Teaching quality in secondary education in Rwanda: Evidence from STEM teachers

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Authors:

This report was written by Dr Anthony Onwuegbuzie, Professor Ricardo Sabates and Dr Emma Carter of the REAL Centre, University of Cambridge, under the direction of Professor Pauline Rose from the REAL Centre and Dr Philip Leonard from Laterite, who were involved in the framing and editing of the paper.

About Laterite and the REAL Centre:

Laterite is a data, research and advisory firm dedicated to bringing high-quality research services to the most underserved markets. Based in East Africa, the firm strives to carry out impactful research that helps decision-makers find solutions to complex development problems.

The REAL Centre at the University of Cambridge pioneers research into overcoming barriers to education, such as poverty, gender, ethnicity, language and disability, and promotes education as an engine for inclusive growth and sustainable development.

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Acronyms

AIMS	African Institute for Mathematical Sciences
CPD	Continuous Professional Development
ESSP	Education Sector Strategic Plan
FGDs	Focus Group Discussions
IPs	Implementing Partners
PCAs	Principal Components Analyses
STEM	Science, Technology, Engineering and Mathematics
TALIS	Teaching and Learning International Survey
TEACh	Teaching Effectively All Children
TIMSS	Trends in International Mathematics and Science Study
TTP	Teacher Training Programme
TVET	Technical and Vocational Education and Training
URCE	University of Rwanda College of Education

The context

Teaching quality is one of Rwanda's strategic priorities to enhance economic development. In Rwanda, the last quarter of a century has seen a commitment at the national level to education as a means of providing a pathway for youth to contribute to Rwanda's economic development (World Bank, 2011). As part of this commitment, in 2000, Rwandan president Paul Kagame launched Vision 2020, a government development programme in Rwanda. Based on human capital theory that links quality education to higher economic growth, this document emphasises the importance of investment in the education of Rwanda's youth (Republic of Rwanda Ministry of Finance and Economic Planning, 2000). The revised document that emerged in 2012 included the following changes: "Provision of high quality educational services will be necessary for consolidating development gains made in the last 10 years" (Republic of Rwanda Ministry of Finance and Economic Planning, 2012, p. 8).

Importantly, however, in neither the 2000 nor the 2012 document was guidance provided in the context of Rwanda about what quality education is in general, and what teaching quality is in particular. Similarly, although the Education Sector Strategic Plan (ESSP) of the Republic of Rwanda Ministry of Education (2010) articulates the priorities of the education sector with respect to education quality, it does not delineate what is meant by teaching quality. Likewise, a core part of Vision 2050—which concerns ensuring high standards of living for all Rwandans—is quality education, which is deemed to be key to quality of life (Gatete, 2016). Unfortunately, no explicit mention is made of the role that teaching quality plays in quality education.

In an attempt to increase teaching quality in Rwanda, several initiatives have emerged in recent years. One of these is the Leaders in Teaching initiative that was launched in Rwanda in 2018 by the Mastercard Foundation. Leaders in Teaching is a long-term initiative with the aim of improving student learning outcomes in science, technology, engineering, and mathematics (STEM) subjects via an array of interventions. These include Continuous Professional Development (CPD) programmes for teachers and school leaders organised by Leaders in Teaching Implementing Partners (IPs) VVOB Rwanda and the University of Rwanda College of Education (URCE), as well as the Teacher Training Programme (TTP) delivered by the African Institute for Mathematical Sciences (AIMS).

There is limited existing evidence on teaching quality in the context of Rwanda, especially at the secondary school level. A rapid literature review of Scopus-Indexed works published between 1960 and February 2021, using the keyword "teaching quality", alongside variants of this term that have been used in the literature,[1] namely, "teacher quality", "teacher effectiveness", "quality teaching", "quality of teaching", and "quality of teachers", revealed only two published works on the topic of

teaching quality in Rwandan schools (Onwuegbuzie and Sabates, 2021): one article (Iwakuni, 2017) involved an examination of teaching quality among prospective lower secondary school teachers in Rwanda, and the other article (Kim et al., 2019) explored the current status of the teaching quality of trainers of Technical and Vocational Education and Training (TVET). Therefore, scant research exists on current teachers in Rwanda on the topic of teaching quality.

The study

This paper involves an investigation of teaching quality in Rwandan secondary schools. In particular, we examine different measures of teaching quality as reported by STEM teachers and their relationship with socio-demographic and locational variables (e.g. gender of teacher, age, years of experience, qualification, area of knowledge, disability status, type of school). The aim of this analysis is to understand both how teaching quality might be measured in secondary schools and the extent to which there is variation about such measures of teaching quality and socio-demographic characteristics of teachers. It should be noted that all associations presented throughout this paper are correlational in nature and should not be interpreted as representing causality.

This paper involves the analysis and interpretation of baseline data collected for the Leaders in Teaching initiative in February and March 2020 from 358 schools within 14 districts. Specifically, the study is based on responses from 1,820 STEM teachers.

Key findings

- We identified 10 measures of teaching quality in Rwandan secondary schools, each with good psychometric properties (e.g. adequate score reliability).

- These 10 measures are subdivided into the following two components that emerged from the analysis: a **cultural values and pedagogical component** and a **motivational component**.

- Teachers at boarding schools (i.e. 12.0% of the respondents) tend to report the most positive levels of satisfaction with resources and materials, whereas teachers of day schools (i.e. 81.8% of the respondents) tend to have the most positive levels of teacher motivation associated with their classroom teaching.

- Compared to their counterparts, younger teachers, male teachers and teachers whose highest degree is a Bachelor's degree tend to report more positive

attitudes towards cultural values and higher levels of perceived teacher knowledge and pedagogy.

- Compared to their counterparts, older teachers, female teachers and teachers whose highest degree is a Bachelor's degree tend to report higher levels of teacher motivation associated with the teaching profession as a whole.

- Compared to their counterparts, older teachers, female teachers, teachers who spend the least time travelling from home to school and teachers at boarding schools indicate a more positive motivational component.

- Compared to their counterparts, younger teachers, male teachers, teachers with the least years of experience, teachers with advanced degrees and teachers at boarding schools indicate a more positive cultural values and pedagogical component.

- Boarding schools and day schools emerge as two groups of schools that differ in some aspects of teaching quality. Therefore, teaching quality should be examined not only across Rwandan secondary schools as a whole but also across boarding schools and day schools separately.

- The research suggests that low teacher motivation and low job satisfaction might be associated with lower perceived teaching quality, while high teacher motivation and high job satisfaction might provide pathways for teaching quality, such as developing or maintaining appropriate cultural values and pedagogical disposition. We suggest further research to explore and test these two sets of teaching quality hypotheses in the context of Rwandan secondary schools.

