Universidad de Oviedo

ANÁLISIS DE FACTORES ASOCIADOS AL RENDIMIENTO Y AL BIENESTAR

Doctoranda: Elena Govorova Govorova

Programa de Doctorado en Ciencias de la Salud

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RESUMEN DEL CONTENIDO DE TESIS DOCTORAL

1.- Título de la Tesis	
Español/Otro Idioma: Análisis de Factores Asociados al Rendimiento y al Bienestar	Inglés: Analysis of Factors Associated with School Performance and Well-being

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RESUMEN (en español)

Antecedentes: Las organizaciones internacionales y los responsables de las políticas educativas destacan la necesidad de implementar medidas universales para mejorar la calidad educativa en todos los niveles. Estas medidas suelen ser generales y aplicables a nivel político, pero carecen de la concreción necesaria para su implementación efectiva en las escuelas. Esta tesis doctoral responde a la creciente demanda de las escuelas por conocer métodos específicos para mejorar los resultados escolares a nivel de centro educativo. El objetivo principal ha sido identificar los factores que influyen en los resultados educativos de los estudiantes, especialmente aquellos que pueden ser controlados por el centro educativo para mejorar su eficacia. Los resultados educativos se han considerado desde un enfoque holístico, combinando el rendimiento académico y el bienestar del alumnado.

Método: Los estudios se basaron en datos del Programa para la Evaluación Internacional de Estudiantes (PISA) de 2015 y 2018, analizando una muestra internacional de estudiantes de países de la OCDE. Se emplearon métodos de análisis cuantitativos tradicionales y novedosos, incluyendo el modelo jerárquico-lineal, el modelo de ecuaciones estructurales multinivel, la metodología de análisis de redes y el enfoque de Diferencia en Diferencia.

Resultados: Los resultados indican que el efecto de los centros educativos en los resultados escolares varía entre países. De media, el 27% de la varianza en la adquisición de competencias básicas se concentra a nivel del centro educativo, mientras que solo un 5-9% de la varianza en el bienestar estudiantil es atribuible al centro. Los factores que más influyen en el rendimiento educativo son la motivación intrínseca, los métodos de enseñanza tradicionales y el conocimiento sobre estrategias eficaces de estudio. Para el bienestar estudiantil, son importantes

el clima de disciplina, las estrategias docentes basadas en indagación y el apoyo del profesor. La metodología de análisis de redes, las ecuaciones estructurales multinivel y el enfoque de Diferencia en Diferencia se presentan como alternativas eficaces para su uso en investigaciones sobre la eficacia escolar.

Conclusiones: Los hallazgos indican que los centros educativos tienen margen para mejorar el rendimiento y el bienestar estudiantil. Esto se puede lograr combinando métodos de enseñanza tradicionales e innovadores para potenciar la motivación intrínseca, fomentando un clima de disciplina positivo, enseñando técnicas de estudio eficaces y proporcionando apoyo y retroalimentación constante a los estudiantes.

RESUMEN (en Inglés)

Background: International organizations and educational policymakers emphasize the need to implement universal measures to improve the quality of education at all levels. However, these measures are often general and policy-focused, lacking the specificity required for effective implementation in schools. This doctoral thesis addresses the growing demand from schools for specific methods to improve educational outcomes at the school level. The primary objective has been to identify factors that influence students' educational outcomes, particularly those that can be controlled by the school to enhance its effectiveness. Educational outcomes have been considered from a holistic perspective, combining academic performance and student well-being.

Method: The studies utilized data from the Programme for International Student Assessment (PISA) for the years 2015 and 2018, analyzing an international sample of students from OECD countries. Both traditional and innovative quantitative analysis methods were employed, including hierarchical linear modeling, multilevel structural equation modeling, network analysis methodology, and the Difference in Differences approach.

