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ORIGINAL ARTICLE

Test de Autoevaluación de Meditación Transcendental: a psychometric study of Peruvian school children and adolescents

Test de Autoevaluación de Meditación Trascendental: un estudio psicométrico de niños y adolescentes peruanos

Teste de Autoavaliação de Meditação Transcendental: um estudo psicométrico de crianças e adolescentes peruanos

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KEYWORDS

Transcendental Meditation, psychometric testing, exploratory factor analysis, school, Peru.

ABSTRACT. The specific, as well as holistic, effects of practicing the Transcendental Meditation technique have been thoroughly documented. Findings associated with the practice have included a range of physiological, psychological and sociological benefits, but have also encompassed measures of general health, well-being and human development. However, few if any indigenous test instruments have been used to gather these data. In Perú, a test instrument called *Test de Autoevaluación de Meditación Transcendental* (i.e., Self-Assessment Test of Transcendental Meditation) designed to measure benefits of Transcendental Meditation in school children and adolescents has been deployed with some degree of success. The test was designed about 25 years ago to measure physical health, cognitive health, emotional health, and school performance,

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and has been completed by about 50,000 primary and secondary school students since its introduction. Recently published studies have documented the results. But the test has never been psychometrically evaluated. The purpose of the present study therefore was to rigorously assess the reliability and construct validity of the instrument using exploratory factor analysis and confirmatory factor analysis. Results of these analyses revealed a five latent factors—more alertness and energy, improved physical and mental health, enhanced cognitive performance, enhanced emotional and behavioural self-regulation, and more fulfilling interpersonal relationships—which reliably predicted an overall scale of health in students. Application of a revised Test de Autoevaluación de Meditación Transcendental is now ready for further use in Perú and, with translation, other school settings.

PALABRAS CLAVE

Meditación Trascendental, pruebas psicométricas, análisis factorial exploratorio, escuela, Perú.

RESUMEN. Los efectos específicos y holísticos de la práctica de la técnica de Meditación Trascendental han sido documentados exhaustivamente. Los hallazgos asociados con la práctica han incluido una variedad de beneficios fisiológicos, psicológicos y sociológicos, pero también han abarcado medidas de salud general, bienestar y desarrollo humano. Sin embargo, se han utilizado pocos, si acaso, instrumentos de prueba indígenas para recopilar estos datos. En Perú, un instrumento de prueba llamado Test de Autoevaluación de Meditación Trascendental, diseñado para medir los beneficios de la Meditación Trascendental en niños escolares y adolescentes, ha sido desplegado con cierto grado de éxito. El test fue diseñado hace unos 25 años para medir la salud física, cognitiva, emocional y el rendimiento escolar, y ha sido completado por aproximadamente 50,000 estudiantes de primaria y secundaria desde su introducción. Estudios publicados recientemente han documentado los resultados. Sin embargo, el test nunca ha sido evaluado psicométricamente. Por lo tanto, el propósito del presente estudio fue evaluar rigurosamente la fiabilidad y la validez de constructo del instrumento utilizando análisis factorial exploratorio y confirmatorio. Los resultados de estos análisis revelaron cinco factores latentes—mayor alerta y energía, mejor salud física y mental, mejor rendimiento cognitivo, mejor regulación emocional y conductual, y relaciones interpersonales más satisfactorias—que predijeron de manera confiable una escala general de salud en los estudiantes. La aplicación de un Test de Autoevaluación de Meditación Trascendental revisado está ahora lista para un uso más amplio en Perú y, con traducción, en otros entornos escolares.

PALAVRAS-CHAVE

Meditação Transcendental, teste psicométrico, análise fatorial exploratória, escola, Peru.

RESUMO. Os efeitos específicos e holísticos da prática da técnica de Meditação Transcendental foram amplamente documentados. As descobertas associadas à prática incluíram uma gama de benefícios fisiológicos, psicológicos e sociológicos, mas também abrangeram medidas de saúde geral, bem-estar e desenvolvimento humano. No entanto, poucos ou nenhum instrumento de teste indígena foram usados para coletar esses dados. No Peru, um instrumento de teste chamado Teste de Autoavaliação de Meditação Transcendental, projetado para medir os benefícios da Meditação Transcendental em crianças em idade escolar e adolescentes, foi implementado com algum grau de sucesso. O teste foi projetado há cerca de 25 anos para medir a saúde física, cognitiva, emocional e o desempenho escolar, e foi completado por cerca de 50.000 estudantes do ensino fundamental e médio desde a sua introdução. Estudos recentemente publicados documentaram os resultados. No entanto, o teste nunca foi avaliado psicometricamente. Portanto, o propósito do presente estudo foi avaliar rigorosamente a confiabilidade e a validade de construção do instrumento usando análise fatorial exploratória e confirmatória. Os resultados dessas análises revelaram cinco fatores latentes—maior alerta e energia, saúde física e mental melhorada, desempenho cognitivo aprimorado, regulação emocional e comportamental aprimorada, e relacionamentos interpessoais mais satisfatórios—que previram de maneira confiável uma escala geral de saúde nos estudantes. A aplicação de um Teste de Autoavaliação de Meditação Transcendental revisado está agora pronta para uso mais amplo no Peru e, com tradução, em outros ambientes escolares.

1. INTRODUCTION

Introduced in the early 1960s and first empirically tested ten years later (Wallace, 1970), the Transcendental Meditation technique, as taught by Maharishi Mahesh Yogi and his trained teachers, is one of the world's most

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extensively tested systems of health and human development. Transcendental Meditation has been described as a simple, natural, effortless and easy-to-learn mental technique for children and adults designed to allow the conscious thinking mind to settle down to experience a profound state of inner silence along with a deep level of physiological rest in preparation for more dynamic and successful action (Schneider et al., 2024, p. 2).

One recent systematic review of data from 1955–2022 found evidence of 8,776 studies on the topic of Transcendental Meditation in 3,054 journals by 18,133 authors from 3,505 organizations (Wani, 2023). For example, according to Wani, Behavioural and Brain Sciences has published 131 studies, BMJ has published 109 studies, Frontiers in Psychology has published 71 studies, Perceptual and Motor Skills has published 70 studies, and The Lancet has published 63 studies.

