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The teacher-student relationship as a predictive variable of school engagement: The mediating role of subjective well-being in a structural equation model with indigenous students aged 10 to 14 years old

La relación docente-estudiante como una variable predictora del compromiso escolar: el rol mediador del bienestar subjetivo en un modelo de ecuaciones estructurales en estudiantes indígenas de entre 10 y 14 años

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Abstract:

The teacher-student relationship is a key factor in students' academic performance, school engagement, and subjective well-being. However, little is known about how this relationship influences these variables among Indigenous students, particularly Mapuche students in Chile. This study evaluates a predictive model of the teacher-student relationship on school engagement and the role of subjective well-being in this relationship in Mapuche students aged 10 to 14. A cross-sectional design was used, with a sample of 300 students aged 10 to 14. Structural equation modeling (SEM) was employed to analyze the relationships among the teacher-student relationship, school engagement, and subjective well-being. Results revealed a moderate significant direct effect of the teacher-student relationship on school engagement ($\beta = .359$, $p < .001$) and subjective well-being ($\beta = .398$, $p < .001$). Moreover, subjective well-being had a significant positive direct effect on school engagement ($\beta = .402$, $p < .001$), suggesting that students with higher levels of well-being exhibit greater school engagement. An indirect effect was also observed between the teacher-student relationship and school engagement, mediated by subjective well-being ($\beta = .160$, $p < .001$). These findings support the hypothesis that subjective well-being strengthens the impact of teacher-student relationships on school engagement. Although the effect size was small, the statistical power of the findings highlights their relevance. Limitations such as the cross-sectional design -restricting causal inferences- and suboptimal reliability indices in the behavioral dimension of school engagement must be considered in future replications. These findings contribute valuable evidence for the development of culturally relevant educational interventions aimed at improving Indigenous students' engagement and enhancing well-being of Indigenous students. They also underscore

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the urgency of formulating public policies that focus not only on academic achievement but also on the holistic development of students.

Keywords: teacher-student relationship, subjective well-being, school engagement, Mapuche students, Chilean education, intercultural education.

Resumen:

La relación docente-estudiante es un factor clave en el rendimiento académico, el compromiso escolar y el bienestar subjetivo de los estudiantes. Sin embargo, se conoce poco acerca de cómo esta relación influye en estas variables en estudiantes indígenas, en particular en estudiantes mapuche en Chile. Este estudio evalúa un modelo predictivo de la relación docente-estudiante con respecto al compromiso escolar y al rol del bienestar subjetivo en estudiantes mapuche de entre 10 y 14 años. Se utilizó un diseño transversal con una muestra de 300 estudiantes. Para analizar los vínculos entre la relación docente-estudiante, el compromiso escolar y el bienestar subjetivo, se empleó el modelamiento de ecuaciones estructurales (SEM por sus siglas en inglés). Los resultados revelaron un efecto directo moderado y significativo de la relación docente-estudiante sobre el compromiso escolar ($\beta = .359$, $p < .001$) y el bienestar subjetivo ($\beta = .398$, $p < .001$). Asimismo, el bienestar subjetivo mostró un efecto directo positivo y significativo sobre el compromiso escolar ($\beta = .402$, $p < .001$), lo que indica que mayores niveles de bienestar se asocian a un mayor compromiso escolar. También se observó un efecto indirecto entre la relación docente-estudiante y el compromiso escolar, mediado por el bienestar subjetivo ($\beta = .160$, $p < .001$). Estos resultados respaldan la hipótesis de que el bienestar subjetivo actúa como un mediador y fortalece la asociación entre la relación docente-estudiante y el compromiso escolar. Aunque el tamaño del efecto fue pequeño, la potencia estadística de los hallazgos resalta su relevancia. No obstante, deben considerarse en futuras réplicas algunas limitaciones, como el diseño transversal, que restringe la inferencia causal, y los índices de confiabilidad subóptimos en la dimensión conductual del compromiso escolar. En conjunto, estos resultados aportan evidencia valiosa para el diseño de intervenciones educativas pertinentes en el ámbito cultural, que promuevan el compromiso y el bienestar de los estudiantes indígenas. Asimismo, destacan la urgencia de generar políticas públicas focalizadas no solo en lo académico, sino también en el desarrollo integral de los estudiantes.

Palabras clave: relación docente-estudiante, bienestar subjetivo, compromiso escolar, estudiantes mapuche, educación chilena, educación intercultural.

1. Introduction

1.1. The challenges related to interculturality in Chilean school education

School education in Chile comprises twelve mandatory levels (plus two optional levels of preschool education). The twelve mandatory levels are divided into basic education (eight levels) and secondary education (four levels). Drawing a parallel with the North American system, basic education corresponds to elementary and middle school, while secondary education aligns with high school (Ministerio de Educación, 2010).

Intercultural education in Chile aims to promote respect and coexistence among diverse cultures by integrating various aspects of Indigenous peoples, including their language, worldview, and other cultural dimensions, into the educational system (Arredondo & Paidacán, 2023).