Results: The results indicate that the impact of schools on educational outcomes varies across countries. On average, 27% of the variance in the acquisition of basic competencies is attributable to the school level, while only 5-9% of the variance in student well-being is linked to the school. The key factors influencing educational performance include intrinsic motivation, traditional teaching methods, and knowledge of effective learning strategies. In contrast, student

Universidad de Oviedo

well-being is most affected by the discipline climate, inquiry-based teaching strategies, and teacher support. The network analysis methodology, multilevel structural equations, and the Difference-in-Differences approach are presented as effective alternatives for research on school effectiveness.

Conclusions: The findings indicate that schools have significant potential to enhance student performance and well-being. This can be achieved by integrating traditional and innovative teaching methods to boost intrinsic motivation, fostering a positive discipline climate, teaching effective study techniques, and providing continuous support and feedback to students.

SR. PRESIDENTE DE LA COMISIÓN ACADÉMICA DEL PROGRAMA DE DOCTORADO EN CIENCIAS DE LA SALUD

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Índice de contenidos

1. Introducción 1

1.1. Funciones y Aportaciones de la Evaluación Educativa 1

1.2. Las Evaluaciones Internacionales como Fuente de Datos para la Investigación 2

1.3. Evaluación Internacional PISA 4

1.4. Los Modelos de Factores Asociados a los Resultados Educativos: Antecedentes y Estado Actual 9

1.5. Resultados del Proceso de Enseñanza: un Enfoque Integral 12

1.5.1. Bienestar del Alumnado 14

1.5.2. Competencias para la Vida 16

1.6. Categorías de Factores Asociados a los Resultados Educativos 18

1.7. Descripción de Factores Asociados a Resultados del Proceso de Enseñanza 20

1.7.1. Variables Predictoras Asociadas al Alumnado 20

1.7.2. Variables Predictoras Asociadas al Centro Educativo 25

1.8. Modelos Metodológicos de Análisis 28

1.8.1. Regresión Lineal Múltiple 30

1.8.2. Modelo Jerárquico Lineal 31

1.8.3. SEM multinivel 35

1.8.4. Análisis de Redes 38

1.8.5. Diferencias en Diferencias 39

2. Hipótesis 41

3. Objetivos 41

4. Estudios 43

1.1. Estudio 1 44

Govorova, E., Benítez, I., & Muñiz M. (2020). How Schools Affect Student Well-Being: A Cross-Cultural Approach in 35 OECD countries. Frontiers in Psychology

1.2. Estudio 2 59

Govorova, E., Benítez, I., & Muñiz M. (2020). Predicting Student Well-Being: Network Analysis Based on PISA 2018. Environmental Research and Public Health

1.3. Estudio 3 78

Govorova, E., Muñoz-Fernández N., Sánchez-Martín M. & Benítez, I. (2023). Multilevel SEM analysis of factors related to achievement results: evidence based on PISA 2015

1.4. Estudio 4 110

Govorova, E., Benítez, I., & Cuesta M. (2023). Strategies for Promoting Reading Competence: Teaching Practices and Enjoyment of Reading. Psicothema

5. Discusión 123

5.1. Efecto de la Escuela en los Resultados de Procesos de Enseñanza 126

5.2. Factores Asociados a los Resultados Educativos 128

5.3. Recomendaciones Dirigidas a los Centros Educativos Sobre cómo Incidir en la Mejora Escolar 132

5.4. Propuestas Metodológicas Innovadoras 136

6. Conclusiones 139

Referencias 140

1. Introducción

1.1. Funciones y Aportaciones de la Evaluación Educativa

La evaluación educativa ha desempeñado un papel fundamental a lo largo de la historia de la educación, evolucionando y adaptándose a las cambiantes necesidades de la sociedad. Su importancia radica en la capacidad para medir el progreso académico, identificar áreas de mejora y adaptar las estrategias pedagógicas, así como para proporcionar retroalimentación útil durante el proceso de aprendizaje y enseñanza (Care et al., 2018; Conley, 2015; García-Jiménez, 2015; Jorba y Sanmartí, 1993). La evaluación también desempeña un papel esencial en la equidad educativa al identificar disparidades en el rendimiento entre diversos grupos de estudiantes (Martínez et al., 2009). Proporciona evidencias que permiten implementar estrategias para abordar las brechas sociales garantizando que todos los estudiantes[1] tengan acceso a oportunidades de aprendizaje de calidad. Además, la evaluación contribuye a la rendición de cuentas, ya que permite medir el logro de objetivos académicos y el cumplimiento de los estándares establecidos (Conley, 2015; Hanushek et al., 2012).