Perhaps the most reliable source of data on Transcendental Meditation are the eight volumes of 678 empirical, theoretical, and review papers published since 1977 (Chalmers et al., 1989a, 1989b, 1989c; Dillbeck, 2020; Orme-Johnson, & Farrow, 1977; Wallace et al., 1991), with many more studies not contained in these collected works (e.g., Avvenuti et al., 2020; Azizoddin et al., 2021; Leach & Lorenzon, 2023; Nestor, Lawson, & Fischer, 2023; Rutledge et al., 2014; Walton et al., 2023). A considerable body of recent evidence by this paper's authors has also emerged from Peru, where some 53,000 children and adolescents in more than 70 schools have been taught Transcendental Meditation since the late 1990s (Fergusson et al., 2020, 2021a, 2022b, 2023a, 2023b, 2023c).

This basic and applied research program measuring the effects of Transcendental Meditation has centered on three main fields of investigation: A) physiological; B) psychological; and C) sociological. Of the first field, focus areas have included metabolic, biochemical, electrophysiological, electroencephalographic, and cardiovascular changes and salutary changes to health more broadly. Of the second field, focus areas have included verbal and non-verbal intelligence, learning, academic performance, and development of personality. And of the third field, focus areas have included rehabilitation, productivity, and quality of life. Each of these three fields of research and the focus areas within them can be viewed as mutually interdependent and it is this holistic effect of practicing Transcendental Meditation on health and well-being which is of most significance, as will be discussed later in this study.

Of the published peer-reviewed studies on Transcendental Meditation, most have used standardized test instruments and measures. For example, in physiological research, measures include respiration rate, basal cortisol, ultra-weak photon emissions, time-domain phase synchrony, and hypertension using standard medical and neurophysiological instrumentation. For psychological research, measures include memory, creativity, field independence, information processing, anxiety, depression, and post-traumatic stress disorder using instruments like the State-Trait Anxiety Inventory (e.g., Throll, 1981), Personal Wellbeing Index (e.g., Fergusson et al., 2023d), and Perceived Stress Scale (e.g., Nidich et al., 2016). For sociological research, measures include recidivism, leadership behaviour, interpersonal experience, and accidental death rates using instruments like the Social Hospitalization Assessment of Personality and Socialization (e.g., Alexander, Rainforth, & Gelderloos, 1991), Maslach Burnout Inventory-Educators Survey (e.g., Elder et al., 2014), and The Industrial Barometer (e.g., Heaton, Schmidt-Wilk, & Travis, 2004). However, and most importantly for the present study, few if any indigenous test instruments specifically designed to measure the impact of Transcendental Meditation, for example when practiced by children and adolescents in a school setting, have been forthcoming.

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Approximately 25 years ago, the third author of this study developed a Spanish-language questionnaire for use in schools in Peru. Exploring student opinions and self-reports, the aim of the questionnaire was to measure holistic changes in student experience as a result of regularly practicing Transcendental Meditation when it was incorporated into the primary and secondary curriculum. This approach was deemed more practical and less cumbersome for primary and secondary school students than administering separate tests to measure different variables. A detailed description of questionnaire development follows. Taking about 15 minutes to complete, the easy-to-administer, paper-and-pencil test developed in Peru, called the *Test de Autoevaluación de Meditación Transcendental* (i.e., Self-Assessment Test of Transcendental Meditation), has been administered to about 50,000 students who have learned Transcendental Meditation. The purpose of the present study is to statistically examine the reliability and validity of this test instrument, confirm its applicability with school children and adolescents, and modify it where necessary for international application.

Instrument development in Peru

Development of the *Test de Autoevaluación* relied on two main sources of published data. First, topics identified as relevant for school children and adolescents in Perú drew on key areas of education sanctioned by the Peruvian Ministry of Education, specifically elements of the primary and secondary curriculum related to exercise, management of emotions and stress, development of critical thinking and decision making, and mental and emotional strength as they relate to academic performance (Adler, 2016). Second, and most importantly for this study, development of the instrument was informed and guided by prior international research findings on Transcendental Meditation.

As noted above, these international findings have been generally organised into areas such as physiological, psychological, and sociological research. The findings from this international research program have been summarised in Table 1.

Based on these international data, 47 items for use in the *Test de Autoevaluación* were isolated from the literature by the second author. Statements about the practice of Transcendental Meditation were then clustered into four main categories: C1 = physical health (derived from physiological research); C2 = cognitive health; C3 = emotional health (derived from psychological research); and C4 = school performance (derived from sociological research). Table 1 shows the three main fields of international research on Transcendental Meditation, the four categories used in the *Test de Autoevaluación* with the four category names, research findings supportive of the category, and example sources related to the category.

Category 1 (C1) included 13 statements about physical health, with students asked to rate their levels of tiredness, energy, sickness, quality of sleep, and athletic ability as a result of practicing Transcendental Meditation. For example, statement #3 was *Tengo más energia* (I have more energy), statement #5 was *duermo mejor* (I sleep better), and statement #12 was *Mis problemas de salud han disminuido* (My health complaints have decreased).

Category 2 (C2) included ten statements related to cognitive health, with students asked to rate their memory, comprehension, and problem-solving ability as a result of practicing Transcendental Meditation. For example, statement #1 was *Mi memoria ha mejorado* (My memory has improved), statement #4 was *Entiendo major las cosas* (I understand things more), and statement #10 was *Encuentro soluciones a los problemas más rápido* (I find solutions to problems faster).

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Category 3 (C3) included 12 statements related to emotional health, with students asked to rate their aggression, affective relations, friendliness, and happiness as a result of practicing Transcendental Meditation. For example, statement #5 was *Soy menos agresiva/agresivo* (I am less aggressive), statement #7 was *Confio en mi* (I trust myself), and statement #11 was *Me siento mas confiado en lo que hago* (I feel more confident in what I do).

Table 1

International research findings on Transcendental Meditation used to guide development of the Test de Autoevaluación to measure holistic student health in Peru

