachers' expectations for student achievement	0.06	0.30	0.47
Mean Score	4.31	3.44	3.94
STD	0.65	0.71	0.60
Reliability – Alpha Cronbach	.94	.85	.87
Eigenvalue	8.72	4.07	1.26
% of Variance	39.6%	18.5%	5.7%

Note: one principal per school.

Multilevel confirmatory analysis. Our exploratory analyses (Table 3) led to a three-dimensional factor structure, which represents the multidimensionality of principals' perceptions of school practices that have ethical meaning. We aimed to confirm this factor structure in the confirmatory modelling approach. A question arose as to the multilevel arrangement of these factors. Do factors remain the same, that is, show similar factor loadings for the school level and the country level? To test this possibility, we first ran an unconstrained *multilevel confirmatory analysis* of items loaded independently on level 1 and level 2 factors, and compared the unconstrained model fit quality to the fit quality of a constrained model, in which factor loadings are equal across the two levels. Table 4 shows that the confirmatory runs were performed on the complementary set ($n = 5348$) of the data.

In our comparative analyses, we focused on the comparative fit index (CFI), as a goodness-of-fit index for testing the change in the fit quality between the unconstrained and the constrained models. Hence, this difference captures the relative goodness-of-fit, or the fit of the hypothesised

Table 4. The multilevel confirmatory model results ($n = 5348$ principals).

Factor 1					
Respecting the rules	Within Level		Between Level		ICC
	Coeff.	SE	Coeff.	SE	
BCBG15G	.65***	.05	.31***	.05	.17
BCBG15J	.61***	.05	.25***	.05	.11
BCBG15K	.49***	.07	.23***	.05	.14
BCBG15I	.65***	.04	.33***	.04	.17
BCBG15F	.67***	.04	.38***	.05	.21
BCBG15H	.64***	.04	.22***	.03	.13
BCBG15E	.64***	.03	.28***	.04	.15
BCBG15D	.53***	.04	.28***	.06	.20
BCBG15C	.56***	.02	.24***	.03	.12
BCBG18A	.38***	.03	.27***	.03	.15
BCBG18B	.42***	.03	.30***	.04	.20
BCBG15B	.50***	.03	.27***	.04	.15
Unconstrained Model fit: CFI = .988, TLI = .984, RMSEA = .038, Chi Square = 837.130, $df = 98$, $p < .001$					
Constrained Model fit: CFI = .987, TLI = .985, RMSEA = .037, Chi Square = 909.770*, $df = 110$, $p < .001$					
Factor 2					
Parents' and students' involvement in schooling	Within Level		Between Level		ICC
	Coeff.	SE	Coeff.	SE	
BCBG14I	.71***	.02	.37***	.05	.17
BCBG14H	.67***	.03	.28***	.06	.15
BCBG14K	.53***	.02	.29***	.03	.15
BCBG14F	.61***	.02	.29***	.05	.12
BCBG14M	.39***	.01	.21***	.04	.13
Unconstrained Model fit: CFI = .995, TLI = .983, RMSEA = .030, Chi Square = 34.105, $df = 6$, $p < .001$,					
Constrained Model fit: CFI = .991, TLI = .984, RMSEA = .029, Chi Square = 59.197*, $df = 11$, $p < .001$					
Factor 3					
Caring for learning	Within Level		Between Level		ICC
	Coeff.	SE	Coeff.	SE	
BCBG14B	.55***	.03	.23***	.02	.12
BCBG14A	.47***	.03	.21***	.02	.11
BCBG14D	.58***	.04	.26***	.03	.12
BCBG14E	.55***	.03	.26***	.03	.13
BCBG14C	.48***	.03	.25***	.04	.14
Unconstrained Model fit: CFI = .995, TLI = .990, RMSEA = .020, Chi Square = 65.729, $df = 21$, $p < .001$					
Constrained Model fit: CFI = .992, TLI = .988, RMSEA = .021, Chi Square = 96.148, $df = 28$, $p < .001$					

*** $p < .001$. # of observations = 5,348, # of clusters = 45.

Note: one principal per school.

model as an empirical increment above a simpler model (Iacobucci, 2010). When goodness-of-fit remains similar, that is, for example, $\Delta CFI < .01$, the equal loading constraint does not cause a severe reduction in the model's goodness-of-fit. Therefore, it can be concluded that the factor structure at the school level remains similar at the country level (Heck and Thomas, 2015).