Survey design

The measures of teaching quality were developed drawing on existing literature and instruments used in low- and lower-middle income countries, along with information gathered in the Rwandan context specifically. In particular, the instrument drew on surveys with teachers for the Economic and Social Research Council-Foreign, Commonwealth and Development Office funded Teaching Effectively All Children (TEACh) project in India and Pakistan and the Accountability from the Grassroots project in India. In addition, we also reviewed survey instruments that have been applied internationally with secondary school level pupils and in the context of teaching STEM subjects, albeit predominately in the Global North. These surveys included the Teaching and Learning International Survey (TALIS) (Organisation for Economic Co-operation and Development, 2018) and Trends in International Mathematics and Science Study (TIMSS) Teacher Questionnaire (IEA TIMSS and PIRLS International Study Center, 2019). It is important to indicate that during the design and piloting, we found that many of the questions in the TALIS and TIMSS instruments could not be readily applied to the context of Rwanda.

Questions from existing surveys were adapted as relevant, and additional questions were included for relevance to the Rwandan context. Notably, the instrument was informed by findings from our qualitative research conducted in Rwanda that explored, via 18 focus group discussions (FGDs), perceptions of quality teaching in Rwandan secondary schools among members of the following five groups of stakeholders: trainee teachers, early career teachers, late career teachers, teacher trainers and deans of studies (Carter et al., 2021).

Self-report (e.g. through questionnaires and surveys) is a common and useful approach for enabling teachers to have an active role in an evaluation process. The existing literature revealed the following **strengths** about using surveys and questionnaires for studying teaching quality:

- Surveys and questionnaires are well suited to enhancing the understanding of teacher mindsets and attitudes (Penfold et al., 2019).

- Teacher self-report/evaluation allows for the self-identification of professional development needs which constitutes a priority in the case of Rwanda and other countries within Sub-Saharan Africa (Borg, 2018; Ochoa et al., 2018).

- Self-reports can give insights that other instruments cannot because teachers themselves are the only ones who possess the full knowledge of their capacities and needs (Goe et al., 2008).

When constructing self-report instruments (e.g., through questionnaires and surveys), it is important to take into account the potential weaknesses associated with this mode of data collection. The existing literature revealed the following **weaknesses** about using surveys and questionnaires for studying teaching quality:

- Obtaining adequate reliability and validity of survey/questionnaire responses is essential (Onwuegbuzie and Daniel, 2002).

- Eliminating social desirability responding bias (Schaeffer, 2019):
  - In the case of teachers, social desirability responding bias might occur if the responses that they provide make them appear to be less competent than are other teachers, or if they are inconsistent with the expectations of evaluators or others in their school environments/communities.
  - Social desirability responding bias can occur in different socio-cultural contexts and teachers have a tendency towards this behaviour.

In addition to confirming some of the attributes of teaching quality that were identified from the existing literature, the FGDs revealed attributes that have not been identified to date. In particular, cultural values emerged from the FGDs as a very important characteristic of a Rwandan teacher and therefore linked to teaching quality. Notably, in the teacher trainers' FGDs, they expressed a belief that it was necessary for teachers to inculcate cultural values in their students by "encouraging children to have cultural values and know the forbidden acts". The importance of this theme to teachers led to a plan to develop two cultural values scales in the survey instrument: Inculcating Cultural Values Scale and the Attitudes Towards Cultural Values Scale. We will expand on these scales and other measures of teaching quality in this paper.

Measures of teaching quality

The information extracted from both the FGDs and existing surveys was used to inform the development of the Teacher Survey.[2] A series of first-order principal components analyses (PCAs)[3] was conducted to examine the structure of the Likert-format items[4] contained in each section of the survey, in order to ascertain whether or not the emergent scale contained any subscales, and, if so, the number of subscales and the number of items representing each scale/subscale. Items in each section of the survey were placed so that they indicated some direction of agreement. Some items tended to be more difficult to assert this direction; yet, PCA deals with this issue by correlating the responses to all items together and then grouping items that are most correlated with each other. The sign of the correlation determined the direction of agreement, with a positive correlation between two items indicating the same direction of agreement and a negative correlation between two items indicating the opposite direction of agreement.

In other words, items that were statistically related with each other but statistically independent from the other items in the section were combined into a factor—which yielded one scale if only one set of items within a section were statistically related with each other, or two or more subscales if two or more sets of items within a section were statistically related with each other. Each scale/subscale thus was assumed to represent the underlying measure of teaching quality that was responsible for the observed correlations among the items.

Overall, with the exception of one scale (i.e. Attitudes Towards Diversity Scale) and one subscale (i.e. Micro-Level Teacher Motivation Subscale), our results provide consistent empirical evidence about the strength of the factors underlying each of the scales, as confirmed by the reliability coefficients which were all close to 0.70 or above, as advocated by Nunnally and Bernstein (1994). These PCAs led to the identification of 10 scales/subscales which were used to represent teaching quality as follows:

1. Inculcating Cultural Values Scale (1 scale containing 6 items)

   This scale measures the degree to which the teacher believes it is necessary for teachers to inculcate Rwandan cultural values in their students. The cultural values that were emphasised here were as follows: honesty and integrity, participating in community activities, showing tolerance towards others, forgiving others, respecting others, and treating each other fairly. The higher the position of the teacher on this scale, the more agreement the teacher indicates that it is necessary to inculcate Rwandan cultural values in their students via their teaching. An example of an item is *"I encourage my students to be honest and to have integrity"*.

2. Attitudes Towards Cultural Values Scale (1 scale containing 6 items)

This scale measures the degree to which the teacher believes it is necessary for teachers to behave in ways that demonstrate respect for Rwandan cultural values. The higher the position of the teacher on this scale, the more agreement the teacher indicates that it is necessary for their teaching to reflect respect for Rwandan cultural values. An example of an item is "*As a teacher, it is important for me to treat students fairly*".

3. Perceived Teacher Knowledge and Pedagogy Scale (1 scale containing 5 items)

This scale measures teachers' level of perceived knowledge of the subject they teach and their pedagogical competence. The higher the position of the teacher on this scale, the more agreement teachers indicate that they have a high level of perceived knowledge of the subject they teach and pedagogical competence. An example of an item related to teacher knowledge is "*I have enough subject knowledge to teach my classes well*"; an example of an item related to pedagogical competence is "*I provide opportunities for my students to apply their learning*".

4. Attitudes Towards Creating a Positive Classroom Environment Scale (1 scale containing 5 items)

This scale measures teachers' level of perceived competence in creating a positive environment for their students in their classrooms. The higher the position of the teacher on this scale, the more agreement teachers indicate that they have a high level of perceived competence in creating a positive environment for their students in their classrooms. An example of an item is "*I encourage students to believe they can do well in their school work*".

5. Attitudes Towards Student-Centred Learning Scale (1 scale containing 5 items)

This scale measures the degree to which the teacher believes it is necessary for teachers to promote student-centred learning in their classrooms. The higher the position of the teacher on this scale, the more agreement teachers indicate that it is necessary for their teaching to promote student-centred learning in their classrooms. Two examples of an item are "*I vary my instruction to include individual, small group and whole class work*" and "*I encourage my students to ask questions*".

6. Attitudes Towards Diversity Scale (1 scale containing 5 items)

    This scale measures the degree to which teachers have a positive attitude towards student diversity in their classrooms. The higher the position of the teacher on this scale, the more agreement teachers indicate that it is necessary for their teaching to reflect a positive attitude towards student diversity in their classrooms. Two examples of an item are "*Girls have more difficulties than other students in STEM subjects*" and "*Students with physical disabilities struggle to grasp learning concepts more than other students*".