En el siglo XXI, la evaluación educativa ha experimentado cambios significativos que han acompañado a la evolución de las innovaciones pedagógicas. Se ha reconocido la importancia de evaluar no solo el conocimiento basado en la memorización de los contenidos, sino también las habilidades prácticas, la creatividad, el pensamiento crítico y la resolución de problemas, trasladándose el foco de la evaluación hacia estas competencias fundamentales en la "educación para el mundo del mañana" (Biesta, 2015; Meroño et al., 2017; Rieckmann, 2016; Schleicher, 2018). Las evaluaciones educativas contemporáneas buscan, por tanto, evaluar el nivel de preparación de los estudiantes para enfrentar desafíos del mundo real y, por ende, medir la eficacia de la educación en la formación de habilidades necesarias para el siglo XXI (OECD, 2019a).

De esta manera, en la sociedad actual la evaluación ya no se limita solo al rendimiento académico, sino que también abarca aspectos emocionales y sociales, así como aspectos asociados al bienestar del alumnado, lo que promueve un enfoque integral al desarrollo del estudiante (Chapman, 2015). Múltiples estudios afirman que el bienestar emocional de los estudiantes es esencial para su éxito global (Fredricks et al., 2011; Zins, 2004), señalando la

[1] A lo largo de este texto, se utilizará el masculino genérico para referirse a ambos géneros. Es importante destacar que esta elección lingüística no pretende excluir ni invisibilizar a ninguna persona, sino que se adopta por razones de conveniencia y claridad en la comunicación escrita. En este trabajo de tesis doctoral se reconoce la diversidad de género y la importancia de un lenguaje inclusivo, y se anima a que cada lector interprete este texto de manera inclusiva, reconociendo la pluralidad y la igualdad de género.

importancia de establecer un entorno de aprendizaje que fomente la salud mental y emocional del alumnado, dado que el aprendizaje y el rendimiento académico están intrínsecamente ligados al bienestar y a la estabilidad emocional (Anderson & Graham, 2016; Durlak et al., 2011).

El cambio de paradigma de evaluación se debe en gran medida a la aparición de evaluaciones educativas a gran escala impulsadas por organizaciones internacionales como la Organización para la Cooperación y el Desarrollo Económicos (OCDE), la Asociación Internacional para la Evaluación del Rendimiento Educativo (IEA), la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO), la Comisión Europea (CE), etc. En un contexto globalizado, su papel se ha vuelto fundamental para la comparación y la competitividad entre sistemas educativos de diferentes países. Las sólidas evidencias empíricas generadas por evaluaciones internacionales, como el Programa para la Evaluación Internacional de Alumnos (PISA), han influido en las políticas educativas a nivel mundial permitiendo formular políticas educativas y diseñar intervenciones específicas para mejorar los resultados del aprendizaje en distintos países y economías (Álvarez Castrillón et al., 2014; Hambleton et al., 2004; Hopfenbeck et al., 2018; Klieme, 2020).

1.2. Las Evaluaciones Internacionales como Fuente de Datos para la Investigación

Las evaluaciones internacionales proporcionan una rica fuente de información que va más allá de las fronteras nacionales y del uso primario que hacen de ellas las distintas administraciones para la toma de decisiones sobre sus sistemas educativos. Son herramientas valiosas para la investigación educativa que generan datos comparativos a nivel global para comprender mejor los sistemas educativos e identificar políticas efectivas (Baumert et al., 2009; Gamazo et al., 2017). Desde la perspectiva científica, estas evaluaciones se caracterizan por alcanzar altos estándares de calidad tanto en términos del diseño procedimental del proceso de evaluación, como de la calidad psicométrica de los instrumentos de medición (Pedró, 2012; Rindermann & Baumeister, 2015; Stanat & Lüdtke, 2015).