For each original item, the intra-class correlation (ICC) coefficient was added to test the variability that stems from the country level. We found that the ICC values were greater than .05 across all items, that is, a meaningful variation existed across countries as well as across schools (Heck and Thomas, 2015). The factor loadings were all high for both within and between levels. We tested whether factor loadings were similar across the two levels by means of measurement invariance, that is, we undertook a comparison between the configural (unconstrained) model fit and the equal loading constrained model. The reduction in CFI between the unconstrained and the constrained model was $.988 - .987 = .001$, for the dimension 'respecting the rules amongst students and teachers', which was lower than .01. Therefore, it was concluded that there was a structural similarity for the 'respecting the rules amongst students and teachers' factor. In other words, we could conclude that a similar 'respecting the rules' factor structure exists, at both the school and the country level. Factor 2, 'parents' and students' involvement in schooling', yielded a similar result. That is, the CFI difference equaled .004. This was also true for the third factor, as the CFI difference for 'caring for learning' was .003. In conclusion, the factor structure as observed within each country (at the school level) was also found between countries (at the country level).

Multiple group analysis. In order to confirm similar dimensionality of factors across countries, Table 5 shows the multiple group analysis that was applied across all 45 countries. This analysis complemented the multilevel approach, in that it compared a country-by-country factor structure. The three factors ('respecting the rules amongst students and teachers', 'parents' and students' involvement in schooling', 'caring for learning') were tested separately subject to increasing constraints (Schmitt and Kuljanin, 2008; Vandenberg and Lance, 2000). In the first configural model, factor loadings were estimated freely for each country, whereas in the metric model, equal loadings across all 45 countries were imposed.

Results show that all factors were similar in structure across all countries by means of factor loadings. When invariance test was assessed, all factors did not show a meaningful reduction in fit ($\Delta CFI < .01$). The CFI differences between the metric and the configural models were .009, .007 and .008 for 'respecting the rules amongst students and teachers', 'parents' and students' involvement in schooling' and 'caring for learning', respectively. These findings demonstrate that the difference was insignificant for all the dimensions. Therefore, we can cautiously conclude that the countries share a similar factor structure in 'caring for learning', 'respecting the rules amongst students and teachers' and 'parents' and students' involvement in schooling' dimensions, and that 'school practices' structure exists across all countries.

Thus, regarding our first and second research goals, that is, whether ethical meanings emerge from shared school practices and what the characteristics of these dimensions are, we found shared ethical meanings across countries in the form of three dimensions; we also found that these dimensions exist amongst the different countries.

The final measurement model. To confirm the full-factor structural model and to answer one of the main study questions (i.e. what dimensions does the factor of ethical school practices include?), we

Table 5. Multiple group analysis for the ethical school practices factors ($n = 5348$ principals).

	Configural Model	Metric Model	Metric versus Configural
Respecting the rules			
CFI	.975	.966	.009
Chi-Square	1955.36	3604.35	1671.33
df	1080	1432	352
P	<.001	<.001	<.001
SRMR	.038	.288	
# of parameters	1350	998	
Parents' and students' involvement in schooling			
CFI	.992	.965	.007
Chi-Square	275.62	798.45	511.10
df	175	351	176
P	<.001	<.001	<.001
SRMR	.023	.138	
# of parameters	725	549	
Caring for learning			
CFI	.994	.986	.008
Chi-Square	612.74	1227.80	614.59
df	518	782	264
P	.003	<.001	<.001
SRMR	.031	.119	
# of parameters	1057	793	

*** $p < .001$. # of observations = 5261, # of countries = 45.

Note: one principal per school.

ran an integrative measurement model on the rest of the sample ($n = 5348$), which included all three sub-factors. Table 6 shows all sub-factor loadings in an integrative measurement model. Since all loading values are high and similar to one another, the overall confirmation of the factor structure is strong. This finding supported the undertaking of further analyses using these latent sub-factors, in comparison to one, single factor of ethical school practices (Common Method Variance [CMV] test; see Podsakoff et al., 2003).

A measure of internal consistency – the composite reliability measure – was added, which replaced the common alpha (Raykov, 1997). Composite reliability is a measure of the latent and observed variance, in which the loadings represent the latent variance. Composite reliability is the ratio between the squared sum of loadings to the variance of the latent factor (set to a unit variance) and the sum of the latent variance from above and the sum of the variances of the observed items. Our results indicated a high level of reliability (composite reliability $> .83$) for all three factors. The model fit was above the acceptance level, CFI = .96, TLI = .95 (Heck and Reid, 2017).

Table 6 shows that 'respecting the rules amongst students and teachers' includes items from the original parameters, 'school discipline and safety' and 'teachers in your school'. In addition, 'parents' and students' involvement in schooling' and 'caring for learning' include only part of the items from the original parameter, 'school emphasis on academic success', dividing this original parameter into sub-factors. These findings suggest that there is an additional ethical meaning to the items appearing in the principals' TIMSS questionnaires.