In 2023, a dropout rate of 1.66% was recorded, corresponding to 50 814 students who discontinued their studies. This represents an increase of 0.2 percentage points compared to

the 2022 rate (Ministerio de Educación, 2023). Focusing exclusively on students of Indigenous origin, they face significantly higher school dropout rates compared to their non-Indigenous peers. This disproportionate representation in dropout rates is attributed to systemic factors that contribute to educational disparities between Indigenous and non-Indigenous students (Burgess & Lowe, 2022). Some of these systemic factors are related to a disconnect between policy and practice, to socio-economic factors or to discrimination, among others (Burgess & Lowe, 2022; Snijder et al., 2021)

The discrimination exerted by the educational system also manifests in its treatment of Mapuche knowledge, both on personal and structural levels, permeating the school context and influencing the curriculum. This is particularly evident in the implementation of the bilingual intercultural education initiative. Although this initiative originally sought to create specialized schools integrating both Western and Mapuche knowledge (addressing content and language), it ultimately segregated Mapuche culture into a distinct category of institutions. By marginalizing Mapuche students and isolating them from traditional schools, this approach has amplified racism and prejudice against Mapuche identity within the educational system (Arias-Ortega et al., 2023; Quilaqueo-Rapiman, 2023).

The characteristics of the teacher and the presence of the aforementioned elements shape the teacher-student relationship, which influences various educational variables at both the student and teacher levels (such as academic performance, motivation, and learning). Moreover, this relationship is interconnected with variables from other domains, including the subjective well-being of both the teacher and the student (Farhah et al., 2021).

1.2. Teacher-student relationship

The teacher-student relationship, defined by Skinner and Pitzer (2012) as the bond between student and teacher, is determined by the quality of affective ties established between them. According to the model proposed by Sabol and Pianta (2012), this relationship constitutes a dyadic bond characterized by three fundamental dimensions: closeness, conflict, and dependency. These dimensions dynamically interact and significantly influence variables such as academic performance, socioemotional development, and school behavior. Teacher-student relationships characterized as supportive alliances promote student engagement and serve as predictors of motivation and academic performance (Pan & Yao, 2023). Given the issues of racial discrimination and teacher prejudice against Indigenous students in our country, it is crucial to examine the respect and acceptance teachers hold toward Indigenous populations and their cultures, as these aspects are central to fostering a positive sense of identity among Mapuche students (Purdie et al., 2000).

In terms of teacher respect and warmth, the presence of teacher prejudices is evident. These prejudices manifest through various patterns of behavior directed toward Indigenous students in our country and are linked to discriminatory acts. Examples include creating relational distance, conveying low academic expectations, dismissing academic progress, and exhibiting paternalistic attitudes toward Mapuche students (Muñoz-Troncoso et al., 2023). Teachers tend to hold lower educational expectations for Indigenous students (Chen, 2024; Medina & González-Jimenez, 2023). This discrimination is pervasive, occurring across gender, educational levels, and socioeconomic status, significantly undermining the teacher-student relationship for this specific group (Arias-Ortega et al., 2023; Castillo et al., 2022).

The teacher-student relationship is a critical factor influencing students' academic and personal development. A positive relationship between teachers and students fosters an environment conducive to learning, emotional well-being, and social competence. Research indicates that when students perceive their teachers as supportive and caring, they are more likely to experience enhanced self-efficacy, reduced anxiety and mental health issues, and improved academic performance (Oh & Song 2021; Lei et al., 2023; Mallik, 2023; Wanders et al., 2020; Wang, 2024; Zhang et al., 2022; Zou et al., 2024). This supportive dynamic is particularly vital in primary education, where students often seek recognition and emotional support from their teachers, which can significantly influence their motivation and engagement in learning activities (Wang, 2024).

The teacher-student relationship significantly affects several other variables that influence the development of students, such as the subjective well-being and school engagement (Engels et al., 2021). Empirical evidence supports the notion that positive interactions between teachers and students can enhance students' emotional states and their involvement in school activities (Goetz et al., 2021; Mastromatteo et al., 2021). Affective teacher-student relationships are positively correlated with students' school engagement and achievement. When students perceive their teachers as supportive and caring; they are more likely to engage actively in their learning processes, leading to improved academic outcomes. This relationship is particularly crucial as students transition to higher grades, where academic challenges increase, and the need for supportive relationships becomes more pronounced (Sadoughi & Hejazi, 2021).

Quality of the teacher-student relationship directly influences school engagement (Hofkens & Pianta, 2022). Positive relationships with teachers lead to higher levels of school engagement, while negative relationships can result in disengagement. Also, positive teacher-student dynamics foster a sense of belonging and motivation, essential for students' overall well-being and engagement in school activities (Thornberg et al., 2022).

1.3. School engagement

School engagement is defined as a meta-construct, a biopsychosocial phenomenon that refers to the simultaneous experience of focus, interest, and intense enjoyment by students in relation to their participation in the teaching-learning process (Fredericks et al., 2004).

According to Sáez-Delgado et al. (2023), school engagement is characterized by students' active participation in academic activities, their emotional connection to the school environment, and their commitment to learning (Pérez-Salas et al., 2021). This systematic review emphasizes the importance of methodological approaches in understanding how engagement manifests among secondary students, suggesting that engagement is not merely a singular experience but rather a composite of various interactions and experiences within the school context.