Field of Research	Category Name Used on the Test de Autoevaluación	Research Finding	Example Sources of Data
A. Physiological Research	Physical Health (Category 1)	Increased Alertness and Decreased Tiredness	Doan (1990); Fergusson, Ortiz Cabrejos, & Bonshek (2020); Jonsson (1989)
		Increased Energy	Alexander et al. (1990); Nidich et al. (2015)
		Reduced Sickness	Orme-Johnson, Alexander, & Hawkins (2005); Perkins & Aquino-Russell (2017)
		Improved Quality of Sleep	Travis et al. (2009); Wendt et al. (2015)
		Improved Overall Health	Orme-Johnson (1987); Smith et al. (1990)
B. Psychological Research	Cognitive Health (Category 2)	Improved Memory	Dillbeck & Szal (1989); O'Halloran et al. (1985)
		Increased Comprehension	Dillbeck et al. (1986); Nataraj & Radhamani (1989)
		Improved Problem-Solving Ability	Nidich, Schneider, Nidich, & Foster (2005); Travis (2014)
		Improved Ability to Focus	Dillbeck et al. (1986); Gelderloos, Lockie, & Chuttoorgoon (1987)
		Increased Learning Ability	Jedrczak, Toomey, & Clements (1986); Nidich et al. (2011); Valosek et al. (2019)
	Emotional Health (Category 3)	Increased Optimism	Bloomfield (1977); Brown (1989); Elder et al. (2014).
		Reduced Aggression	Benn (2003); Shourie (2012); Walton & Levitsky (2003)
		Increased Friendliness	Fehr, Nerstheimer, & Torber (1977); Gelderloos (1987)
		Improved Interpersonal Relations	Rosaen & Benn (2006); Sandhu & Kaur (1999)
		Increased Happiness	Alexander, Rainforth, & Gelderloos (1991); Bleasdale, Peterson, & Nidich (2019); Wendt et al. (2015)
		Increased Confidence	Singh & Kaur (2008); Trama & Cheema (2016)
C. Sociological Research	School Performance (Category 4)	Improved Academic Achievement	Nidich & Nidich (1989); Vela Valenzuela, Dillbeck, & Sacristán Rock (2022); Wallace, Orme-Johnson, Mills, & Dillbeck (1984)
		Friendliness Toward Classmates	Ng, Nidich & Nidich (2021)
		Decreased Drop-out Rate and Truancy	Colbert (2013)
		Increased Efficiency at School	Cranson et al. (1991); Dillbeck & Orme-Johnson (1987)
		Increased Enthusiasm and Satisfaction	Gaylord et al. (1989); Levine (1972)

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Category 4 (C4) included 12 statements related to academic and general performance at school, with students asked to rate their satisfaction and efficiency at school, getting along with classmates, academic achievement, and truancy as a result of practicing Transcendental Meditation. For example, statement #1 was *Me siento satisfecho en mi colegio* (I feel satisfied in my school), statement #3 was *Hago más cosas en menos tiempo* (I do more things [at school] in less time), and statement #12 was *La rutina de trabajo es más divertida* (the work routine [at school] is more fun).

The overall purpose of the *Test de Autoevaluación* was thus to measure the holistic effects of Transcendental Meditation and to capture student data on a wide range of impacts.

Two versions of the *Test de Autoevaluación* were developed. Both versions use the same 47 statements requiring a response but the first (developed in 2000) allowed only binary 'Yes/No' responses while the second (developed in 2020) required a self-reported rating on a 1–10 Likert scale. On this scale, 1–3 represented 'definitely disagree', 4–5 represented 'disagree', 6–7 represented 'agree', and 8–10 represented 'definitely agree'. Scores of <5.50 on the second version therefore mean that a student definitely disagrees or disagrees with the statement, while scores of ≥5.50 mean the student agrees or definitely agrees with the statement. Three published studies in Perú have reported findings related to the *Test de Autoevaluación*.

The first study using binary responses (scored Yes = 2, No = 1) was carried out with 91 randomly selected school children, ranging in age from 11–16 years, in a remote Peruvian town in the central mountains called Huay-Huay (Fergusson et al., 2021b). Using the *Test de Autoevaluación* to ask students about their experience with Transcendental Meditation, the study considered whether or not the practice impacted their personal and academic lives, and if so to what extent.

Cronbach alpha coefficients computed for scale reliability of a) statements within categories, b) categories in relation to each other, and c) to the overall construct of holistic health (i.e., the combined score of all categories) yielded internal consistencies of C1 Cα = .52, C2 Cα = .60, C3 Cα = .55, and C4 Cα = .62, Cα = .81 for average reliability between categories, and Cα = .86 for reliability of all categories combined. Data indicated a majority of school children in Huay-Huay self-reported benefit from practicing Transcendental Meditation across all four categories, with 73 %, 81 %, 86 %, and 82 % of students agreeing that practice of Transcendental Meditation had improved their physical, cognitive and emotional health, and school performance. These findings were not influenced by gender, age or grade level.

The second study asked students to rate their experience with Transcendental Meditation using the ten-point Likert scale and sampled 520 students, ranging in age from 10–17 years at four schools in Peru (Fergusson et al., 2022a). Cronbach alpha coefficients computed for scale reliability of the combined score of all categories was Cα = .92. Data also indicated a majority of children in the four schools reported benefit from the practice of Transcendental Meditation across all four categories: 59 %, 69 %, 77 %, and 79 % of students agreed that practicing Transcendental Meditation had improved their physical, cognitive and emotional health, and school performance. These findings indicated the average response to all categories in School #1 was 6.94, in School #2 was 6.38, in School #3 was 6.31, and in School #4 was 6.63, average scores which mean students consistently agreed with statements that Transcendental Meditation benefited their health and school performance. Findings showed the total average scores for all participants ≥5.50 (i.e., an average response of

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agree/definitely agree) for C1 = 6.34, for C2 = 7.65, for C3 = 7.72, and for C4 = 7.88, with an average total score of 7.39 on the ten-point scale.

The third study conducted at Institución Educativa Privada Prescott in Puno using the ten-point Likert scale explored the experience of 107 volunteer primary and secondary students, ranging in age from 10–17 years (Fergusson et al., 2022b). These students were divided into two groups: Group A, students who meditated together in their classes at school prior to the COVID-19 pandemic, consisted of 53 students; and Group B, students who meditated together online at the same time while in home isolation during the COVID-19 pandemic, consisted of 54 students.

Findings suggest 47 % of participants (25 out of 53) and 56 % of participants (30 out of 53) in Group A agreed or definitely agreed their C1 physical health and C2 cognitive health, respectively, had benefited from the practice of Transcendental Meditation before home isolation, while 100 % of participants (54 out of 54) and 96 % of participants (52 out of 54) in Group B agreed or definitely agreed they had benefited from the practice while in home isolation. Similarly, 60 % of participants (32 out of 53) and 57 % of participants (30 out of 53) in Group A agreed or definitely agreed that their C3 emotional health and C4 school performance respectively had benefited from the practice of Transcendental Meditation before home isolation, while 96 % of participants (52 out of 54) and 98 % of participants 53 out of 54) in Group B agreed or definitely agreed they had benefited from the practice while in home isolation.

Average responses to all categories for Group A = 6.38 and for Group B = 7.62, meaning students in both Groups generally agreed with statements that practicing Transcendental Meditation had benefited their health and school performance before (Group A) and during (Group B) the pandemic. Again, these findings were not influenced by gender, age or grade level.