7. Job Satisfaction: Subscale 1: Satisfaction with Support and Opportunity (containing 6 items)

    This scale measures the degree to which teachers are satisfied with the support and opportunities that are available to them as teachers. The higher the position of the teacher on this scale, the more agreement the teachers indicate about being satisfied with the support and opportunities that are available to them as teachers. Two examples of an item are "*I am satisfied with the support from the head teacher*" and "*I am satisfied with the opportunities for in-service training available to me*".

8. Job Satisfaction: Subscale 2: Satisfaction with Resources and Material (containing 6 items)

    This scale measures the degree to which teachers are satisfied with the resources and materials that are available to them to teach their students. The higher the position of the teacher on this scale, the more agreement the teachers indicate about being satisfied with the resources and materials that are available to them as teachers. Two examples of an item are "*I am satisfied with the amount of material/resources I have access to*" and "*I am satisfied with the availability of textbooks in school for myself and all the children in my class*".

9. Micro-Level Teacher Motivation Subscale (containing 5 items)

    This scale measures the level of teacher motivation associated with their classroom teaching. The higher the position of the teacher on this scale, the more the teacher indicates a high level of teacher motivation associated with their classroom teaching. An example of an item is "*I have difficulty keeping up with all the changes in the curriculum*".

10. Macro-Level Teacher Motivation Subscale (containing 7 items)

This scale measures the level of teacher motivation associated with the teaching profession as a whole. The higher the position of the teacher on this scale, the more the teacher indicates a high level of teacher motivation associated with the teaching profession as a whole. Two examples of an item are "*My work inspires me*" and "*I am enthusiastic about my job*".

Characteristics of the STEM teachers

The majority of STEM teachers are male. Approximately three quarters (73.2%) of the teachers in the sample are male (see Table 1). This underrepresentation of female STEM teachers might explain, in part, the finding that female students lag behind male students in STEM subjects (Cheriyan et al., 2021), as well as the underrepresentation of women in STEM fields in Rwanda.

The majority of STEM teachers are younger than 35 and have less than 10 years of teaching experience. Slightly less than two thirds (61.6%) of the teachers were less than 35 years of age (see Table 1). Based on this finding, it is not surprising that more than two thirds (69.5%) of STEM teachers in Rwanda have 10 years or less of teaching experience. However, it should be noted that Rwanda has the 29th youngest population among the 230 countries/territories, with an overall median age of 19.7, and a median age of 18.9 for males and 20.4 for females (Central Intelligence Agency, 2020). This might explain why the STEM teachers are relatively young and have relatively low levels of teaching experience. In any case, these two sets of findings regarding the age and teaching experience of the STEM teachers might have implications for the extent and type of mentoring and continuous professional development that STEM teachers are likely to need.

Table 1: Characteristics of the STEM teachers

Socio-demographic variable	Mean	Standard deviation	Minimum	Maximum
Age of all teachers	34.17	6.33	19	64
Age of female teachers	32.82	5.52	20	55
Age of male teachers	34.66	6.53	19	64
Years of teaching experience	9.12	5.81	1	39
Years of teaching experience of female teachers	8.37	5.36	1	31
Years of teaching experience of male teachers	9.40	5.94	1	39

Source: Leaders in Teaching data 2019-20

Female STEM teachers are younger and have less teaching experience. In general, female teachers are statistically significantly ($d = 0.29$)[5] younger than are male teachers. Further, female teachers have statistically significantly less teaching experience than do male teachers ($d = 0.18$). These findings appear to suggest that there has been an increase in female STEM teachers in recent years, which would represent a somewhat positive finding—indicating that the Government of Rwanda is

making progress towards addressing the imbalance in the gender distribution of qualified teachers, which is consistent with Vision 2020.

Female teachers are less likely to be school subject leaders than are male teachers. Slightly more than two thirds of the teachers do not have any leadership responsibilities (i.e. they are regular teachers) (see Table 2). Approximately one quarter of the teachers are school subject leaders. Interestingly, Fisher's Exact tests[6] revealed that compared to male teachers, while female teachers are statistically significantly more likely to be regular teachers, they are statistically significantly less likely to be school subject leaders (see Table 2). After controlling for the age of the teachers, female teachers remain statistically significantly (p = .045) less likely to be school subject leaders. This latter finding, which highlights a gender imbalance in teacher leadership positions, suggests that more efforts to support female teachers to leadership positions are needed—especially bearing in mind that teacher leaders can serve as a pipeline for school leaders. Teacher leaders also can be a key component for both the success of schools and the professionalisation of teachers (Cosenza, 2015; Greenlee, 2007). Consistent with this finding, only approximately one in five school leaders in Rwandan secondary schools are women (Cheriyan et al., 2020; Le Saux et al., 2021).

Table 2: Role of the teacher by gender

Role	All teachers (%)	Male teachers (%)	Female teachers (%)	χ^2Test (p value)
Regular teacher	69.0	66.9	74.5	.002*
School subject leader	23.1	24.3	19.7	.004*
Head of Department	4.7	5.1	3.5	.15
Contract teacher	0.8	0.8	0.8	.82
School-based mentor	0.8	1.0	0.2	.14
Director of studies	0.4	0.4	0.4	.82

Source: Leaders in Teaching data 2019-20
* p < .01

The majority of teachers either have a Bachelor's degree qualification or an advanced diploma in education. Specifically, approximately 7 out of 10 teachers either have a Bachelor's degree qualification (40.3%) or an Advanced Diploma in Education qualification (32.9%). The remaining qualifications were as follows: Postgraduate Diploma in Education (13.5%) and Certificate in Teaching (A2) (1.9%).

Interestingly, 1 in 10 teachers reported having no qualification in teaching. We found no statistically significant difference between the male teachers and female teachers with respect to their qualification. This is demonstrated in Table 3, which shows that similar proportions of male and female teachers have earned the following qualifications: Bachelor's degree qualification, Postgraduate Diploma in Education, Certificate in Teaching and no qualification in teaching (see Table 3). However, we found a statistically significant difference between male teachers and female teachers with regard to Advanced Diploma in Education qualification (see Table 3).

Table 3: Educational qualifications by gender of the teacher

Educational qualification	Male teachers (%)	Female teachers (%)	Fisher's Exact test (*p* value)
Bachelor's degree	40.5	39.6	.75
Advanced Diploma in Education qualification	31.1	37.8	.008*
Postgraduate Diploma in Education	14.3	11.5	.14
Certificate in Teaching	2.1	1.4	.44
No qualification in teaching	10.6	8.8	.29

Source: Leaders in Teaching data 2019-20

* $p < .01$

The small percentage of teachers who report having a disability are more likely to be older and have more teaching experience. Specifically, 3% of the teachers reported having a disability. Interestingly, teachers with disability are statistically significantly older than teachers without disabilities (see Table 4). Similarly, these teachers have statistically significantly more teaching experience than teachers without disabilities (see Table 4). No statistically significant difference in disability rate prevails between the female teachers (3.3%) and male teachers (2.9%). Of the teachers who reported having a disability, the most commonly reported disability was low vision (58.2%), followed by loco-motor disabilities (34.5%). Of the remaining teachers with a disability, each of the following disabilities was represented by one teacher: blindness, hearing impairment, speech impairment, and mental health disability. No teacher reported having multiple disabilities.