González et al. (2022) further elaborate on this concept by utilizing the Student Engagement Instrument (SEI), which assesses different dimensions of engagement, including the emotional, behavioral, and cognitive aspects. Their analysis indicates that school engagement is crucial for academic success and is influenced by various factors, including teacher-student relationships and the overall school climate. The SEI serves as a valuable tool for measuring these dimensions and understanding the underlying factors that contribute to student engagement.

Additionally, Pérez-Salas et al. (2021) highlight the role of teacher-student relationships and special educational needs in shaping student engagement and disengagement. Their findings suggest that positive interactions with teachers and supportive peer relationships are essential for fostering engagement among students, particularly those with special educational needs. This underscores the relational aspect of engagement, where the quality of interactions within the school environment significantly impacts students' motivation and involvement in their learning processes.

1.4. Subjective well-being

Subjective well-being is conceptualized as an individual's self-evaluation of their happiness and life satisfaction, integrating both affective responses and cognitive appraisals of life circumstances. This multidimensional construct has been extensively studied, highlighting its complexity and broad applicability (Diener et al., 2009; Diener, 2000; Cobo-Rendón et al., 2024).

The framework of subjective well-being distinguishes between emotional and cognitive components. Emotional aspects encompass positive and negative affect, while cognitive evaluations are captured through measures of life satisfaction, reflecting an individual's overall assessment of their quality of life (Diener et al., 2009).

As a measure of societal progress, subjective well-being provides valuable insights into population-level quality of life. The systematic evaluation of happiness and life satisfaction underscores the critical role of subjective well-being in shaping individual behaviors and influencing broader societal outcomes (Diener, 2000).

1.5. Empiric evidence of subjective well-being and school engagement

Perceived teacher support, a fundamental component of the closeness dimension of the teacher-student relationship, positively contributes to significant changes in students' school engagement, particularly in the behavioral dimension: the greater the perceived teacher support, the stronger the emotional and behavioral engagement (Diestra et al., 2023). This phenomenon has also been observed among Indigenous students. For instance, Canadian Indigenous students attribute part of their academic success to the development of strong and meaningful relationships with their teachers (Ribeiro et al., 2023).

Empirical evidence suggests a significant relationship between subjective well-being and school engagement among students. Subjective well-being has been shown to positively influence students' engagement in their educational environments. Students who perceive higher levels of well-being are more likely to exhibit greater school engagement, which includes behavioral, emotional, and cognitive dimensions of participation in school activities (Cui et al., 2023). This relationship underscores the importance of fostering a supportive school environment that enhances students' overall well-being.

Other studies suggest that students with higher levels of subjective well-being tend to have a more robust internal locus of control, which in turn enhances their engagement in academic activities (Cui et al., 2023). This aligns with the notion that positive emotional states can lead to increased motivation and commitment to schoolwork, thereby fostering a more engaged learning experience.

Saxer et al. (2021) also provide a multidimensional approach to measuring well-being in students, emphasizing that aspects such as positive relationships and engagement in school activities are interconnected. Their findings suggest that interventions aimed at improving students' social relationships and overall well-being can lead to increased engagement in school, particularly during critical developmental stages.

Other studies reinforce the idea that social support from peers, parents, and teachers plays a crucial role in enhancing both subjective well-being and school engagement. Students who feel supported in their social environments are more likely to engage actively in school, highlighting the interdependence of social factors and individual well-being (Nguyen & Nguyen, 2021; Estell & Perdue, 2013).

1.6. Associations between the teacher-student relationship, school engagement, and subjective well-being

The teacher-student relationship represents a dyadic system where both student and teacher engage in reciprocal interactions. Based on Bowlby's (1969) framework, the teacher-student relationship plays a crucial role in the emotional development and educational engagement of students. When these relationships are positive, they become not only a pivotal factor in an individual's academic trajectory but also in their personal development. This relationship constitutes a critical element in fostering various processes associated with students' development and educational trajectories, such as school engagement (Fredericks et al., 2004).

The impact of the teacher-student relationship extends both within and beyond the classroom, acting as a protective factor. Students who experience higher-quality relationships with their teachers are more likely to seek help and receive treatment for mental health issues and report better results in subjective well-being measurements. Conversely, students with lower-quality teacher relationships are more prone to isolation when facing mental health challenges (Stein & Russell, 2021). For indigenous students, friendly and caring teachers are

perceived as positive influences with a significant impact on fostering school engagement (Tessaro et al., 2021).

The quality of the teacher-student relationship is a significant predictor of school engagement, particularly for students at risk of behavioral problems. Their study highlighted those positive relationships with teachers foster better academic habits and contribute to students' overall adjustment in school, thereby enhancing their subjective well-being (Pedditzi et al., 2022). This underscores the idea that supportive teacher-student relationships can act as a protective factor, promoting both emotional stability and academic success.

1.7. Gap and research questions

Analyzing the collected evidence and the interrelation among variables reveals the existence of profound connections between these concepts. However, significant gaps remain regarding the directionality of the influence between variables and the potential impact each exerts on the other.

Moreover, we have not found studies that analyze or delve into the existence of theoretical models that reveal a structure explaining the linkage among the variables. While we have encountered models that encompass interactions between the teacher-student relationship and school engagement, none have been tested that include the influence of subjective well-being.