Previous publications (e.g., Fergusson et al., 2021b, 2022a, 2022b) reported results based upon scoring the *Test de Autoevaluación* according to the original four-category conceptualization of the instrument, rather than an empirically based analysis of the factor structure of the instrument. The objectives of the present study therefore were to investigate: A) whether the four-category structure of the original *Test de Autoevaluación* is valid when measured using factor analysis; B) whether the category structure needs modification; and C) whether the factor structure of the instrument, if modified, is consistent for different age and gender subgroups (i.e., primary school versus secondary school, and girls versus boys).

We anticipated that practice of Transcendental Meditation by school children and adolescents in Perú would have holistic and measurable effects, and therefore all (or most) items on the *Test de Autoevaluación* would be intercorrelated, and a latent variable (or variables) would underlie intercorrelations among the items. We conjectured that the instrument would have a meaningful total score.

2. METHOD

Participating schools and students

The following school and student were supplied by *Instituto Maharishi de Ciencia y Tecnología del Perú*. Six primary and secondary schools in Peru participated in this research. One thousand, one hundred and eighty-one students completed the *Test de Autoevaluación* in 2023. Table 2 identifies the participating schools and the number of students from each school who completed the questionnaire. In Peru, compulsory education is

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organised into primary and secondary levels, with six grades in each. In the present study, students in 4th grade primary (9–10 years old), 5th grade primary (10–11 years old), 6th grade primary (11–12 year olds), 1st grade secondary (12–13 year olds), 2nd grade secondary (13–14 year olds), 3rd grade secondary (14–15 year olds), 4th grade secondary (15–16 year olds), and 5th grade secondary (16–17 year olds) participated in the study. Of the 1,181 students who participated, 667 were primary school and 514 were secondary school students, and 610 were girls and 571 were boys.

Table 2

Participating schools and student participants

Participating School	Total Enrolment in Year Data Were Collected	Number of Participating Students	Age Range of Participating Students
Institución Educativa Emblemática Cesar Vallejo	1,400	413	9–13
Institución Educativa Privada Prescott	300	53	12–17
Institución Educativa Colegio Santa María Reyna	400	70	10–17
Colegio Tomasa Ttito Condemayta	600	351	12–17
Hogar de Niñas Virgen de Fatima de Chejoña	75	36	12–17
Glorioso Colegio Nacional de San Carlos	1,500	258	9–13
Total	**4,275**	**1,181**	**9–17**

School #1: Institucion Educativa Emblematica Cesar Vallejo, a government-run public school, is located in the La Victoria district of central Lima. La Victoria is one of the most densely populated and dangerous areas of Lima and is home to about 185,000 people within its 8.7km^2 area. It is mainly a residential community, with barrios (i.e., slums) in the north, pueblos jóvenes (i.e., squatter settlements) in the east, and middle-income housing in the south, but with high levels of crime and unemployment throughout the district. Cesar Vallejo has an enrolment of 1,400 mostly disadvantaged students across all primary and secondary grade levels. Transcendental Meditation was introduced into the curriculum in 2014, with approximately 2,000 students instructed in the practice between 2014–2019.

School #2: Institución Educativa Privada Prescott, a private school, is located in the city of Puno on Lake Titicaca in the southeast of the country. Puno is home to the Aymara people, a continuous pre-Incan civilization living at 3,800m on the Altiplano in the Andean highlands. With a total population of about 3.0 million people, the Aymara are distributed across eastern Bolivia, southern Perú and northern Chile, with the largest group concentrated in the Lake Titicaca region. The Prescott school, established in 1992 to offer primary and secondary education, seeks to develop the values of honesty, work, social sensitivity, responsibility towards the community, and respect for the family, the homeland and the globalized world. Approximately 300 students attend the school, with 2,000 students having been instructed in Transcendental Meditation since 1998.

School #3: Institución Educativa Colegio Santa María Reyna, a private school, is located in the Ventanilla district of the Constitutional Province of Callao. Approximately 500,000 people inhabit the coastal region of Callao, but Ventanilla is an underprivileged district and was mostly deserted until about 40 years ago. Colegio Santa María Reyna seeks to develop student potential by not only conforming to the National Curriculum but also by incorporating what it calls 'alternative methodologies'. The school has an enrolment of 400 students, with

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Transcendental Meditation introduced into the primary and secondary curriculum in 2016; approximately 500 students have been instructed in the practice over five years.

School #4: Colegio Tomasa Ttito Condemayta, a government-run public school, is located in the Acomayo district of Cusco. In addition to its unique geographic location high in the Andes at 3,300m, the Acomayo district is populated by 24,000 mostly indigenous Quechua who, like the Aymara of Puno, are a pre-Incan people of Perú, Bolivia, and Chile. This secondary school, named after Doña Tomasa Ttito Condemayta Hurtado de Mendoza (1729–1781) a leading force in the indigenous uprising against Spanish colonial rule under King Tupac Amaru II in the 18th century, has approximately 600 students with almost all of them having learned Transcendental Meditation during 2019.

School #5: Hogar de Niñas Virgen de Fatima de Chejoña, an all-girls Centro de Acogida Residencial (or residential shelter centre) located about 30km southeast of Puno's central district two kilometres from the eastern bank of Lake Titicaca at an altitude of 3,800m, high on Perú's Altiplano. Girls at Hogar de Niñas attend local primary and secondary schools, but live and are cared for at the residential shelter.

School #6: Glorioso Colegio Nacional de San Carlos is famous throughout Perú because it was founded in 1825 by Simón Bolívar, the military and political leader who led Colombia, Venezuela, Ecuador, Perú, Panama, and Bolivia to independence from the Spanish. San Carlos, with approximately 1,500 students across all primary and secondary grade levels, also located at an altitude of 3,800m, is a government-run school located in Puno on the eastern banks of Lake Titicaca in the country's southeast. About 5,000 students attending San Carlos have been instructed in Transcendental Meditation between 1997 and 2022, including 600 in 2022.

Data for responses obtained from the six participating schools were entered for all 47 items of the Test de Autoevaluación, along with student characteristics on age, gender, and grade level. Data were complete for all students and items, with no missing data. Three items on the Test de Autoevaluación were not included in analysis of the factor structure of the instrument, two because they were not directly related to assessment of academic outcomes or core factors affecting educational experience, and a third was concerned with school attendance, resulting in 44 items at the conceptual model stage. A further item was dropped from the conceptual model because of poor fit with factor groupings of other items. Therefore 43 items were included in the final factor analysis.