Table 6. Confirmatory factor analysis (measurement model), standardised coefficients ($n = 5348$ principals).

Factor	Coefficient	Standard Error
Respecting the rules:		
BCBG15G Theft	.82***	.01
BCBG15J Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.)	.81***	.01
BCBG15K Physical injury to teachers or staff	.76***	.01
BCBG15I Physical injury to other students	.87***	.01
BCBG15F Vandalism	.81***	.01
BCBG15H Intimidation or verbal abuse among students (including texting, emailing, etc.)	.77***	.01
BCBG15E Profanity	.77***	.01
BCBG15D Cheating	.72***	.01
BCBG15C Classroom disturbance	.72***	.01
BCBG18A Arriving late or leaving early (teachers)	.58***	.02
BCBG18B Absenteeism (teachers)	.57***	.01
BCBG15B Absenteeism (i.e. unjustified absences)	.64***	.01
CR	.94	
Parents' and students' involvement in schooling:		
BCBG14I Parental support for student achievement	.77***	.01
BCBG14H Parental expectations for student achievement	.70***	.01
BCBG14K Students' desire to do well in school	.80***	.01
BCBG14F Parental involvement in school activities	.71***	.01
BCBG14M Students' respect for classmates who excel in school	.62***	.01
CR	.84	
Caring for learning:		
BCBG14B Teachers' degree of success in implementing the school's curriculum	.78***	.01
BCBG14A Teachers' understanding of the school's curricular goals	.70***	.01
BCBG14D Teachers working together to improve student achievement	.75***	.01
BCBG14E Teachers' ability to inspire students	.77***	.01
BCBG14C Teachers' expectations for student achievement	.77***	.01
CR	.87	

* $p < .05$. ** $p < .01$. *** $p < .001$. Goodness-of-Fit: CFI = .966, TLI = .957; RMSEA = .044, SRMR = .046.

Note: one principal per school.

The second step: the relationship between school practices that have ethical meaning and students' science achievements

In order to evaluate the relationships between the shared dimensions of the principals' reflections on ethical school practices and students' scores in science, we used the measurement model framework on the full sample ($n = 8353$), while undertaking a separate regression of the students' scores on each factor ('caring for learning', 'respecting the rules amongst students and teachers' and 'parents' and students' involvement in schooling').

Figure 1 illustrates the MIMIC (Multiple Indicators Multiple Causes) model. The slope at the school level (level 1) can be estimated as a random effect, that is, the slope varies between countries. In this illustration, λ represents loadings, ϵ represents measurement errors and β represents the regression slope from ethical school practices to the science scores. Note that these

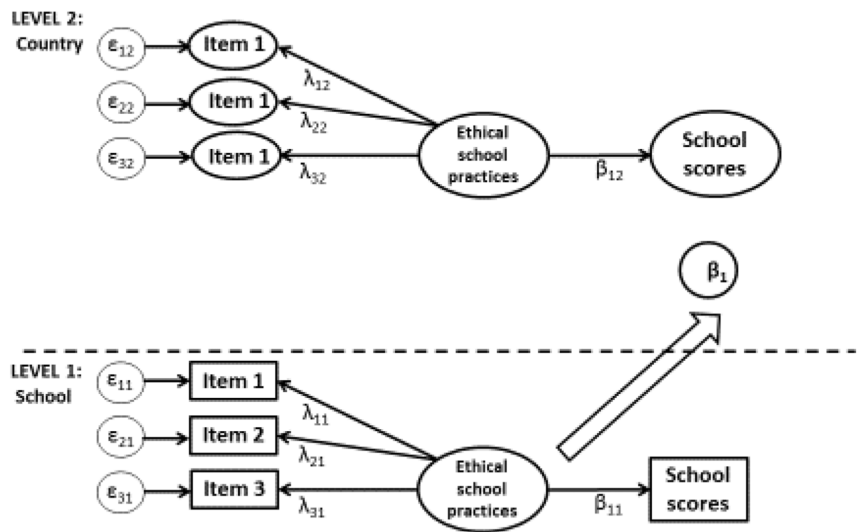


Figure 1. The multilevel model structure for the effect of ethical school practices on schools' science achievements.

parameters appear at both the school level and the country level. However, at the country level, all items appear as latent, as they are not explicitly measured, but rather are extracted from the model.

Plausible data. The TIMSS data provide students' scores in a plausible value format. There are five imputed values that are substituted for the single score per student. Plausible values are imputations that are meant to avoid a single measurement of a test score, and they include a prior distribution, rather than a point estimate (von Davier et al., 2009). This approach is commonly used in large-scale data, which have fewer measurements or one measurement per respondent at level one.