This knowledge gap becomes even more pronounced when exploring differences across student sociodemographic characteristics. If the impact of teachers on students varies depending on their vulnerability and individual traits, it raises the question of whether a model exists to describe the relationship among these variables and whether it is possible to structure a model that effectively describes the relationship among these variables. Among the sociodemographic variables, this study aims to provide a deeper understanding of the teacher's role in culturally diverse contexts, an area that has been scarcely studied in Chile.

The general objective of the study is to evaluate a predictive model of school engagement, using the teacher-student relationship as a predictor variable and subjective well-being as a mediating variable in Mapuche students aged 10 to 14.

The specific objectives are:

- Estimate the psychometric properties of the three scales in Mapuche students aged 10 to 14.
- Analyze the direct effect of the teacher-student relationship over the school engagement in Mapuche students aged 10 to 14.
- Analyze the indirect effect of the teacher-student relationship over the school engagement in Mapuche students aged 10 to 14.

2. Method

2.1. Design

The present study adopted a non-experimental, correlational and explanatory, utilizing a cross-sectional design.

A cross-sectional design is particularly well-suited for this study as it enables the concurrent examination of the relationships between teacher-student interactions, school engagement, and subjective well-being across diverse sociodemographic variables, including age, gender, and cultural background (e.g., Mapuche/Chilean). This methodological approach permits the collection of data at a single point in time, allowing researchers to identify patterns and associations without requiring the extended time and resources associated with longitudinal studies. Specifically, cross-sectional designs are adept at capturing the dynamics of teacher-

student relationships and their influence on student engagement, particularly within primary education contexts (Yi & Kutty, 2023).

This design holds significant value in educational research, as it facilitates the exploration of how multiple factors, such as the quality of teacher-student relationships, shape student behaviors and levels of engagement in heterogeneous populations (Endedijk et al., 2021). Moreover, cross-sectional studies yield valuable insights into the associations between teacher-student relationships and student outcomes, making them an appropriate choice for investigating the complex interactions that underpin students' subjective well-being and engagement (Pérez-Salas et al., 2021).

By adopting a cross-sectional design, this research aims to address the stated research questions effectively, providing a nuanced understanding of the factors influencing school engagement and well-being across diverse student populations.

2.2. Participants

The study sample was selected through a non-probabilistic convenience sampling method, comprising 300 students (133 male and 167 female) from ages 10 to 14. For The mean age was 13.1 years (SD = 1.247). The age distribution is shown below in Table 1.

Table 1. Age distribution.

Age	Mapuche students	Chilean students
10 years old	17	47
11 years old	27	78
12 years old	42	67
13 years old	51	99
14 years old	163	134
Total	300	425

Inclusion criteria were an age range of 10 to 14 years, identifying as Mapuche, having a Mapuche last name and enrollment in formal education at a public school. Conversely, exclusion criteria were defined as having limited proficiency in reading in Spanish, which could impede the ability to respond to questionnaires, or being part of an educational setting outside the scope of regular education (such as hospital schools, special schools, among others).

2.3. Instruments

Various instruments were used for data collection:

- Teacher-student relationship (TSR): the teacher-student relationship subscale of the Student Engagement Instrument (Appleton et al., 2006) was utilized. It consists of nine Likert-type items, scored from 1 to 4. The adaptation for the Chilean population by González et al. (2022) was used, showing acceptable reliability for Chilean students (ω = .700) and adequate validity according to the cited article. The scale contains items such as "My teachers are there for me when I need them". The 9 items are measured on a Likert scale ranging from 1 to 5 (1 = strongly disagree / 2 = disagree / 3 = neither agree nor disagree / 4 = agree / 5 = strongly agree).

- Student Engagement (SE): the 19 items of the student engagement subscale within the Multidimensional Student Engagement Scale by Wang et al. (2019) were applied. Psychometric properties were measured for the Chilean school population by Pérez-Salas et al. (in press). For the student engagement scale, high results were found regarding internal consistency and reliability (ω = .949). To respond to the 19 items, a Likert-type response scale was used, consisting of five points. The scale is subdivided into behavioral engagement, cognitive engagement, affective engagement, and social engagement. The scale contains 19 items measured on a Likert scale ranging from 1 to 5 (1 = very different from me / 2 = somewhat different from me / 3 = neither different nor similar to me / 4 = similar to me / 5 = very similar to me).
- Subjective Well-being (SWB): the Subjective Well-being Scale short version (EBS-8) by Calleja et al. (2022) was utilized to measure subjective well-being. The scale consists of 8 Likert-type items scored from 1 to 6. They found high results regarding internal consistency and reliability (α = .958, ω = .957). This scale was developed and tested with the general Mexican population, specifically among individuals aged between 12 and 81 years. This original version, in neutral Spanish, was applied to the participants.

2.4. Procedure

The current study constitutes the preliminary phases of a more extensive research endeavor, subject to analysis and scrutiny by the Scientific Ethics Committee of the Faculty of Medicine of the University of Concepción (CEC 25/2022), as well as the Ethics, Bioethics, and Biosafety Committee of the Vice-Rector's Office for Research and Development of the same university (CEBB 1476-2023). The study obtained validation from both committees

Subsequent to receiving authorization letters, the project underwent assessment by the respective organizations in charge of the schools. Upon approval, contact was initiated with the establishments to engage them in the project.