En primer lugar, las evaluaciones internacionales brindan datos cuantitativos detallados sobre el rendimiento académico de los estudiantes en distintos países y regiones. El análisis de estos resultados permite identificar patrones, tendencias y desviaciones en la calidad de la educación entre países (OECD, 2019b). La comparación entre ellos ayuda a contextualizar los resultados alcanzados identificando los puntos fuertes y los desafíos específicos de cada sistema educativo, a menudo asociados a factores geopolíticos de un país, pero también a la evolución histórica en la legislación educativa o la planificación y ordenación académica (UNESCO, 2020).

En segundo lugar, las evaluaciones internacionales suelen incluir información adicional sobre factores socioeconómicos y culturales, entornos de aprendizaje, prácticas pedagógicas, así como aspectos psicológicos y socioafectivos de los estudiantes (OECD, 2019a). Estos datos complementarios permiten a los investigadores realizar análisis más profundos y comprender cómo diferentes variables influyen en el rendimiento educativo construyendo modelos de factores asociados al éxito educativo. La contribución fundamental de las evaluaciones internacionales es la identificación de mejores prácticas y la formulación de recomendaciones para mejorar la eficacia de las instituciones académicas y de los sistemas educativos en general (Snart, 2011).

En la actualidad las evaluaciones a gran escala más importantes son las que se enumeran a continuación, ordenándose según el número de países o territorios participantes:

PISA (Programa para la Evaluación Internacional de Estudiantes, o *Programme for International Student Assement* en inglés**)** es un estudio internacional promovido por la OCDE que evalúa las competencias de estudiantes de 15 años en lectura, matemáticas y ciencias en más de 80 países del mundo (OECD, 2019a, 2023a, 2023b).

PIRLS (Estudio Internacional de Progreso en Comprensión Lectora, o *Progress in International Reading Literacy Study* en inglés**)**, una evaluación llevada a cabo por la IEA, se centra en la evaluación de la comprensión lectora en estudiantes de cuarto grado[2] (I. V. S. Mullis & Martin, 2019). Sesenta y seis países o territorios participaron en la última edición del estudio, PIRLS 2021.

TIMSS (Estudio Internacional de Tendencias en Matemáticas y Ciencias, o *Trends in International Mathematics and Science Study* en inglés**)**, también auspiciado por la IEA, mide el rendimiento en matemáticas y ciencias en estudiantes de cuarto y octavo grado[3] en más de 60 países (I. V. S. Mullis et al., 2021).

TALIS (Estudio Internacional de la Enseñanza y del Aprendizaje, o *Teaching and Learning International Survey* en inglés), promovido por la OCDE, se dirige a los docentes y se centra en la recogida de diversa información en más de 50 países acerca de los aspectos relacionados con su labor, por ejemplo, la formación recibida, sus prácticas y percepciones, la evaluación de su trabajo, la retroalimentación y reconocimiento percibidos, el liderazgo escolar y la gestión, etc. (OECD, 2020c).

PIAAC (**Programa para la Evaluación Internacional de las Competencias de la Población Adulta**, o *Programme for the International Assessment of Adult Competencies* en

[2] Equivale al 4º curso de Educación Primaria en el sistema educativo de España
[3] Equivale al 2º curso de Educación Secundaria Obligatoria en el sistema educativo de España

inglés), también iniciativa de la OCDE, que se centra en analizar las competencias clave de la población en edad laboral (de 16 a 65 años), realizado hasta la fecha en alrededor de 40 países. Este estudio comparativo examina las características educativas y sociolaborales de los adultos y establece vínculos entre estas características y el uso cotidiano de habilidades esenciales en tres áreas cognitivas fundamentales: lectura, matemáticas y resolución adaptativa de problemas (Rouet et al., 2021).