Data analysis

The investigation proceeded in three stages. In the first stage, we constructed a model of the factor structure of the *Test de Autoevaluación* derived from the first dataset. In the second stage, we cross-validated the structural model on a separate dataset. In the third stage, we compared factor loadings of the *Test de Autoevaluación* items among demographic subgroups of the data, i.e., between primary school grade levels versus secondary school grade levels, and between girls versus boys. Statistical software programs used were: SPSS ver. 29 and AMOS ver. 29. So that the model obtained from the first stage could be validated on a separate set of data at the second stage of analysis, responses from each of the six schools were divided equally into two halves. Half of the data from the six schools formed the initial model development sample (n = 590), upon which construction of the structural model of the instrument in stages 1 and 2 was based. The other half of data (n = 591) formed the cross-validation sample upon which validity of the structural model was assessed and validated at the second stage.

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In the first stage of the investigation, a model of the factor structure of the *Test de Autoevaluación* was constructed and tested against the study data. First, a conceptual model of the factor structure was formulated, based on the theoretical considerations that guided the development of the instrument. As a result of inspecting the content of the instrument, microclusters of items were identified and served as the basis for building a conceptual model of the factor structure of the instrument. The conceptual model was subsequently tested by performing exploratory factor analysis and confirmatory factor analysis. To formulate the conceptual model, we started by considering the 14 microconstructs that served as the basis for writing the items of the *Test de Autoevaluación* when the instrument was originally developed. For each microconstruct there was an initial conceptual cluster of items, as shown in Table 3.

Table 3

Clustered items grouped conceptually to assess effects of Transcendental Meditation

Microconstruct Name and Items
1. More alertness and less tiredness
I am less tired than before
I am more alert and awake
I feel less tired
2. Increased energy
I have more energy
I go home from school with more energy
3. Decreased anxiety
I worry less than before
I am less nervous
I am less anxious and tense
4. Increased self-confidence
I trust in myself
I feel more confident in what I do
5. Improved efficiency
I have more time to enjoy with my friends and my family
I get things done more easily
My efficiency has increased
I do more things in less time
I achieve more than before
6. More positive emotions
I am a more enthusiastic person
I am more optimistic
I am less aggressive
I am more enthusiastic in what I do
I have more good humour
7. Improved ability to focus
I am more able to focus
I am more persistent in what I do
8. Increased happiness
I feel more satisfied
I feel predominantly happy
I feel satisfied in my school
I feel happier with my family
The work routine is more fun
9. Improved physical health
I don't get sick as often
My health complaints have decreased

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Table 3

Clustered items grouped conceptually to assess effects of Transcendental Meditation (continuation)

Microconstruct Name and Items
10. Enhanced learning ability
My ability to study has improved
I understand things more now
11. Improved memory
My memory has improved
I remember things more now
12. Better interpersonal relations
I get along better with people
I am less shy
I have more friends
My affective relationships improved
I get along better with my classmates
13. Improved sleep quality
I sleep better
I no longer suffer from insomnia
14. Improved thinking ability
I find solutions to problems faster
I have more original ideas
I am better able to put my ideas into practice
I make up my mind more precisely

Because in a confirmatory factor analysis there should be at least three measured variables (i.e., items on the *Test de Autoevaluación* in our case) for each latent variable (factor), the initial grouping of items was rearranged by merging some of the clustered items together, taking into account the content of items, which resulted in a smaller final conceptual cluster of items. Principal component analysis was used to ascertain whether the grouping of items into clusters was consistent with data for the model development sample. In addition, principal component analysis was performed on the items within each final conceptual cluster of items to check that each cluster was comprised of a single homogeneous factor and that all items in the cluster had high loadings on the factor.

The conceptual model of the factor structure was represented as a structural equation model (SEM), which was fit to the data by performing confirmatory factor analysis in AMOS using the maximum likelihood method. The SEM was comprised of latent variables (factors), indicator variables (i.e., items on the *Test de Autoevaluación*), and disturbance variables to account for residual variance. In the SEM, for each cluster of items there was a latent variable, representing a factor underlying all the items in the cluster. Standardised regression coefficients from the confirmatory factor analysis yielded factor loadings for the *Test de Autoevaluación* items on the latent variables. Items with factor loadings of at least 0.4 on the same latent variable formed a subscale. To represent a total scale comprised of the subscales, the SEM also included a higher order factor underlying the factors associated with the subscales. A model solution that was estimated using confirmatory factor analysis was admissible only if all variances for the latent variables and residuals were positive.

Goodness of fit of the model solution was evaluated based on fit indices commonly reported for confirmatory factor analysis (i.e., a goodness of fit index, GFI). The goodness of fit was also compared against the goodness

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of fit of alternative models. Potential alternative models were identified based on combining a pair of latent variables by merging clusters of items associated with them into a single cluster with a single underlying it, or by switching an item from one latent variable cluster to another. Construction of alternative models by merging clusters was performed only when consistent with the content of the relevant items. Construction of alternate models did not allow for correlations between disturbance variables as this would yield models that were not grounded in theory. Alternative models were compared by comparing fit indices and model parsimony based on the Akaike Information Criteria (AIC).

Replicability of model fit across the model development and cross-validation subsamples was performed using the compare groups feature of Amos. This feature was also used to compare the fit across demographic subgroups. Model comparison was based on examining the factor loadings for subsamples, as well as examining the p-value for the overall difference between the subsamples being compared in the measurement weights obtained for the model. In view of the large sample size, the alpha level for this comparison was set at .01. Screening for potential univariate outliers in the *Test de Autoevaluación* items was performed by examining box plots. Potential multivariate outliers were identified by calculating Mahalanobis distances for the clusters of items comprising the latent variables in the structural equation model of the *Test de Autoevaluación.*

3. RESULTS

Descriptive statistics and outliers. The model development subsample and the cross-validation subsample were similar on age and gender (see Table 4). Means of the items of the *Test de Autoevaluación* were between 5.67 and 8.34; standard deviations ranged from 2.22 to 3.44.

Table 4

Descriptive statistics of the model development subsample and the cross-validation subsample by school level

	Model Development Subsample	Cross-Validation Subsample
Primary Level		
Number of students	316	306
Age, mean±SD	10.9±0.9	10.9±0.9
% male	43.4%	41.8%
Secondary Level		
Number of students	240	253
Age, mean±SD	14.3±1.4	14.2±1.4
% male	53.8%	54.2%
Both Primary and Secondary Levels		
Number of students	556	559
Age, mean±SD	12.4±2.0	12.4±2.0
% male	47.8%	47.4%

The univariate distributions of all items were approximately normal, as evidenced by skewness and kurtosis statistics less than 2.0 in absolute value. There were no univariate outliers. A total of 66 multivariate outliers were excluded from the data; 561 responses in the model development subsample and 554 responses in the cross-validation subsample were included in the data analyses.