Variable	Teachers with disability Mean (Standard Deviation)	Teachers without disability Mean (Standard Deviation)	*t* value	Cohen's *d*
Age	38.40 (9.30)	34.04 (6.17)	5.07**	0.69
Years of teaching experience	11.40 (7.80)	9.05 (5.73)	2.96*	0.41

Source: Leaders in Teaching data 2019-20

* p = .003

** $p < .0001$

The majority of teachers walk to work, and their journey takes 30 minutes or less. The vast majority of teachers (75.4) walk to their schools. The remaining travel modes used by less than 8% of the participants are as follows: private bus (7.4%), public bus (6.3%), private bicycle (5.5%) and private motor car (3.0%). Most teachers (72.0%) take 30 minutes or less to travel to work (Mean = 28.00, Standard Deviation = 25.64). This implies that these teachers take one hour or less to travel to and from their school on a daily basis. Interestingly, there is no statistically significant difference in travel time as a function of disability status, gender or teacher type. Finally, there is no statistically significant difference as a function of disability status, gender or teacher type in the proportion of teachers who live within the cell and those who live outside the cell.

Teaching quality measures of STEM teachers

The two cultural values scales generated the most positive responses of all the teaching quality scales/subscales. Table 5 presents the mean item rating for each of the 10 scales/subscales. As stated earlier, each of these 10 scales/subscales contains 5-point, Likert-format items (i.e. 1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, 5 = strongly agree) such that a higher score on a scale/subscale indicates stronger agreement with the items assessed under each scale/subscale.

Table 5 shows that the two cultural values scales (namely the Attitudes Towards Cultural Values Scale and the Inculcating Cultural Values Scale), generated the most positive responses, respectively (i.e. indicated the most positive attitudes). In contrast, the Satisfaction with Resources and Material Subscale yielded the least positive responses (i.e. indicated the least positive attitudes). In fact, both the Attitudes Towards Cultural Values Scale and the Inculcating Cultural Values Scale generated statistically significantly more positive responses than did all other scales/subscales, with effect sizes ranging from medium (i.e. d = 0.53; representing the difference between scores on the Inculcating Cultural Values Scale and on the Attitudes Towards Creating a Positive Classroom Environment Scale) to extremely large (i.e. d = 2.51; representing the difference between scores on the Attitudes Towards Cultural Values Scale and the Satisfaction with Resources and Material Subscale).[7]

Table 5: Mean item rating by the gender of the teacher for each of the 10 scales/subscales

Scale/Subscale	Mean (Standard Deviation)			
	All teachers	Male teachers	Female teachers	*t* value
Inculcating Cultural Values Scale	4.73 (0.36)	4.74 (0.35)	4.72 (0.37)	1.20
Attitudes Towards Cultural Values Scale	4.78 (0.31)	4.78 (0.31)	4.76 (0.32)	1.73
Perceived Teacher Knowledge and Pedagogy Scale	4.40 (0.43)	4.41 (0.43)	4.37 (0.44)	1.69
Attitudes Towards Creating a Positive Classroom Environment Scale	4.58 (0.37)	4.59 (0.57)	4.57 (0.38)	0.92
Attitudes Towards Student-Centred Learning Scale	4.53 (0.40)	4.54 (0.41)	4.51 (0.40)	1.30
Attitudes Towards Diversity Scale	3.60 (0.71)	3.62 (0.70)	3.55 (0.71)	1.76
Satisfaction with Support and Opportunity Subscale	3.99 (0.67)	3.98 (0.68)	4.01 (0.63)	-0.83
Satisfaction with Resources and Material Subscale	2.70 (0.78)	2.69 (0.79)	2.71 (0.76)	-0.44
Micro-Level Teacher Motivation Subscale	3.80 (0.63)	3.79 (0.64)	3.83 (0.58)	-1.44
Macro-Level Teacher Motivation Subscale	3.75 (0.71)	3.70 (0.72)	3.90 (0.66)	-5.07*

Source: Leaders in Teaching data 2019-20

Note: The mean and standard deviation values pertain to the individual item responses for each scale/subscale. For example, for the 5-point, Likert-format Inculcating Cultural Values Scale that contains six items, the mean item rating of 4.73 for all teachers indicates that the majority of teacher respondents tended to *agree* or to *strongly agree* to each of the six items.

* $p < .0001$

There is no difference between male teachers and female teachers for 9 of the 10 scales/subscales. Of the 10 measures, there is no difference between male teachers and female teachers with respect to nearly all of them (see Table 5). In fact, the only scale that yielded a statistically significant difference between the male and female teachers was the Macro-Level Teacher Motivation Subscale, with the female teachers reporting statistically significantly more positive levels of teacher motivation

associated with the teaching profession as a whole (e.g. "*I think that the teaching profession is valued in society*"; *d* = .28).

There is no difference between teachers who report having a disability and teachers who report not having a disability for 9 of the 10 scales/subscales. Of the 10 measures, there is no difference between teachers who report having a disability and teachers who report not having a disability with regard to nearly all of them (see Table 6). In fact, the only scale that yielded a statistically significant difference between the two groups was the Satisfaction with Resources and Material Subscale, with the teachers who report having a disability reporting statistically significantly more positive levels of satisfaction with resources and material (e.g. "*I am satisfied with the amount of material/resources I have access to*"; *d* = .38) than do teachers who report not having a disability.

Table 6: Mean item rating by the disability status of the teacher for each of the 10 scales/subscales

Scale/Subscale	Teachers with a disability Mean (Standard Deviation)	Teachers without a disability Mean (Standard Deviation)	*t* value
Inculcating Cultural Values Scale	4.73 (0.35)	4.73 (0.36)	-0.12
Attitudes Towards Cultural Values Scale	4.74 (0.32)	4.78 (0.31)	-0.90
Perceived Teacher Knowledge and Pedagogy Scale	4.34 (0.38)	4.40 (0.44)	-1.02
Attitudes Towards Creating a Positive Classroom Environment Scale	4.58 (0.33)	4.58 (0.37)	-0.10
Attitudes Towards Student-Centred Learning Scale	4.56 (0.37)	4.53 (0.40)	0.51
Attitudes Towards Diversity Scale	3.55 (0.59)	3.60 (0.71)	-0.49
Satisfaction with Support and Opportunity Subscale	4.04 (0.62)	3.99 (0.67)	0.58
Satisfaction with Resources and Material Subscale	2.98 (0.70)	2.69 (0.78)	2.75*
Micro-Level Teacher Motivation Subscale	3.83 (0.67)	3.80 (0.63)	0.36
Macro-Level Teacher Motivation Subscale	3.90 (0.61)	3.74 (0.71)	1.60

Source: Leaders in Teaching data 2019-20

Note: The mean and standard deviation values pertain to the individual item responses for each scale/subscale. For example, for the 5-point, Likert-format Inculcating Cultural Values Scale that contains six items, the mean item rating of 4.73 for all teachers with a disability indicates that the majority of teacher respondents tended to *agree* or to *strongly agree* to each of the six items.