ICILS (Estudio Internacional sobre Competencia Digital, o *International Computer and Information Literacy Study* en inglés) es otra evaluación a gran escala de la IEA llevada a cabo en 35 países. ICILS se centra en las competencias relacionadas con el uso de la información y la tecnología en octavo grado (Fraillon et al., 2013, 2020).

SSES (Estudio sobre las Competencias Sociales y Emocionales, o *Survey on Social and Emotional Skills* en inglés), también diseñado por la OCDE, mide las habilidades socioemocionales desarrolladas por los estudiantes de 10 y 15 años respectivamente (OECD, 2021) en más de 15 países o territorios.

TERCE (Tercer Estudio Regional Comparativo y Explicativo), estudio promovido por la UNESCO, evalúa el rendimiento y los factores asociados a este en áreas como matemáticas, ciencias y lectura en estudiantes de 15 países de América Latina (UNESCO, 2016b).

Los datos resultantes de las evaluaciones internacionales son liberados después de la publicación, es decir, cuando los organismos responsables emiten los informes correspondientes los datos se ponen a disposición pública para investigadores y analistas. Cabe destacar que la disponibilidad de datos comparativos a nivel internacional no solo beneficia a los investigadores, sino también a los responsables de la formulación de políticas y a los educadores. La información derivada de estas evaluaciones puede guiar la toma de decisiones, inspirar reformas educativas y promover la adopción de enfoques innovadores basados en evidencia.

1.3. Evaluación Internacional PISA

La evaluación PISA constituye una evaluación integral del rendimiento educativo de estudiantes de 15 años que analiza sus conocimientos y habilidades al concluir la enseñanza obligatoria. Este análisis abarca los 37 países de la OCDE con economías desarrolladas y más de 50 países no miembros que participan en el proyecto. Se lleva a cabo en ciclos de tres años, cada uno enfocado en detallar y precisar una de las tres áreas de evaluación. Por ejemplo, el primer ciclo en el año 2000 se centró en lectura, seguido por matemáticas en 2003 y ciencias en 2006. Posteriormente, se reinició el ciclo en 2009 con una evaluación detallada de lectura, repitiendo el enfoque en matemáticas en 2012 y en ciencias en 2015. En 2018, se volvió a

destacar la lectura, permitiendo evaluar la evolución del rendimiento durante un amplio período de 18 años (para lectura). En el ciclo PISA 2022, las matemáticas fueron el área central, completando así un ciclo de 19 años (para matemáticas). PISA no solo evalúa la capacidad de los estudiantes para reproducir conocimientos, sino también su habilidad para extrapolar y aplicar ese conocimiento en contextos desconocidos, tanto dentro como fuera de la escuela (OECD, 2019a). Este enfoque refleja cómo las economías modernas valoran a los individuos no solo por lo que saben, sino por su capacidad para aplicar ese conocimiento.

Además de las materias clásicas, los últimos ciclos de PISA han incorporado evaluaciones de competencias innovadoras para medir habilidades relevantes en la sociedad del siglo XXI. En el estudio PISA 2015, el enfoque innovador fue la resolución colaborativa de problemas; en el PISA 2018, la competencia global, y en el PISA 2022, el pensamiento creativo. Según la definición de la OCDE (2019a), se entiende por competencia global la capacidad de los estudiantes para comprender los asuntos globales complejos, reconocer y considerar diferentes perspectivas culturales, comprender y apreciar la interconexión del mundo y tomar decisiones responsables en un contexto globalizado.