Results of model development and cross-validation. The model development process resulted in a model that included 43 items of the Test de Autoevaluación, five subscales corresponding to factors underlying groups of

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items, as shown in Table 5, and a total scale corresponding to a higher order factor underlying the subscales. Table 5 shows fit indices for the final model, compared to scoring based on the four- category structure of the original Test de Autoevaluación, as well as alternatives to the final model. Alternative models that were explored were based upon either four or three subscales instead of the final five subscales, or upon merging all items into one total scale. Alternative models with four or three subscales were formed from the final model with five subscales by merging pairs of subscales with the highest intercorrelations.

Table 5

Fit statistics for the final model and alternative models, based on the model development subsample

Model	AIC	CFI	GFI
Original scoring of the Test (four categories)	3735.688	0.801	0.748
Final model (five factors, plus total scale)	2929.162	0.861	0.804
Alternative model 1 (four factors, plus total scale)	3042.241	0.857	0.803
Alternative model 2 (three factors, plus total scale)	3093.075	0.854	0.800
Alternative model 3 (total scale only)	3610.407	0.810	0.734

As shown in Table 5, comparison of the AIC numbers indicated that the final model was the most parsimonious choice, while also providing the best fit statistics—with the final model having the highest values of comparative fit index (CFI) and the goodness of fit index (GFI). Fit for the final model was substantially better than fit for the original four-category structure, and also compared to fit of the model that included a total scale but no subscales.

Table 6 shows model fit indices for final model, based upon the model development subsample and the cross-validation subsample. The values for the two subsamples of root mean square error of approximation (RMSEA) were <.08 and the ratios of χ2/df were between 2.0 and 5.0, suggesting adequate fit. The values of CFI are slightly below the target level of 0.90, however, when fitting models with large numbers of indicator variables more relaxed cutoff thresholds for adequate CFI are appropriate (Hair et al., 2010). In the final model, one item related to tiredness (i.e., 'I am less tired than before') was dropped from the model due to insufficient loading and was not included in any subscale. One item from microcluster 1) More alertness and less tiredness ('I am more alert and awake') and microcluster 2) Increased energy, together with the item 'I sleep better' from microcluster 13, formed a four-item subscale which was labelled 'Alertness and energy'. Items from microclusters 3) Decreased anxiety and 9) Improved physical health, an item assessing improved sleep from microcluster 13 ('I no longer suffer from insomnia'), and an item assessing decreased aggressiveness from microcluster 6 ('I am less aggressive') formed an eight-item subscale that was labelled 'Physical and mental health'.

Table 6

Fit statistics for the confirmatory factor model of the Test de Autoevaluación for the model development subsample and in the cross-validation subsample

Subsample	χ^2	*df*	χ^2/df	RMSEA	CFI	GFI
Model development	2749.16	856	3.21	0.063	0.875	0.804
Cross-validation	2530.24	856	2.95	0.059	0.867	0.812

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Items from microclusters relating to 10) Enhanced learning ability, 11) Improved memory, 14) Improved thinking ability, along with one item from microcluster 7 ('I am more able to focus'), were grouped together to form an eight-item subscale, which was labelled 'Cognitive performance'. The largest subscale, comprised of 18 items, was formed by merging microclusters 4) Increased self-confidence, 5) Improved efficiency, 6) More positive emotions, and 8) Greater happiness, along with one item from microcluster 7 ('I am more persistent in what I do') and with one item from microcluster 14 ('I make up my mind more precisely'). In view of the content of these items, the subscale was interpreted as indicative of 'Emotional and behavioural self-regulation'. Items on efficiency were included in this subscale because they were highly correlated with other items in the subscale (r = .96).

The five-item microcluster 12) Better interpersonal relations formed a subscale and was given the label 'Interpersonal relations'. In the final version of the model, each of the 43 items loaded on one, and only one, factor (Table 7). Therefore, the set of items comprising each subscale was separate from items comprising other subscales and each subscale was unidimensional. This was confirmed by principal component analysis, which showed there was just one factor underlying the items comprising each subscale. Loadings of the items on each subscale were positive and were all above 0.4.

Table 7

Loadings of each item in the five subscales of the Test de Autoevaluación in the model development subsample and the cross-validation sample

Subscales and Items	Model Development Subsample	Cross-Validation Subsample	Difference
1. Alertness and energy			
I am more alert and awake	0.66	0.64	–0.02
I sleep better	0.58	0.56	–0.02
I have more energy	0.71	0.60	-0.11
I go home from school with more energy	0.60	0.58	-0.02
2. Physical and mental health			
I don't get sick as often	0.55	0.53	–0.02
My health complaints have decreased	0.66	0.63	–0.03
I no longer suffer from insomnia	0.59	0.53	–0.06
I feel less tired	0.58	0.61	0.03
I worry less than before	0.64	0.68	0.04
I am less nervous	0.69	0.66	–0.03
I am less anxious and tense	0.65	0.60	–0.05
I am less aggressive	0.49	0.54	0.05
3. Cognitive performance			
I am more able to focus	0.71	0.73	0.02
My ability to study has improved	0.58	0.54	–0.04
I understand things more now	0.72	0.77	0.05
My memory has improved	0.71	0.74	0.03
I remember things more now	0.66	0.67	0.01
I find solutions to problems faster	0.67	0.65	–0.02
I have more original ideas	0.71	0.69	–0.02
I am better able to put my ideas into practice	0.70	0.62	–0.08

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Table 7

Loadings of each item in the five subscales of the Test de Autoevaluación in the model development subsample and the cross-validation sample (continuation)

Subscales and Items	Model Development Subsample	Cross-Validation Subsample	Difference
4. Emotional and behavioural self-regulation			
I am a more enthusiastic person	0.65	0.70	0.05
I am more optimistic	0.61	0.65	0.04
I am more enthusiastic in what I do	0.76	0.79	0.03
I have more good humour	0.63	0.60	–0.03
I feel more satisfied	0.71	0.72	0.01
I feel predominantly happy	0.60	0.59	–0.01
I feel satisfied in my school	0.61	0.60	–0.01
I feel happier with my family	0.55	0.51	–0.04
The work routine is more fun	0.67	0.66	–0.01
I trust in myself	0.64	0.62	–0.02
I feel more confident in what I do	0.68	0.66	–0.02
I am more persistent in what I do	0.75	0.74	–0.01
I make up my mind more precisely	0.67	0.68	0.01
I get things done more easily	0.62	0.57	–0.05
My efficiency has increased	0.74	0.75	0.01
I do more things in less time	0.69	0.68	–0.01
I achieve more than before	0.70	0.66	–0.04
I have more time to enjoy my friends and family	0.52	0.53	0.01
5. Interpersonal relationships			
I get along better with people	0.73	0.78	0.05
I am less shy	0.67	0.72	0.05
I have more friends	0.66	0.70	0.04
My affective relationships improved	0.48	0.47	–0.01
I get along better with my classmates	0.67	0.72	0.05

As shown in Table 8, the average loadings on each subscale were similar for the two subsamples. Therefore, the items comprising each subscale were the same in both subsamples. Loadings of the subscales on the total scale were similar in the two subsamples and ranged from 0.70 to 0.98 (Table 9).