* $p < .01$

There is a difference between teachers at day schools and teachers at boarding schools for 5 of the 10 scales/subscales. Of the 10 measures, there is a statistically significant difference between teachers at day schools and those of boarding schools (see Table 7) with respect to the following 5 measures: Perceived Teacher Knowledge and Pedagogy Scale, Attitudes Towards Diversity Scale, Satisfaction with Support and Opportunity Subscale, Satisfaction with Resources and Material Subscale and Micro-Level Teacher Motivation Subscale. Specifically, whereas teachers of day schools had more positive attitudes towards diversity ($d = .28$) and a more positive level of teacher motivation associated with their classroom teaching ($d = .62$), teachers of boarding

schools had more positive levels of perceived knowledge of the subject they teach and their pedagogical competence (d = .27), satisfaction with support and opportunity (d = .25), and satisfaction with resources and material (d = .99).

Table 7: Mean item rating by type of school of the teacher for each of the 10 scales/subscales

Scale/subscale	Teachers of a day school Mean (Standard Deviation)	Teachers of a boarding school Mean (Standard Deviation)	*t* value
Inculcating Cultural Values Scale	4.74 (0.35)	4.73 (0.35)	0.14
Attitudes Towards Cultural Values Scale	4.78 (0.31)	4.77 (0.35)	0.50
Perceived Teacher Knowledge and Pedagogy Scale	4.38 (0.44)	4.50 (0.43)	-3.69*
Attitudes Towards Creating a Positive Classroom Environment Scale	4.59 (0.37)	4.57 (0.36)	0.68
Attitudes Towards Student-Centred Learning Scale	4.53 (0.40)	4.54 (0.39)	-0.26
Attitudes Towards Diversity Scale	3.63 (0.70)	3.44 (0.74)	3.67*
Satisfaction with Support and Opportunity Subscale	3.96 (0.68)	4.13 (0.59)	-3.41*
Satisfaction with Resources and Material Subscale	2.58 (0.74)	3.31 (0.74)	-13.28*
Micro-Level Teacher Motivation Subscale	3.86 (0.60)	3.49 (0.65)	8.41*
Macro-Level Teacher Motivation Subscale	3.75 (0.72)	3.73 (0.66)	0.33

Source: Leaders in Teaching data 2019-20

Note: The mean and standard deviation values pertain to the individual item responses for each scale/subscale. For example, for the 5-point, Likert-format Inculcating Cultural Values Scale that contains six items, the mean item rating of 4.74 for all teachers of a day school indicates that the majority of teacher respondents tended to *agree* or to *strongly agree* to each of the six items.

* $p < .01$

Broadly speaking, perceptions of teaching quality in Rwandan secondary schools comprises a *cultural values and pedagogical component* and a *motivational component*. A second-order PCA[8] was conducted to examine the structure of each of the 10 scales/subscales that was identified by the first-order PCA. This analysis indicated two factors. The first factor contained the following 5 scales: inculcating cultural values, attitudes towards cultural values, perceived teacher

knowledge and pedagogy, attitudes towards creating a positive classroom environment, and attitudes towards student-centred learning. The second factor comprised the following 3 scales/subscales: satisfaction with support and opportunity, satisfaction with resources and material, and macro-level teacher motivation. Whereas the first factor indicated a **cultural values and pedagogical component**, the second factor indicated a **motivational component**. This means that teachers who have high scores in the cultural values and pedagogical component are likely to demonstrate the following dimensions of teaching quality:

- They believe that it is necessary for teachers to inculcate Rwandan cultural values in their students.

- They believe that it is necessary for teachers to behave in ways that demonstrate respect for Rwandan cultural values.

- They indicate a high level of perceived knowledge of the subject they teach and pedagogical competence.

- They indicate a high level of perceived competence in creating a positive environment for their students in their classrooms.

- They believe that it is necessary for their teaching to promote student-centred learning in their classrooms

In contrast, teachers who have high scores in the motivational component are likely to demonstrate the following dimensions of teaching quality:

- They are satisfied with the support and opportunities that are available to them as teachers.

- They are satisfied with the resources and materials that are available to them to teach their students.

- They indicate a high level of teacher motivation associated with the teaching profession as a whole.

Interestingly, the attitudes towards diversity scale was not included as part of either component, suggesting that this variable is not an essential part of teaching quality in the Rwandan context. It should be noted that neither a high pedagogical component nor a high emotional component implies that the teacher is a better teacher than a

teacher with a lower component, but rather that the teaching methods of the former are more aligned to specific factors.

There is no difference between male teachers and female teachers in terms of the cultural values and pedagogical component, but there is a difference between male teachers and female teachers for the motivational component (see Table 8). The difference between male and female teachers with regard to the motivational component is statistically significant, with female teachers reporting statistically significantly more positive levels associated with the motivational component (*d* = .17).

Table 8: Mean item rating by the gender of the teacher for each of the two major teaching components

| Component | Mean (Standard Deviation) | | | *t* value |
	All teachers	Male teachers	Female teachers	
Cultural values and pedagogical component	4.61 (0.29)	4.62 (0.29)	4.59(0.30)	1.83
Motivational	3.48 (0.58)	3.46 (0.59)	3.55 (0.55)	-3.00*

Source: Leaders in Teaching data 2019-20
Note: The mean and standard deviation values pertain to the aggregate of the individual item responses for each scale/subscale that is contained within each component. For example, for the cultural values and pedagogical component which contains five scales/subscales (i.e. inculcating cultural values, attitudes towards cultural values, perceived teacher knowledge and pedagogy, attitudes towards creating a positive classroom environment, and attitudes towards student-centred learning), the mean component score of 4.61 for all teachers indicates that the majority of teacher respondents tended to *agree* or to *strongly agree* to items related to this component.
* *p* < .01

There is no difference between teachers who report having a disability and teachers who report not having a disability for either the cultural values and pedagogical component or the motivational component (see Table 9).

Component	Teachers with a disability Mean (Standard Deviation)	Teachers without a disability Mean (Standard Deviation)	t value
Cultural values and pedagogical component	4.59 (0.27)	4.61 (0.29)	-0.71
Motivational	3.63 (0.52)	3.48 (0.58)	1.85

Source: Leaders in Teaching data 2019-20

Note: The mean and standard deviation values pertain to the aggregate of the individual item responses for each scale/subscale that is contained within each component. For example, for the cultural values and pedagogical component which contains five scales/subscales (i.e. inculcating cultural values, attitudes towards cultural values, perceived teacher knowledge and pedagogy, attitudes towards creating a positive classroom environment, and attitudes towards student-centred learning), the mean component score of 4.59 for all teachers with a disability indicates that the majority of these teacher respondents tended to *agree* or to *strongly agree* to items related to this component.