Upon securing authorization from the educational establishments, informed consents and assents were extended to the students. Subsequent to the collection of these consents, coordination was undertaken to determine the date and time for the application of the instruments, a process executed within each school.

2.5. Data analysis

Due to the lack of psychometric properties estimation for the Mapuche sample, confirmatory factor analyses were conducted for the three scales to be used. In addition, reliability analyses were performed. A structural equation model was evaluated, incorporating the correlations found in the confirmatory factor analyses. All the analysis were conducted using Mplus Version 8.8. The data is available upon request.

3. Results

3.1. Teacher-student relationship subscale

3.1.1. Confirmatory factor analysis

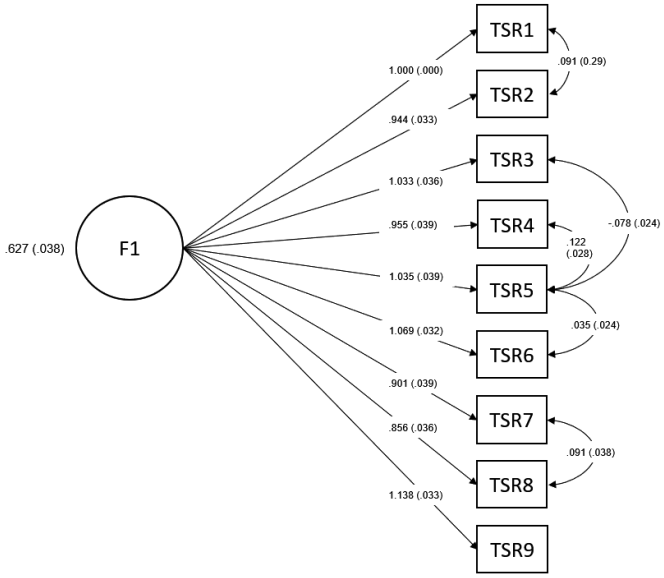
The original confirmatory factor analysis (CFA) model exhibited a moderate fit, with an RMSEA of .089 and a CFI of .986, which, although indicating acceptable fit, also revealed room for improvement. In order to optimize the model's adequacy, changes based on modification indices were implemented by incorporating correlations among the measurement errors of certain items (TSR1 with TSR2, TSR5 with TSR6, TSR7 with TSR8, TSR5 with TSR4, and TSR5 with TSR3). These variations resulted in a significantly improved fit. Moreover, the inclusion of error correlations reflects the nature of the measured construct, reducing unexplained variance without compromising the model's validity. Consequently, the modified CFA version reflects

a more robust factorial structure that is better adjusted to the data, thereby providing stronger empirical support for the interpretation of the scale.

The results of the CFA for the unidimensional structure of the scale, after the modifications, show an excellent fit ($\chi^2(22) = 31.377$, $p = .0887$, CFI = .998, TLI = .997, RMSEA = .038 [90% CI: .000-.066] [Jordan, 2021]). In the corresponding figure (see Figure 1), the results of the CFA are graphically presented. The obtained factor loadings, all statistically significant, ranged between .677 and .901. In particular, items TSR6 and TSR9 exhibited the highest factor loadings (.846 and .901, respectively), while item TSR8 displayed the lowest loading (.677).

Regarding convergent validity, an average variance extracted (AVE) of .621 was obtained, indicating good convergent validity. These results support the factorial validity of the scale within the proposed model.

Figure 1. Confirmatory factor analysis of the teacher student-relationship subscale.



Note: the values shown in the figure correspond to unstandardized coefficients.

3.1.2. Reliability

The internal consistency coefficients for the teacher-student relationship scale in the Mapuche sample were as follows: Cronbach's $\alpha = .917$ (95% CI: .902-.930) and McDonald's $\omega = .917$ (95% CI: .903-.931).