PISA, como programa continuo, proporciona valiosas ideas para las prácticas y políticas educativas, además de ofrecer un seguimiento de las tendencias educativas en diferentes países y subgrupos demográficos (Schleicher, 2009). Los resultados revelan el potencial educativo al mostrar lo que los estudiantes logran en sistemas educativos de alto rendimiento y con mejoras notables. Aunque PISA no establece relaciones de causa y efecto entre políticas y resultados educativos, sí permite comparar sistemas educativos, ayudando a los responsables políticos a fijar metas y aprender de las mejores prácticas en diferentes lugares del mundo.

En la presente tesis doctoral todos los estudios realizados se basan en la evaluación PISA. A continuación, se enumeran las principales razones para seleccionar esta evaluación como fuente de datos:

Alcance Internacional: Los resultados del estudio PISA representan a la población educativa de más del 80% de los países de todo el mundo, lo que permite comparaciones internacionales sobre el rendimiento educativo a nivel mundial. Es la única evaluación educativa a gran escala con una cobertura tan alta de países/economías y, por tanto, de contextos y realidades (OECD, 2016b, 2019b).

Enfoque en Competencias: PISA no se centra únicamente en la adquisición de conocimientos, sino también en la capacidad de los estudiantes para aplicar lo que saben en situaciones del mundo real. El enfoque de educación por competencias está en el punto de mira de las administraciones. Muchos sistemas educativos adaptan su legislación, los currículos y los programas educativos a este nuevo paradigma, impulsados por los rápidos avances tecnológicos

(Okubo, 2024). Las evidencias recogidas por PISA representan una valiosa fuente de información cuya explotación permitirá crear una base científica sólida para orientar futuras políticas educativas.

Evaluación Integral: Además de medir el rendimiento competencial, PISA también recopila datos sobre el contexto educativo, las actitudes de los estudiantes hacia el aprendizaje, el entorno familiar y otros factores que influyen en el rendimiento escolar. Los factores contextuales evaluados en PISA se seleccionan y se documentan en los marcos teóricos de cada ciclo de evaluación. Se basan en una revisión rigurosa de las últimas investigaciones académicas disponibles e incorporan los constructos más innovadores hasta la fecha (Schleicher, 2007).

Metodología contrastada: La metodología del estudio PISA es la referente en el mundo de evaluaciones a gran escala. Los procesos procedimentales, el procedimiento de muestreo, el diseño de instrumentos de evaluación y su posterior validación, la metodología de análisis de datos, etc. se basan en altos estándares de calidad acordados por los expertos del consorcio de los países participantes (OECD, 2020b). Esta metodología además se caracteriza por la transparencia y replicabilidad. Los marcos teóricos de cada ciclo de evaluación son de acceso abierto, proporcionan información completa de las áreas de evaluación seleccionadas, incluyendo su definición, clasificación y validación (OECD, 2016a, 2019a, 2023a). Los informes técnicos recogen los procedimientos de análisis realizados en cada ciclo de PISA (OECD, 2005, 2009, 2017). Además, PISA también publica manuales de análisis de datos, en los que se explican los pasos a seguir para realizar análisis secundarios, y se proporcionan *scripts* programados para replicar algunos de los análisis más complejos (OECD, 2009b).

En el presente trabajo se han utilizado los datos de todos los países de la OCDE participantes. Cabe destacar que la naturaleza de la presente investigación requiere que los datos sean representativos a nivel de país. De esta forma, en el caso de España los casos correspondientes a las muestras ampliadas de comunidades autónomas fueron excluidos del análisis, centrándose únicamente en los casos de los estudiantes que forman parte de la muestra representativa a nivel país. Las muestras de los demás países analizados en el estudio no fueron ampliadas más allá de la muestra representativa.

En PISA los alumnos participantes responden a una prueba de rendimiento y a un cuestionario de contexto. Este último es una parte importante de la evaluación PISA, ya que permite analizar relaciones entre rendimiento y diferentes factores relacionados tanto con los centros educativos como con variables externas a ellos, incluyendo el entorno socioeconómico de los estudiantes, sus actitudes e intereses y el entorno de aprendizaje en los centros educativos.