* $p < .01$

There is no difference between teachers at day schools and teachers at boarding schools for the cultural values and pedagogical component but there is a difference for the motivational component (see Table 10). The difference between these two groups of teachers with regard to the motivational component is statistically significant, with teachers at boarding schools reporting statistically significantly more positive levels associated with the motivational component ($d = .49$).

Table 10: Mean item rating by type of school of the teacher for each of the two major teaching components

Component	Teachers of a day school Mean (Standard Deviation)	Teachers of a boarding school Mean (Standard Deviation)	t value
Cultural values and pedagogical component	4.61 (0.29)	4.64 (0.28)	-1.47
Motivational	3.43 (0.58)	3.72 (0.55)	-6.34*

Source: Leaders in Teaching data 2019-20

Note: The mean and standard deviation values pertain to the aggregate of the individual item responses for each scale/subscale that is contained within each component. For example, for the cultural values and pedagogical component which contains five scales/subscales (i.e. inculcating cultural values, attitudes towards cultural values, perceived teacher knowledge and pedagogy, attitudes towards creating a positive classroom environment, and attitudes towards student-centred learning), the mean component score of 4.61 for all teachers of a day school indicates that the majority of these teacher respondents tended to *agree* or to *strongly agree* to items related to this component. * $p < .01$.

Methods of analysis

In the following sections, we look for associations between the 10 teaching quality variables (dependent variable set) and selected socio-demographic and locational variables (predictor variable set). For this purpose, we use canonical correlation analysis to examine the relationships between two sets of variables. Only statistically significant associations are discussed throughout the analyses.

The teaching quality variables are:
- inculcating cultural values
- attitudes towards cultural values
- perceived teacher knowledge and pedagogy
- attitudes towards creating a positive classroom environment
- attitudes towards student-centred learning
- attitudes towards diversity
- satisfaction with support and opportunity
- satisfaction with resources and material
- micro-level teacher motivation
- macro-level teacher motivation

The eight socio-demographic and locational variables comprise the following variables:
- gender (dichotomous)
- age (ratio scale)
- years of teaching experience (ratio scale)
- travel time (ratio scale)
- highest education level (different dichotomisations; e.g. Bachelor's degree vs. advanced diploma)
- qualifications (different dichotomisations; e.g. Bachelor's degree vs. advanced diploma)
- disability status (dichotomous; i.e. report having a disability vs. report not having a disability)
- type of school (dichotomous; i.e. day school vs. boarding school).

Antecedents of teaching quality

Relationship between the teaching quality measures and the socio-demographic and locational variables

Age, gender, and travel time from home to school simultaneously are related to attitudes towards student-centred learning, job satisfaction and levels of teacher motivation. The canonical correlation analysis[9] (see Appendix Table 1) reveals that the relationship between the **socio-demographic and locational variables** and the teaching quality variables are best characterised by two sets of relationships.

The first set (i.e. Function 1 of Appendix Table 1) indicates that type of school predicts satisfaction with resources and material and levels of teacher motivation associated with their classroom teaching. More specifically, this relationship revealed the following:

- Teachers at boarding schools tend to report the most positive levels of satisfaction with resources and material.

- Teachers at day schools tend to have the most positive levels of teacher motivation associated with their classroom teaching.

Interestingly, based on the size of both the standardised canonical function coefficients and the canonical structure coefficients for the first function (Appendix Table 1),[10] type of school best predicts satisfaction with resources and material.

The second set (i.e. Function 2 of Appendix Table 1) indicates that age, gender, and highest qualification simultaneously are related to attitudes towards cultural values, levels of perceived teacher knowledge and pedagogy and levels of teacher motivation associated with the teaching profession as a whole. More specifically, this relationship revealed the following:

- Younger teachers tend to report more positive attitudes towards cultural values than do older teachers.

- Male teachers are more likely to report that it is necessary for their teaching to reflect respect for Rwandan cultural values than female teachers.

- Teachers whose highest degree is a Bachelor's degree are more likely to report that it is necessary for their teaching to reflect respect for Rwandan cultural values than teachers whose highest degree is an advanced degree (i.e. higher than a Bachelor's degree).

- Younger teachers tend to report higher levels of perceived teacher knowledge and pedagogy than older teachers.

- Male teachers tend to report higher levels of perceived teacher knowledge and pedagogy than female teachers.

- Teachers whose highest degree is a Bachelor's degree tend to report higher levels of perceived teacher knowledge and pedagogy than teachers whose highest degree is an advanced degree.

- Older teachers tend to report higher levels of teacher motivation associated with the teaching profession as a whole than younger teachers.

- Female teachers tend to report higher levels of teacher motivation associated with the teaching profession as a whole than male teachers. In fact, female teachers are 1.22 standard deviations higher in levels of teacher motivation associated with the teaching profession as a whole than male teachers.

- Teachers whose highest degree is a Bachelor's degree tend to report higher levels of teacher motivation associated with the teaching profession as a whole than teachers whose highest degree is an advanced degree.

Relationship between the two key summary dimensions of teaching quality and the socio-demographic and locational variables

This section contains the results of a canonical correlation analysis examining the relationship between the aforementioned set of eight **socio-demographic and locational variables** (i.e. gender, age, teaching experience, highest education level, qualifications, travel time, disability status and type of school) and the two summary dimensions of the teaching quality: **cultural values and pedagogical component** and **motivational component** (see Appendix Table 2). This canonical correlation analysis reveals that the relationship between the socio-demographic and locational variables and the dimensions of teaching quality are most characterised by two sets of relationships.

Age, gender, travel time and type of school simultaneously are related to the motivational component. The first canonical set (i.e. Function 1 of Appendix Table 2) reveals that the relationship between the socio-demographic and locational variables and the two key summary dimensions of teaching quality are most characterised by the following relationship: age, gender, travel time and type of school simultaneously are related to the motivational component. More specifically, this relationship revealed the following:

- Older teachers indicate a more positive motivational component than younger teachers.

- Female teachers indicate a more positive motivational component than male teachers.

- Teachers who spend the least time travelling from home to school indicate the most positive motivational component.

- Teachers at boarding schools indicate a more positive motivational component than teachers of day schools.

Interestingly, based on the standardised coefficient and structure coefficient, type of school is the best predictor within this multivariate relationship.

Age, gender, years of experience, highest qualification, and type of school simultaneously are related to the cultural values and pedagogical component. The second canonical set (i.e. Function 2 of Appendix Table 2) reveals that the relationship between the socio-demographic and locational variables and the two key summary dimensions of teaching quality are most characterised by the following relationship: age, gender, years of experience, highest qualification and type of school simultaneously are related to the cultural values and pedagogical component. More specifically, this relationship revealed the following:

- Younger teachers indicate a more positive cultural values and pedagogical component than older teachers.

- Male teachers indicate a more positive cultural values and pedagogical component than female teachers.

- Teachers with the least years of experience indicate the most positive cultural values and pedagogical component.

- Teachers with advanced degrees indicate the most positive cultural values and pedagogical component compared to teachers with a Bachelor's degree.

- Teachers at boarding schools indicate a more positive cultural values and pedagogical component than teachers of day schools.