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Table 8

Comparison of factor loadings on the Test de Autoevaluación subscales in the model development subsample and in the cross-validation subsample

	Subscale Loadings for Model Development Subsample		Subscale Loadings for Cross-validation Subsample	
Subscale	Average Loading	Range (Min–Max)	Average Loading	Range (Min–Max)
1. Alertness and energy	0.64	0.60–0.69	0.59	0.52–0.63
2. Physical and mental health	0.65	0.57–0.71	0.63	0.53–0.69
3. Cognitive performance	0.67	0.57–0.75	0.67	0.53–0.73
4. Emotional and behavioural self-regulation	0.64	0.46–0.75	0.64	0.47–0.80
5. Interpersonal relationships	0.67	0.50–0.76	0.65	0.47–0.74

Cronbach alpha coefficients for the subscales and total scale were all above 0.7 and were similar on the total scale and the three subscales with seven or more items (Table 10). The *p*-value for the comparison of groups on structural coefficients was not significant (p = .98). Taken together, evidence indicates adequate fit of the structural equation model and replication of the factor structure of the Test de Autoevaluación across the two subsamples.

Table 9

Loadings of the subscales on the total scale in the model development subsample and in the cross-validation subsample

Subscale	Model Development Subsample	Cross-Validation Subsample
1. Alertness and energy	0.91	0.89
2. Physical and mental health	0.72	0.72
3. Cognitive performance	0.88	0.94
4. Emotional and behavioural self-regulation	0.97	0.97
5. Interpersonal relationships	0.88	0.84

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Table 10

Cronbach's alpha coefficients for the Test de Autoevaluación subscales and total scale in the model development sample and in the cross-validation sample

		Alpha Coefficients	
Subscale and Total Scale	No. of items	Model Development Subsample	Cross-validation Subsample
1. Alertness and energy	4	.76	.72
2. Physical and mental health	8	.84	.83
3. Cognitive performance	8	.91	.90
4. Emotional and behavioural self-regulation	18	.94	.94
5. Interpersonal relationships	5	.79	.82
Total Scale	**43**	**.96**	**.97**

Comparison of factor structure for demographic subgroups. Cross-validation was performed using the compare groups feature of Amos. This feature was also used to compare the fit across demographic subgroups.

Table 11

Comparison of factor loadings on the Test de Autoevaluación subscales in the primary school grades subscale and in the secondary school grades subsample

	Subscale Loadings for Primary School Grades		Subscale Loadings for Secondary School Grades	
Subscale	Average Loading	Range (Min–Max)	Average Loading	Range (Min–Max)
1. Alertness and energy	0.62	0.55–0.68	0.60	0.58–0.62
2. Physical and mental health	0.65	0.56–0.70	0.53	0.42–0.62
3. Cognitive performance	0.69	0.58–0.74	0.66	0.55–0.73
4. Emotional and behavioural self-regulation	0.66	0.46–0.80	0.63	0.52–0.72
5. Interpersonal relationships	0.67	0.50–0.76	0.64	0.43–0.74

Primary school grade levels versus secondary school grade levels. The *p*-value for the comparison of factor loadings in the primary school subsample versus the secondary school subsample was statistically significant ($p < .001$). However, the average item loadings on four out of the five subscales were similar in the two subsamples, with the exception of the physical and mental health subscale (see Table 11). Nevertheless, all item loadings were above 0.4. Hence, the items comprising each subscale were the same in both subsamples, and therefore the composition of subscales is consistent across both subsamples and no distinction between how the instrument tested primary school students and secondary school students could be observed. Cronbach's alpha coefficients were greater than 0.7 for all subscales in both subsamples, as shown in Table 12.

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Table 12

Cronbach's alpha coefficients for the Test de Autoevaluación subscales and total scale in the primary school grades subsample and in the secondary school grades subsample

		Alpha Coefficients	
Subscale and Total Scale	No. of Items	Primary School Grades	Secondary School Grades
1. Alertness and energy	4	.74	.71
2. Physical and mental health	8	.86	.77
3. Cognitive performance	8	.91	.88
4. Emotional and behavioural self-regulation	18	.94	.93
5. Interpersonal relationships	5	.82	.78
Total Scale	**43**	**.97**	**.96**

Boys versus girls. The *p*-value for comparison of the factor loadings in the girls subsample versus the boys subsample was not statistically significant ($p = .24$). However, the average item loadings on the five subscales were similar in the two subsamples (see Table 13). All item loadings were above 0.4. Hence the items comprising each subscale were the same in both gender subsamples, and therefore the composition of subscales is consistent across both subsamples and no distinction between how the instrument tested girls and boys could be observed. Cronbach's alpha coefficients were greater than 0.7 for all subscales in both subsamples, as shown in Table 14.

Table 13

Comparison of factor loadings on the Test de Autoevaluación subscales in the subsamples of girls and boys.