We considered the five plausible values by TIMSS's IEA IDB Analyzer (Foy, 2017). Note that for the principals' data, we retained the plausible procedure by aggregating each plausible value into the school level. Any further analysis which included scores was then performed independently for each value. The mean (i.e. across countries) regression slope is reported.

As shown in Table 7, the analysis based on the MIMIC model in Mplus v.8.0 provided an answer to the research question concerning the effect of principals' reflections on ethical school practices on student achievement in science. To perform this analysis, we used the multilevel approach for schools at level one and countries at level two (Heck and Reid, 2017). For each factor, the effect on students' science scores is presented as non-standardised and standardised regression coefficients. Our findings show significant positive effects on 8th grade science achievements from factors at the individual school level and at the country level. More specifically, the higher the dimensions – 'caring for learning', 'respecting the rules amongst students and teachers' and 'parents' and students' involvement in schooling' – the higher the country's mean score in science, at both the school and the country level.

Table 7. Principals' perceptions of ethical school practices and science achievements ($n = 8353$ principals).

Factor	Non-standard		Standard	
	Coefficient	Standard Error	Coefficient	Standard Error
Factor 1: respecting the rules				
Within countries	11.70***	1.37	.21***	.02
R ²			.04***	.01
Between Countries	42.41***	6.40	.75***	.07
R ²			.55***	.10
CFI = .988, TLI = .985; RMSEA = .036, SRMR = .030, Chi-Square = 1408.83, $df = 120$, $p < .001$				
Factor 2: parental and students' involvement				
Within countries	26.03***	1.62	.47***	.02
R ²			.22***	.02
Between Countries	32.01***	7.53	.57***	.10
R ²			.32***	.12
CFI = .994, TLI = .988; RMSEA = .020, SRMR = .010, Chi-Square = 59.73, $df = 14$, $p < .001$				
Factor 3: caring for learning				
Within countries	18.18***	1.33	.33***	.02
R ²			.11***	.01
Between Countries	16.20*	7.87	.29*	.13
R ²			.08	.08
CFI = .990, TLI = .983; RMSEA = .020, SRMR = .017, Chi-Square = 143.68, $df = 33$, $p < .001$				

* $p < .05$. ** $p < .01$. *** $p < .001$. # of observations = 8353 # of countries = 45.

Note: one principal per school

In summary, regarding our third goal, which was to investigate the effect of school practices that have ethical meanings on transnational science achievements, we conclude that the principals' shared reflections of ethical school practices across countries positively predicts students' science achievements.

Discussion

The main goal of this study was to ascertain whether we could elicit ethical meanings of school practices from principals' TIMSS questionnaires across 45 countries. The novelty of this study is reflected by the findings, which provide added ethical meaning to principals' questionnaires by unveiling new concepts shared by principals in 45 different countries.

More specifically, our analysis answered the questions which were derived from the main goal of this study. Regarding the first question, whether we may elicit a shared concept of ethical school practices across participating TIMSS countries based on principals' responses to TIMSS questionnaires, our analysis provides a deeper transnational meaning to principals' perceptions of school practices by suggesting shared ethical practices across countries which were implicit in the original parameters. Regarding the second question (i.e. what dimensions does the concept of ethical school practices include?), we revealed three dimensions that expand the literature

regarding ethical practices in school leadership: 'respecting the rules amongst students and teachers', 'parents' and students' involvement in schooling' and 'caring for learning'.

Specifically, our first dimension, 'respecting the rules amongst students and teachers' includes principals' perceptions of students' and teachers' misbehaviours (e.g. student vandalism, teacher absenteeism). This dimension predominantly includes perceptions of standards to which *students and teachers* are expected to adhere, thereby adding to the literature, which has focused, until now, mainly on the dimension that describes *principals'* respect for the democratic system and *principals'* activity to resolve the discrepancies between teachers' and students' beliefs and school regulations. Our second dimension, 'parents' and students' involvement', includes mainly different strategies amongst parents, students and school management regarding how to improve students' learning, thereby adding to the literature, to date, which focuses mainly on the dimension that describes general concepts such as 'shared interest' and 'collaboration'. Our third dimension, 'caring for learning', contains mainly such aspects as teachers' ability to inspire students' learning and collaboration between teachers to improve student achievement, thereby adding to the dimension described in the literature, which focuses mainly on strategies, assessments and continual professional learning programmes.