Summary of findings

In this paper, we explored antecedents of teaching quality in Rwandan secondary schools. We found the following:

- Teaching quality in Rwandan secondary schools is measured via 10 scales/subscales, each with good psychometric properties (e.g. adequate score reliability).

- There is no difference between male teachers and female teachers for 9 of the 10 scales/subscales, with the only difference being that female teachers report higher levels of teacher motivation associated with the teaching profession as a whole.

- There is no difference between teachers who report having a disability and teachers who report not having a disability for 9 of the 10 scales/subscales, the only difference being that teachers who report having a disability report higher levels of satisfaction with resources and material.

- There is a difference between teachers at day schools and teachers at boarding schools for 5 of the 10 scales/subscales. Specifically, whereas teachers at day schools had more positive attitudes towards diversity and more positive level of teacher motivation associated with their classroom teaching, teachers at boarding schools had more positive levels of perceived knowledge of the subject they teach and their pedagogical competence, satisfaction with support and opportunity, and satisfaction with resources and material.

- Teachers at boarding schools tend to report the most positive levels of satisfaction with resources and material, whereas teachers of day schools tend to have the most positive levels of teacher motivation associated with their classroom teaching.

- Compared to their counterparts, younger teachers, male teachers and teachers whose highest degree is a Bachelor's degree tend to report more positive attitudes towards cultural values and higher levels of perceived teacher knowledge and pedagogy.

- Compared to their counterparts, older teachers, female teachers and teachers whose highest degree is a Bachelor's degree tend to report higher levels of teacher motivation associated with the teaching profession as a whole.

- Overall, the 10 teaching quality indicators in Rwandan secondary schools could be summarised by two components: a cultural values and pedagogical component and a motivational component.

- Using these two components, we found that, compared to their counterparts, older teachers, female teachers, teachers who spend the least time travelling from home to school and teachers at boarding schools indicate a more positive motivational component.

- Compared to their counterparts, younger teachers, male teachers, teachers with the least years of experience, teachers with advanced degrees and teachers at boarding schools indicate a more positive cultural values and pedagogical component.

Conclusion, policy recommendations, and opportunities for further research

Attributes of teaching quality, as reported by the teachers, are related to certain socio-demographic and locational variables. In this paper, we sought to understand both how teaching quality might be measured in Rwandan secondary schools and the extent to which these measures of perceived teaching quality vary as a function of socio-demographic characteristics of teachers. Our findings suggest that there is a gender context, an age context, a time context and an educational qualification context to the perceptions of teaching quality in Rwandan secondary schools. In addition, type of school (i.e. boarding school versus day school) appears to play an especially important role in the context of teaching quality.

Boarding schools and day schools emerge as two groups of schools that differ in some aspects of teaching quality. Teachers at boarding schools differ from teachers of day schools with respect to 5 of the 10 teaching variables. Also, these two sets of teachers differ with respect to both key summary dimensions of teaching quality. Therefore, teaching quality should be examined not only across Rwandan secondary schools as a whole but also across boarding schools and day schools separately.

The 10 teaching quality indicators in Rwandan secondary schools could be summarised by two components: a cultural values and pedagogical component and a motivational component. The cultural values and pedagogical component represents a pedagogical process that has a cultural framework which appears to guide the pedagogical approaches beyond the curricular, instructional and assessment criteria. In contrast, the motivational component refers to motivation factors in the context of teaching in Rwanda—specifically, teacher motivation and job satisfaction—that are hypothesised as either moderating or mediating teaching quality. Under this hypothesis, low teacher motivation and low job satisfaction are associated with lower perceived teaching quality, whereas high teacher motivation and high job satisfaction provide pathways for teaching quality, such as by developing and/or maintaining appropriate cultural values and pedagogical disposition. Both qualitative and quantitative approaches can be used further to explore and to test, respectively, these two sets of teaching quality hypotheses in the context of Rwandan secondary schools.

The findings have led to the following policy recommendations that have been subdivided into the following three levels: systems, school leadership and teachers.

<u>Systems</u>

1. Teaching quality is multidimensional and involves 10 measures. It might be useful to focus on these measures in teacher assessment frameworks and use the results to develop training plans for teachers that focus on areas where they show less positive attitudes.
2. The cultural values component of teaching quality represents a brand-new finding. Policy makers may wish to consider how to incorporate these values in the way that pedagogical approaches are understood and assessed.

<u>School leadership</u>

1. Because boarding schools and day schools have different structural issues, teaching quality is perceived differently by teachers in these schools. Therefore, a one-size-fits-all approach should not be used to address teaching quality.
2. School leaders might consider designing interventions that are targeted for teachers identified via the measures as tending to have less positive attitudes towards cultural values and/or less positive attitudes towards perceived teacher knowledge and pedagogy.
3. School leaders might consider implementing mentoring programmes whereby teachers who they have identified as exhibiting quality teaching can mentor those teachers who have been identified as tending to have less positive attitudes.
4. Feedback given to teachers by school leaders could include feedback not only pertaining to these measures of teaching quality, but also to help address some of the main issues that are emerging from measures of teaching quality, particularly pertaining to issues of gender and other aspects of equity.
5. School leaders might consider monitoring how scoring low(er)/high(er) on each of these 10 measures of teaching quality manifests itself in the classroom.

<u>Teachers (pedagogy)</u>

1. Teachers might consider collaborating with other teachers to identify and share best pedagogical practices with each other.
2. Once teachers have been made aware of the areas of teaching quality for which they obtain low(er) scores, they could be encouraged to design a plan to address those areas that are within their control.

Potential areas for further research on teaching quality in Rwanda secondary schools could include the following:

1. Replicating this study to determine how stable the present relationships are between the socio-demographic and locational variables and the teaching quality variables.

2. Investigating the relationship between teaching quality and school quality, using school-level variables such as the following three dimensions used by Le Saux et al. (2021): leaders' and teachers' satisfaction with available equipment (i.e. measure of school inputs), proportion of STEM teachers with a Bachelor's degree (school-level measure of teaching quality) and STEM examination passing rates for students (i.e. school-level measure of students' learning outcomes).

3. Investigating alternative measures of teaching quality. In particular, qualitative research data (e.g. via semi-structured interviews, FGDs, classroom observations) could be used to identify these measures.

4. Using modelling techniques, such as structural equation modelling, to determine how a selected set of teaching quality variables relate to each other.

5. Investigating how the relationships and patterns reported in this paper have been affected by COVID-19 by linking the current data with data collected during this pandemic.