	Subscale Loadings for Girls		Subscale Loadings for Boys	
Subscale	Average Loading	Range (Min–Max)	Average Loading	Range (Min–Max)
1. Alertness and energy	0.59	0.55–0.64	0.64	0.61–0.68
2. Physical and mental health	0.61	0.53–0.69	0.58	0.49–0.69
3. Cognitive performance	0.69	0.56–0.74	0.67	0.56–0.74
4. Emotional and behavioural self-regulation	0.67	0.55–0.78	0.64	0.49–0.76
5. Interpersonal relationships	0.68	0.50–0.78	0.64	0.45–0.73

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Table 14

Cronbach's alpha coefficients for the for the Test de Autoevaluación subscales and total scale in subsamples of girls and boys

		Alpha Coefficients	
Subscale and Total Scale	No. of items	Girls	Boys
1. Alertness and energy	4	.71	.77
2. Physical and mental health	8	.84	.82
3. Cognitive performance	8	.91	.90
4. Emotional and behavioural self-regulation	18	.94	.93
5. Interpersonal relationships	5	.83	.79
Total Scale	**43**	**.96**	**.96**

4. DISCUSSION AND CONCLUSION

The four-category structure of the original Test de Autoevaluación was valid when assessed against international findings using face validity, but when measured using factor analysis five latent subscales not four were identified and thus the structure of Test de Autoevaluación needs modification. Confirmatory factor analysis in the present study clearly shows that the five-factor structure of the final model provides a better fit for the Test de Autoevaluación compared to the four-category structure based upon the original conceptualization of the instrument.

In the original Test de Autoevaluación, C1 was related to physical health composed of 13 statements, but this category has now been broken into two subscales: 'Alertness and energy' (four items) and 'Physical and mental health' (eight items). Loadings on this subscale were somewhat lower in the secondary school subsample (i.e., 0.42–0.62 for secondary students versus 0.56–0.70 for primary students), but we can perhaps attribute this difference to changes associated with adolescence; more importantly item loadings for the secondary subsample were still well within acceptable statistical limits.

The original C2 category with 10 items is largely unchanged as a construct and has been renamed 'Cognitive performance' (eight items). The original C3, which related to emotional health with 12 items, now includes behavioural self-regulation and has been expanded to 18 items called 'Emotional and behavioural self-regulation'.

A new subscale related to 'Interpersonal relationships' consisting of five items has entirely replaced the C4 school performance category, which initially had 12 items. Items related to school performance have been amalgamated into other subscales because they did not accurately represent a latent factor. For example, statements *Me siento satisfecho en mi colegio* ('I feel satisfied in my school') and *La rutina de trabajo es más divertida* ('The work routine is more fun') from C4 both loaded convincingly (0.60–0.67) to the 'Emotional and behavioural self-regulation' subscale. The five new subscales are thus more nuanced and valid than the original four categories and have been organised according to Figure 1.

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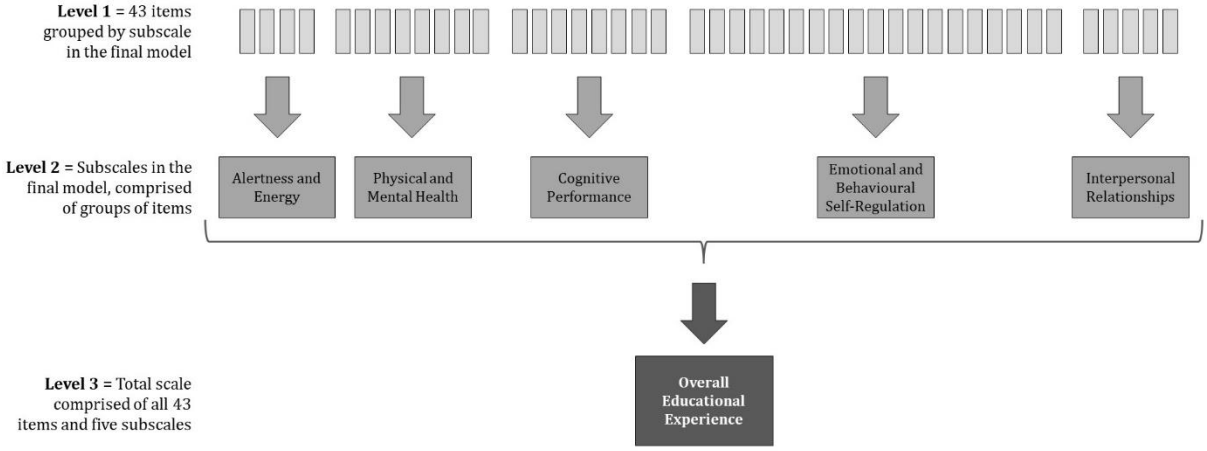
Figure 1

Three levels of psychometric organisation and their relations of 43 clustered items (top), five subscales (middle), and one main factor or total scale (bottom)



Excluding the aforementioned minor difference in 'Physical and mental health' between grade levels, the subscales are largely consistent for different age groups (i.e., primary school scores versus secondary school scores) and for different genders (i.e., girls' scores versus boys' scores). In psychometric theory, Cronbach's alpha coefficients between *Cα* .96–.97, as observed in this study for the total scale, are considered extremely reliable and thus rated as 'excellent' in health research (Izah, Sylva, & Hait, 2023). They were also higher than the values for Cronbach's alpha reported in previous studies that used the *Test de Autoevaluación*: *Cα* = .86 (Fergusson et al., 2021b) and *Cα* = .92 (Fergusson et al., 2022a). Moreover values of alpha for the new subscales, which ranged from *Cα* = .72–.94 were markedly higher than the alpha values for the original categories, which ranged from *Cα* = .52–.62 (Fergusson et al., 2022a).

We anticipated that practise of Transcendental Meditation by school children and adolescents in Perú would have holistic and measurable effects, and that all (or most) items on the *Test de Autoevaluación* would be intercorrelated, with a latent variable (or variables) undergirding correlations among items and subscales. Therefore, we conjectured that the instrument would have a meaningful total score. By removing the aforesaid four items, we have demonstrated that all remaining items on the *Test de Autoevaluación* are intercorrelated and that one holistic underlying variable related to the holistic health and development of school children and adolescents is measured by this questionnaire.

This holistic variable can be referred to as the 'enhanced educational experience' of students who practise the Transcendental Meditation technique. Our intention now is to reapply and measure the revised *Test de Autoevaluación de Meditación Transcendental* in more schools in Peru and to begin its application in other international school settings.

Conflicto de intereses / Competing interests:

Los autores declaran que no incurren en conflictos de intereses.

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Rol de los autores / Authors Roles:

Lee Fergusson: Conceptualización, metodología, curación de datos, investigación, recursos, escritura – borrador original, escritura – revisión y edición, visualización, supervisión, administración del proyecto, adquisición de fondos.

Maxwell Rainforth: Metodología, software, validación, análisis formal, investigación, recursos, escritura – borrador original, escritura – revisión y edición, visualización.

Javier Ortiz-Cabrejos: Investigación, recursos, escritura – borrador original.

Anna Bonshek: Conceptualización, escritura – revisión y edición, adquisición de fondos.

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Los autores declaran no haber incurrido en aspectos antiéticos, ni haber omitido aspectos legales en la realización de la investigación.

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