Las respuestas cognitivas de estudiantes se analizan mediante técnicas psicométricas enmarcadas en la Teoría de Respuesta al Ítem (TRI). En concreto para las respuestas binarias se utiliza el modelo generalizado de Rasch (Rasch, 1960) - el modelo logístico de dos parámetros (2PLM) (Birnbaum, 1968). Para las respuestas politómicas se emplea el modelo de crédito parcial generalizado (GPCM) (Muraki, 1992).

Debido al diseño matricial de la prueba PISA, se utiliza una compleja metodología de imputación de puntuaciones de estudiantes que consiste en la generación de una distribución a posteriori de valores para cada sujeto con sus probabilidades asociadas, denominados valores plausibles (Martínez-Arias, 2006). En PISA 2015 y PISA 2018 se generaron diez valores plausibles para cada escala de rendimiento - lectura, matemáticas, ciencias.

Los resultados de PISA se expresan mediante escalas. Inicialmente, la puntuación media de la OCDE para las tres áreas era de 500 (en PISA 2000), con una desviación típica de 100. Esto implica que aproximadamente dos tercios de los estudiantes de los países de la OCDE obtuvieron puntuaciones entre 400 y 600 puntos, reflejando así niveles de competencia en una determinada área de conocimiento. En los ciclos posteriores de PISA, la puntuación media de la OCDE ha variado ligeramente alrededor de este punto inicial. Específicamente, durante las siete primeras ediciones de PISA, los valores promedio de la OCDE se situaban en un rango de 496 a 507 puntos. Sin embargo, en PISA 2022, se ha registrado una disminución significativa, atribuida a las repercusiones de la pandemia de COVID-21.

El cuestionario de contexto recopila información demográfica del estudiante y datos sobre variables no cognitivas. Algunas de estas variables, como el género o la repetición de curso, se utilizan como índices simples, mientras que otras contribuyen a la construcción de índices y constructos más complejos. Por ejemplo, una de las escalas más relevantes de PISA, conocida como "Índice Social, Económico y Cultural" (ISEC o ESCS por sus siglas en inglés), se construye a partir de tres componentes principales: el nivel ocupacional de los padres (tomando el nivel más alto entre ambos padres), el nivel educativo de los padres (también considerando el nivel más alto entre ambos progenitores) y las características del hogar (incluyendo indicadores como el número de libros en casa). Estos índices se han utilizado para explorar posibles relaciones entre variables no cognitivas y el rendimiento estudiantil. De hecho, desde el inicio de PISA en el año 2000, se ha observado una fuerte correlación entre el ESCS y el rendimiento académico del alumnado (OECD, 2023b), lo que ha sido objeto de numerosos estudios.

Otras escalas no cognitivas en PISA evalúan, desde la perspectiva de los estudiantes, aspectos relacionados con el ambiente de aprendizaje como el clima de disciplina en el aula, la relación profesor-alumno o el comportamiento estudiantil que puede obstaculizar el proceso de aprendizaje (como el absentismo escolar o la falta de respeto hacia los profesores, entre otros).

Además, PISA evalúa los aspectos subjetivos de los estudiantes, como la motivación intrínseca e instrumental, la percepción de autoeficacia, el grado de compromiso, etc.

La riqueza de los datos recogidos en PISA permite modelar con precisión los procesos de enseñanza y aprendizaje con el fin de identificar los factores asociados a los mayores logros educativos.

En la presente tesis doctoral se han utilizado los datos de evaluaciones PISA 2015 y PISA 2018. A continuación, se proporciona una breve descripción de cada una de ellas.