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Appendix Table 1: Canonical correlation analysis: Canonical solution for the two statistical significant functions: Relationship between the eight socio-demographic and location variables and ten teaching quality variables

Variable	Function 1[a]		Function 2[b]	
Socio-demographic and location variables	**Standardised Coefficient**	**Structure Coefficient**	**Standardised Coefficient**	**Structure Coefficient**
Age	0.33*	.26	-0.55*	-.40*
Gender	0.04	-.11	-0.77*	-.73*
Travel time	-0.10	-.22	0.27	.18
Years of experience	-0.14	.19	0.01	-.38*
Highest degree	0.18	.22	0.44*	.40*
Qualifications	-0.20	.05	-0.11	.23
Disability status	0.04	.08	-0.09	-.15
Type of school	0.93*	.96*	0.03	.12
Teaching quality variables				
Creating a positive classroom environment	-0.17	-.09	-0.08	.19
Inculcating values	0.11	-.01	-0.04	.23
Student-centred learning	-0.03	-.02	0.29	.35*
Teacher knowledge and pedagogy	0.11	.17	0.31*	.35*
Values	0.07	-.01	0.30*	.33*
Job satisfaction: Satisfaction with support and opportunity	-0.07	.23	0.18	-.16
Job satisfaction: Satisfaction with Resources and Material	0.96*	.83*	-0.27	-.38*
Micro-level motivation	-0.36*	-.48*	-0.35*	-.14
Macro-level motivation	-0.42*	-.01	-0.85*	-.65*
Diversity	-0.05	-.20	0.21	.24

*Practically significant coefficients with the effect sizes larger than .3 (Lambert and Durand, 1975).

Variables that are italicised but not bolded have either a standardised coefficient or a structure coefficient on one or more canonical functions that is practically significant.

Variables that are bolded have both a standardised coefficient and a structure coefficient on one canonical function that are practically significant.

Variables that are bolded and italicised have both a standardised coefficient and a structure coefficient on both canonical functions that are practically significant.

Variables that are neither bolded not italicised (i.e. normal font) have a non-practically significant standardised coefficient and a non-practically significant structure coefficient on both canonical functions.

[a]R_{c1} = .40; R_{c1}^2 = 15.89% (Eigenvalue = .19; Wilk = .76; F = 4.19, $p < .0001$)

[b]R_{c2} = .23; R_{c2}^2 = 5.13% (Eigenvalue = .05; Wilk = .90; F = 1.97, $p < .0001$)

Appendix Table 2: Canonical correlation analysis: Canonical solution for the statistical significant function: Relationship between the eight socio-demographic and location variables and two key summary dimensions of teaching quality

Variable	Function 1[a]		Function 2[b]	
Socio-demographic and location variables	Standardised Coefficient	Structure Coefficient	Standardised Coefficient	Structure Coefficient
Age	-0.38*	-.25	-1.09*	-.67*
Gender	-0.54*	-.42*	-0.38*	-.31*
Travel time	0.31*	.36*	0.06	-.07
Years of experience	0.07	-.22	-0.35*	-.48*
Highest degree	0.28	.19	0.04	-.22
Qualifications	0.04	.14	-0.47*	-.34*
Disability status	-0.16	-.21	0.06	-.03
Type of school	-0.72*	-.67*	0.45*	.40*
Teaching quality Dimension				
Cultural values and pedagogical component	0.42*	.11	0.96*	.99*
Motivational component	-1.04*	-.91*	0.11	.40*

*Practically significant coefficients with the effect sizes larger than .3 (Lambert & Durand, 1975).

Variables that are italicised but not bolded have either a standardised coefficient or a structure coefficient on one or more canonical functions that is practically significant.
Variables that are bolded have both a standardised coefficient and a structure coefficient on one canonical function that are practically significant.
Variables that are bolded and italicised have both a standardised coefficient and a structure coefficient on both canonical functions that are practically significant.
Variables that are neither bolded not italicised (i.e. normal font) have a non-practically significant standardised coefficient and a non-practically significant structure coefficient on both canonical functions.

[a]R_{c1} = .24; R_{c1}^2 = 5.93% (Eigenvalue = .06; Wilk = .93; F = 6.22, p < .0001)
[b]R_{c2} = .13; R_{c2}^2 = 1.62% (Eigenvalue = .02; Wilk = .98; F = 2.96, p < .01)

Endnotes

[1] Although other terms appear in the literature, we believe that the term "teaching quality" is most appropriate because *teaching quality* is made up of *teacher characteristics* (who teachers are) and *teaching processes* (what teachers do)—as opposed to terms like *teacher quality*, which might imply the quality of a teacher (i.e., quality of a person).

[2] The survey can be obtained from the following source: https://www.educ.cam.ac.uk/centres/real/researchthemes/teachingandlearning/leaders/

[3] In the context of scale development, principal component analysis is a statistical procedure performed on a set of items in order to determine which items in the set form logical subsets that are statistically independent from each other. Specifically, items that are statistically related to each other but are statistically independent from other subsets of variables are combined into a component, which yield a scale/subscale. Therefore, each component is assumed to represent the underlying phenomena/constructs that are responsible for the observed correlations among the items. As such, the principal component analysis reduces the dimensionality of the set of items.

[4] A Likert-type or Likert-format scale is a symmetric agree-disagree scale (i.e. containing the same number of "agree" and "disagree" options) in which each participant responds to a series of statements (not questions) by specifying her/his level of agreement or disagreement. The creator of the Likert-format scale, the psychologist Rensis Likert, distinguished between a scale that stemmed from collective responses to a set of items (usually eight or more) and a scale wherein responses are scored along a range. Strictly speaking, a Likert scale refers only to the former. The phrase "Likert-format" scale is more appropriate than is the phrase "Likert scale" to distinguish the fact that the x-point scale (e.g. 5-point scale: 1 = strongly agree vs. 2 = agree vs. vs. 3 = neutral vs. 4 = disagree vs. 5 = strongly disagree) represents a variation from the original Likert scale.

[5] Cohen's (1988) *d* is a quantitative measure of the magnitude for the difference between two means. It is a standardised mean difference that is represented by the difference between two means and divided by a pooled standard deviation. This difference is known as an *effect size*, which, as the term suggests, indicates how large an effect of something is. Because the values are standardised, it is possible to compare values between different variables.

[6] Fisher's exact test—named after its inventor, Sir Ronald Fisher—is a statistical significance test that is used when analysing contingency tables, wherein the statistical significance (i.e. *p* value) of the deviation from a null hypothesis is calculated exactly.

[7] Cohen's (1988) *d* criteria for effect sizes associated with difference between two means are as follows: $d = .2$ represents a small effect size; $d = .5$ represents a moderate effect size; and $d = .8$ represents a large effect size.

[8] A second-order principal components analysis is an exploratory analysis which yields factors that are determined from the correlation among the factors, as opposed to a first-order principal components analysis which yields factors that are derived from the correlation among the manifest variables or items.

[9] A canonical correlation analysis is utilized to examine the relationship between two sets of variables when each set contains more than one variable (cf. Thompson, 1984).

[10] Standardised canonical function coefficients are computed weights that are applied to each variable in a given set in order to determine the composite variate used in the canonical correlation analysis. Therefore, standardized canonical function coefficients are analogous to beta coefficients in a regression analysis or to factor pattern coefficients in exploratory factor analysis/principal components analysis. In contrast, canonical structure coefficients are the correlations between a given variable and the scores on the canonical composite (i.e. latent variable) in the set to which the variable belongs. Therefore, structure coefficients indicate the extent that each variable is related to the canonical composite for the variable set. Specifically, structure coefficients are essentially bivariate correlation coefficients that range in value between -1.0 and +1.0, inclusive. Importantly, the square of the structure coefficient (not presented) provides the proportion of variance that the original variable shares linearly with the canonical variate (Thompson, 1984).