3.2. Subjective Well-Being Scale

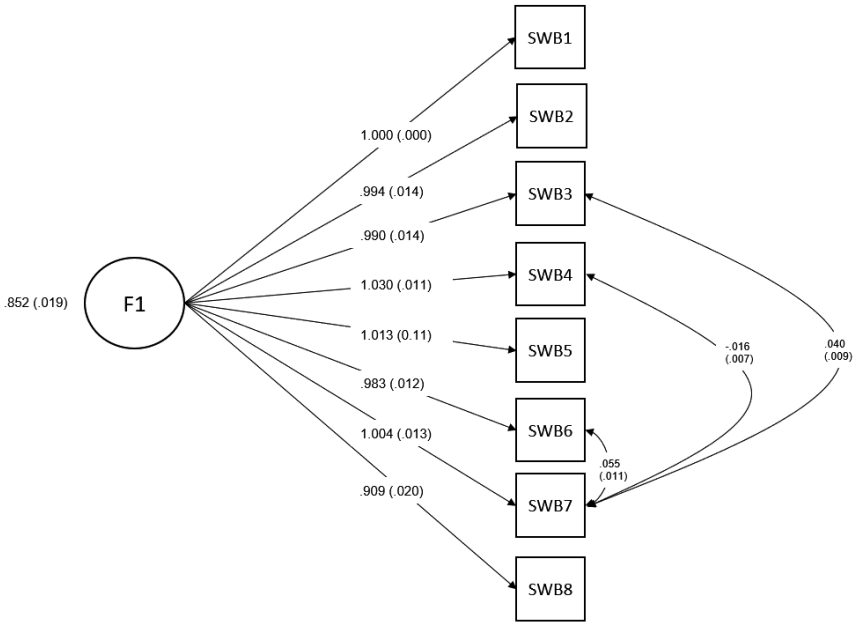
3.2.1. Confirmatory factor analysis

The original confirmatory factor analysis (CFA) model for the Subjective Well-Being Scale (SWB) exhibited inadequate fit, with a $\chi^2(20) = 100.300$, $p = .0000$, an RMSEA of .116 (90% CI: .094-.139), a CFI of .997, a TLI of .996, and an SRMR of .010. These values indicated deficiencies in the model's fit to the data, evidencing the need for modifications to improve its adequacy. Based on the modification indices, correlations among the measurement errors of items SWB3 with SWB7, SWB4 with SWB7, and SWB6 with SWB7 were incorporated. The inclusion of these correlations reflects the structure of the measured construct, reducing the unexplained variance without compromising the model's validity.

As a result of these modifications, the adjusted CFA model showed a substantial improvement in fit, with a $\chi^2(17) = 42.743$, $p = .0005$, an RMSEA of .071 (90% CI: .045-.098), a CFI of .999, a TLI of .998, and an SRMR of .007. This indicates that the revised model fits the data more adequately. In the corresponding figure (see Figure 2), the results of the adjusted model are graphically presented. The factor loadings obtained, all statistically significant, ranged between .839 and .951. In particular, item SWB4 exhibited the highest factor loading (.951), while item SWB8 showed the lowest (.839).

Regarding convergent validity, the average variance extracted (AVE) was .852, which supports the model's adequate convergent validity. Overall, these results confirm the factorial validity of the Subjective Well-Being Scale within the proposed model, ensuring a more robust representation of the evaluated construct.

FIGURE 2. Confirmatory factor analysis of the Subjective Well-Being Scale.



Note: the values shown in the figure correspond to unstandardized coefficients.

3.2.2. Reliability

In the Mapuche sample, the internal consistency coefficients for the Equality-Based Respect Scale were as follows: Cronbach's $\alpha = .968$ (95% CI: .963-.974) and McDonald's $\omega = .969$ (95% CI: .963-.974).

3.3. School engagement subscale

3.3.1. Confirmatory factor analysis

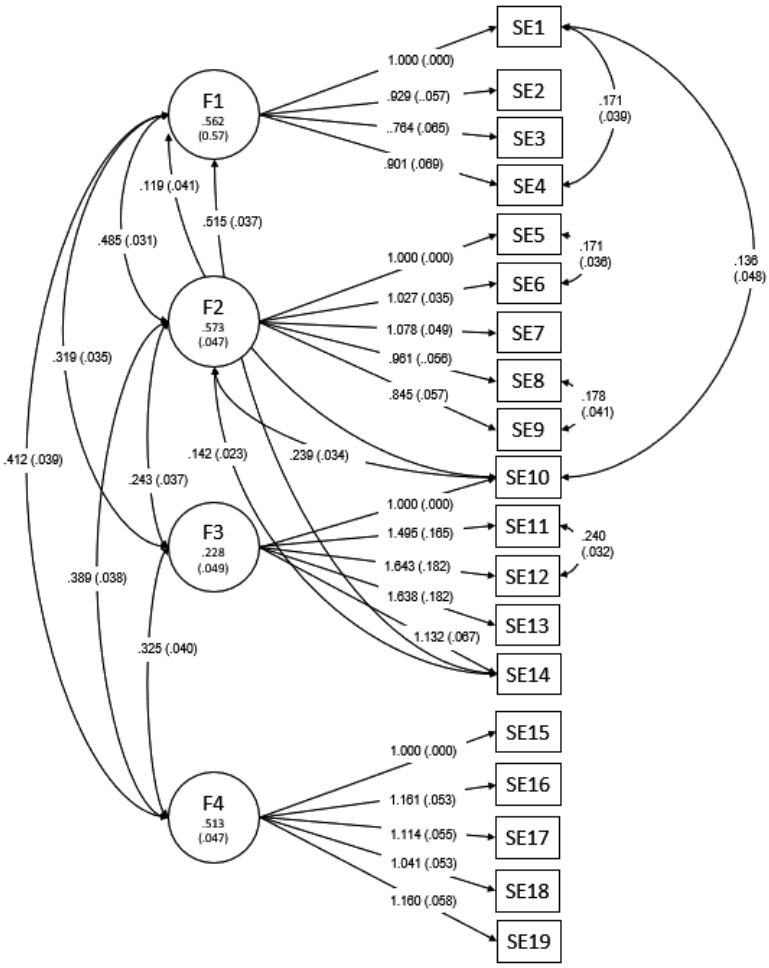
The original confirmatory factor analysis (CFA) model yielded a CFI of .920, a TLI of .906, and an SRMR of .063, which, although indicative of an adequate fit, suggested room for improvement given an RMSEA of .106. In order to optimize the model's adequacy, modifications based on modification indices were implemented by incorporating correlations among the measurement errors of certain items (SE1 with SE4, SE1 with SE10, SE5 with SE6, SE8 with SE9, and SE11 with SE12), as well as correlations between factors (F2 with F1, F3 with F1 and F2, F4 with F1, F2, and F3) and between some items and certain factors (SE10 with F1 and F2, SE14 with F1 and F2). These modifications resulted in a significantly improved fit. Furthermore, the inclusion

of error correlations reflects the nature of the measured construct, reducing unexplained variance without compromising the model's validity. Consequently, the modified CFA model reflects a more robust factorial structure that is better aligned with the data, thereby providing stronger empirical support for the interpretation of the scale.