Regarding the third and the fourth question (i.e. Will we find a relationship between the dimensions of ethical school practices and students' science achievements in the countries participating in TIMSS 2015? What characterises these relationships?), we found that these dimensions positively predicted students' TIMSS 8th grade achievements in science at both the school and the country levels. Thus, the findings demonstrate the importance of school practices that were deemed ethical and their contribution to student achievement.

In summary, the novelty of this study, that is, eliciting implicit ethical dimensions, adding meaning and clarifications to existing dimensions that describe the ethical practices in school leadership, may assist principals in shaping and refining their practices in their schools. It seems that our study points to shared perceptions of the TIMSS principals' questionnaire, which show how shared ethical school practices positively affect student achievement at the school and country level.

Thus, our findings suggest a transnational approach, by supporting shared ethical practices across countries. Nonetheless, we acknowledge the fact that countries differ from each other demographically, economically, socially and politically. Therefore, an examination of shared ethical school practices in each country is needed, while the unique context in each country must be considered. Actually, we mean that each country will explore our suggested transnational characteristics of ethical practices by considering the country's unique beliefs, practices, culture and policy involved.

Conclusions

The novel findings of this study indicate that principals' responses to TIMSS questionnaires manifest ethical meanings that are shared by principals across all the surveyed countries. This led us to the understanding that the TIMSS principals' questionnaire has an added meaning, which goes beyond its original parameters. Our results also contribute to understanding the broader meaning of shared perceptions of school ethical practices amongst principals by identifying three ethical dimensions: 'respecting the rules amongst students and teachers', 'parents' and students' involvement in schooling' and 'caring for learning'. This may be a new transnational measure which, up until now, has never been investigated in principals' TIMSS questionnaires and which

may warrant exploring the similarities and differences between countries based on this measure. These shared ethical practices were also supported by the ability to predict student achievement across countries, by examining principals' ethical perceptions vis-à-vis school rules, parents' and students' involvement, and caring for learning.

Strengths, limitations and directions for future research

The strength of this study is reflected in our findings, which expand upon the meaning of ethical practices in school leadership described in previous studies. Moreover, our findings add ethical meanings that can be attributed to the TIMSS principals' questionnaires. Our study revealed the concept of ethics in school practices, considering principals' ranking and mainly using an advanced statistical approach, which included multilevel confirmatory analysis and confirmatory factor analysis, and which demonstrated high internal reliability for the different dimensions of ethics in principals' perceptions of school practices. Future studies should continue to investigate whether our findings assist in developing updated measures for ethical aspects in school practices, based on students' and teachers' TIMSS questionnaires.

This study focused on analysing 45 countries together. Future studies should perhaps consider analysing the relationship between our proposed dimensions and students' science achievements by comparing high and low science-achieving countries, developed and developing countries, countries with high and low expenditure on education and other comparisons that may affect the relationship between ethics in principals' practice and students' science achievements within the unique context of each country.

In future studies, examining the relationship between principals' perceptions of ethical school practices elicited in the questionnaires and student achievement using a comparative approach (2015 vs 2019 data) may facilitate the development of a longitudinal study and a broader perspective.

The trend of current studies on educational leadership leans towards shared and distributed leadership. The mid-level school leaders (e.g. pedagogical, subject and year-level coordinators) form a meaningful part of this leadership. Therefore, future studies may consider exploring the dimensions elicited in this study amongst educational leaders in other leadership levels and roles.

One of the limitations of this study is that the identification of TIMSS items as having ethical meaning was implied. Therefore, future studies may investigate the validity of these items as reflecting ethics in school practice by, for example, examining the perceptions of additional principals, beyond the present sample of TIMSS 45 countries.

In addition, since the principals' perceptions were gleaned from self-reports, the data may be somewhat biased and inaccurate. However, the strategies used by the TIMSS administration to maintain the anonymity and privacy of the participants helps reduce the potential of this inaccuracy.

Moreover, the questionnaires were administered in different languages in the various countries. Thus, it is difficult to ensure that the phrasing of the questionnaires and the cultural appropriateness of content are identical in the different languages. However, we believe that the TIMSS administration is aware of this limitation and will act to reduce this bias in each future round of data collection.

One additional limitation is that this study focused only on the relationships between principals' reports of ethical school practices and student achievement in science. Future studies may focus on causal relationships based on an intervention process (i.e. whether high levels of parental

involvement will lead to improved student achievement, while examining principals' reports of ethical school practices.

Moreover, ethical school practices can be defined in many different ways and measured differently as well. To minimise bias, future studies perhaps should use an integrative approach to examine the reports of teachers, principals and students simultaneously when exploring ethical school practices. Follow-up research should examine further definitions of ethical school practices, compare these with the present study's definitions and show how these new definitions might relate to science achievements and academic achievements in other subjects.

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