The results of the CFA for the four-factor structure of the scale, after these modifications, indicate an adequate fit, with $\chi^2(137) = 377.823$, $p = .001$, CFI = .961, TLI = .952, and RMSEA = .077 (90% CI: .067-.086) (Jordan, 2021). In the corresponding figure (see Figure 3), the results of the CFA are graphically presented. The factor loadings obtained, all statistically significant, ranged between .477 and .831. In particular, items SE16 and SE19 exhibited the highest factor loadings (.831 in both cases), while item SE10 showed the lowest loading (.477).

Regarding convergent validity, the average variance extracted (AVE) for the four factors was as follows: F1 = .45, F2 = .57, F3 = .60, and F4 = .62, indicating acceptable convergent validity, especially for factors 2, 3, and 4. Discriminant validity was assessed using the Fornell and Larcker criterion, and it was verified that, in general, the AVE of each factor exceeded the square of the correlations between factors, thereby supporting the discriminant validity of the final model. Overall, these results corroborate the factorial validity of the scale within the proposed model.

Figure 3. Confirmatory factor analysis of the school engagement subscale.



Note: the values shown in the figure correspond to unstandardized coefficients.

3.3.2. Reliability

The reliability coefficients (with scores ranging from α = .666 to .920 and ω = .674 to .922) are detailed for each factor and for the overall scale in the table below (see Table 2). Although the internal consistency obtained for the behavioral engagement factor falls within a moderate range, its inclusion is justified by the confirmatory factor analysis results, which indicate adequate factorial validity within the proposed theoretical model.

Table 2. McDonald's omega and Cronbach's alpha for school engagement.

Dimension	McDonald's omega (range)	Cronbach's alpha (range)
Conductual (F1)	.674 (.613-.734)	.674 (.613-.734)
Cognitive (F2)	.840 (.812-.869)	.840 (.812-.869)
Emotional (F3)	.854 (.828-.880)	.850 (.822-.875)
Social (F4)	.835 (.803-.862)	.835 (.803-.862)
Total scale	.810 (.776-.843)	.810 (.776-.843)

3.4. Model

This section presents the results obtained from applying Structural Equation Modeling (SEM) to data collected in the Mapuche sample. The aim is to examine the relationships among various latent variables: Teacher-Student Relationship (TSR), Subjective Well-Being (SWB), and School Engagement (SE).

The analysis was conducted using Mplus Version 8.8, employing the WLSMV estimator due to the categorical nature of the observed variables. Data from 300 participants were analyzed, distributed across three main latent variables.

The model fit indices indicate a good fit:

- Chi-squared (χ^2) = 1482.494, with 584 degrees of freedom and p <.001
- RMSEA = .072 (.067 - 0.76)
- CFI = .961, TLI = .958
- SRMR = .067

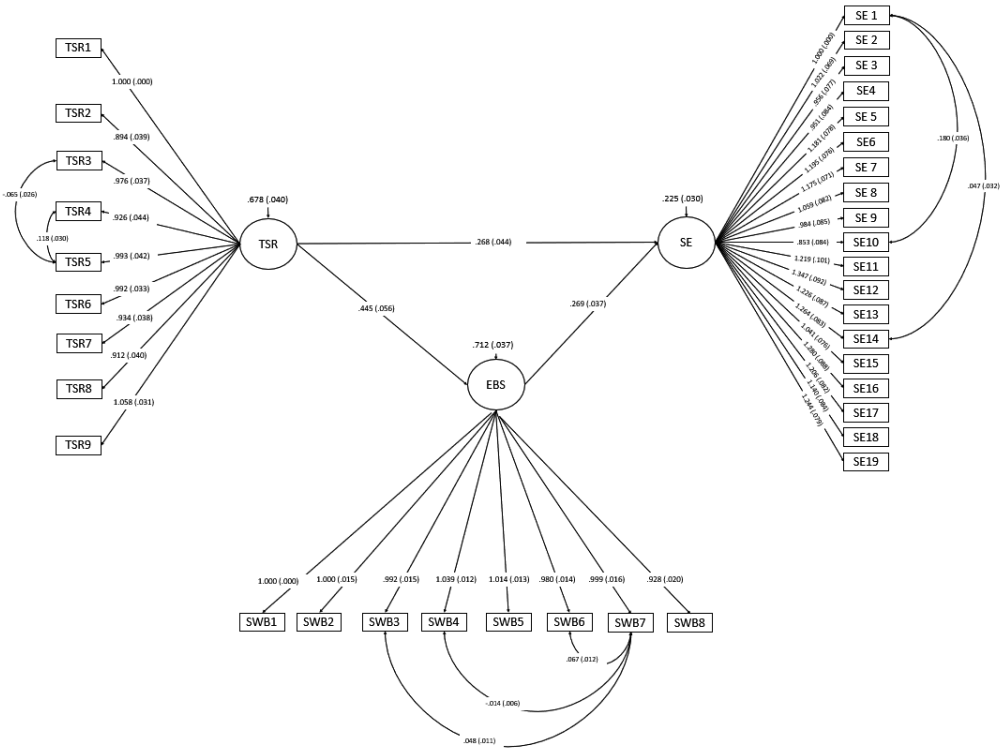
These results suggest that the proposed model adequately represents the underlying structure of the data. The model included three latent factors, and the structural relationship are detailed in Table 3.

Table 3. Standardized coefficients of the structural relationships.

Structural relationship	B	*p* value
Teacher student relationship → school engagement	.359	<.001
Subjective well-being → school engagement	.402	<.001
Teacher student relationship → subjective well-being	.398	<.001

Regarding the indirect effects, the model showed a low magnitude (β = .160) mediation of the subjective well-being, but with a great statistical power (*p* <.001). Hereafter is presented the figure of the full model (Figure 4 below).

FIGURE 4. Structural equations model.



Note: the values shown in the figure correspond to unstandardized coefficients.

4. Discussion

Regarding the first specific objective, it was possible to estimate the psychometric properties of the three instruments used. All demonstrated good reliability and validity, except for the behavioral dimension of school engagement. While this constitutes a limitation of the study, the dimension was nonetheless included due to its theoretical relevance and the results of the confirmatory factor analysis.

With respect to the factor analyses, all scales exhibited good fit indices, supporting the adequacy of the specified factorial structure in representing the variables. This is of utmost importance given the limited cultural relevance of certain measurement instruments, representing a step forward in the consolidation of tools with sociocultural pertinence.

Regarding the second specific objective, a moderate significant direct effect was found from the teacher-student relationship to the school engagement (β = .359, *p* <.001). This finding suggests that strong and positive bonds between teachers and Mapuche students, fortify the school engagement. This aligns directly with previous studies that have established emotional support and the perception of a positive relationship with teachers as significant predictors of school engagement (Gil et al., 2023; Miranda-Zapata et al., 2021).

Research suggests that the impact of the teacher-student relationship is even more pronounced in contexts where additional educational or sociodemographic challenges are present (Gutiérrez et al., 2017). This becomes particularly relevant in the case of Mapuche students, considering that ethnic background entails various educational barriers and increases the risk of school dropout due to the inadequate adaptation of the educational system to sociocultural differences (Muñoz, 2021; Muñoz & Millán, 2019; Mansilla et al., 2016).

A significant positive direct effect of subjective well-being on school engagement was also found ($\beta = .402$, $p < .001$), suggesting that higher subjective well-being is associated with greater school engagement among Mapuche students. These findings are consistent with previous research, which has demonstrated that students with higher levels of subjective well-being tend to exhibit greater personal involvement in learning activities, indicating that subjective well-being functions as a precursor to school engagement (López et al., 2022; Saracostti et al., 2019).

Finally, a significant positive indirect effect was identified between the teacher-student relationship and school engagement, mediated by the subjective well-being ($\beta = .160$, $p < .001$). This suggests that subjective well-being functions as a mediator in this relationship, influencing the connection between these two variables. These results are consistent with previous research indicating that subjective well-being mediates this link, affecting factors such as intrinsic motivation, social support, and academic resilience, among others (Pazmiño et al., 2024; González, 2021; Lara et al., 2021).

The results establish important relationships between the variables described in the model, fulfilling the general objective of evaluating a predictive model of the teacher-student relationship on school engagement and subjective well-being in Mapuche students aged 10 to 14. Although the effect size is small, it demonstrates significant statistical power, which enhances the relevance of the findings.

Nevertheless, this study has notable limitations that should be addressed when replicating the model. First, the cross-sectional design limits the ability to infer causality from the observed effects. Additionally, suboptimal reliability indices were found for the behavioral dimension of school engagement, suggesting the need for further refinement when replicating the results.

This study highlights critical sociocultural implications for Chile, particularly regarding the Mapuche population. The findings demonstrate that positive teacher-student relationships significantly enhance school engagement and subjective well-being, suggesting the need for culturally responsive educational practices. Strengthening these relationships can help mitigate the historical educational disadvantages faced by Indigenous students in Chile.

Future research should employ longitudinal designs to clarify causal relationships and further refine culturally sensitive instruments, particularly for measuring behavioral engagement. Expanding qualitative approaches could deepen the understanding of Indigenous students' experiences, while comparative studies across Latin American Indigenous groups may reveal broader patterns relevant to intercultural education.

Authors' contributions

Joaquín Brieba-Fuenzalida: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Software; Supervision; Validation; Visualization; Writing (original draft); Writing (review and editing).

Artificial intelligence (AI) policy

Generative artificial intelligence was used to assist in the language refinement of selected paragraphs in this manuscript.

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