PISA 2015, la sexta edición del estudio recogió datos de una muestra de 509.053 alumnos de 15 años de 72 países que, a su vez, representan a una población de 26.276.834 estudiantes. La muestra de los 35 países de la OCDE es de 248.620 alumnos y representa a 13.113.815 estudiantes cercanos a la finalización de los estudios obligatorios (OECD, 2017b). En PISA 2015 se evaluaron los tres dominios clave, lectura, matemáticas y ciencias, no obstante, el principal foco de evaluación fue la competencia científica, a la que fueron dedicados alrededor del 60% de ítems del instrumento cognitivo. Aquí, el enfoque se centraba en la comprensión de conceptos científicos fundamentales y en la capacidad de aplicar el conocimiento científico para comprender y explicar fenómenos naturales y tecnológicos. Además, la evaluación de ciencias incluyó la capacidad de interpretar datos científicos, realizar inferencias y comprender el método científico. PISA 2015 también recopiló datos demográficos y de contexto de los estudiantes, así como información sobre el entorno educativo y los recursos disponibles en cada país participante. El cuestionario de contexto dirigido a los estudiantes participantes recogió numerosos constructos relacionados con la motivación y las actitudes de los estudiantes hacía las ciencias, así como su percepción y valoración de las prácticas docentes utilizadas en las clases de ciencias (OECD, 2016a). Adicionalmente, el cuestionario de estudiante por primera vez integraba un módulo centrado en la evaluación del bienestar del alumnado (Borgonovi & Pál, 2016). La base de datos de PISA 2015 es la principal fuente de información utilizada en los estudios 1 y 3.

PISA 2018, es la séptima edición del estudio, en la que participaron 609.673 estudiantes de 15 años, procedentes de 79 países del mundo. Estos estudiantes representaban a una población de 28.583.303 alumnos. Un total de 294.527 alumnos de 15 años de los 37 países de la OCDE representaron a 13.575.903 estudiantes en el último año de educación obligatoria (OECD, 2020a). El dominio principal evaluado en PISA 2018 fue el de lectura, acompañado de una evaluación de matemáticas y ciencias, aunque con una dedicación menor en cuanto a la dedicación en el instrumento de evaluación. La evaluación de la competencia lectora no solo buscaba medir la habilidad de los estudiantes para comprender y analizar textos escritos, sino también su capacidad para evaluar la información y argumentos presentados en diferentes

contextos. Además de evaluar la comprensión literal e inferencial, PISA 2018 puso un énfasis especial en la comprensión crítica, que implica la capacidad de discernir la validez y la fiabilidad de la información, así como las opiniones presentadas en los textos (OECD, 2019a). Al igual que en otras ediciones de PISA, se recogieron los datos de contexto a través de cuestionarios dirigidos a los estudiantes y al equipo directivo. El cuestionario de estudiante incorporaba escalas específicas centradas en las prácticas y las estrategias lectoras, así como en la valoración de los hábitos de lectura de los estudiantes dentro y fuera del aula. La base de datos de PISA 2018 es la principal fuente de información utilizada en los estudios 2 y 4.

1.4. Los Modelos de Factores Asociados a los Resultados Educativos: Antecedentes y Estado Actual

Los modelos de factores asociados a los resultados educativos representan un campo fundamental en la investigación educativa, con antecedentes que se remontan décadas atrás. La publicación del informe Coleman hace más de cincuenta años (Coleman, 1969) dio inicio a una era de investigación educativa que trata de identificar los principales factores determinantes del rendimiento educativo (Creemers & Kyriakides, 2007). Desde los primeros estudios de Coleman et al. (1966) y Jencks et al. (1972), que exploraron la relación entre el estatus socioeconómico y los resultados académicos, hasta los modelos más actuales que consideran una gama más amplia de factores contextuales, este campo ha experimentado una evolución significativa. Inicialmente, los modelos de factores asociados se centraban en características individuales del estudiante, como el rendimiento previo y el estatus socioeconómico de la familia (Sirin, 2005). Sin embargo, la investigación posterior demostró la importancia de considerar factores contextuales más amplios, como la calidad de la enseñanza, el clima escolar y las políticas educativas, dando inicio al movimiento de Eficacia Escolar. Uno de los propósitos fundamentales de la Investigación sobre Eficacia Escolar radica en calcular la magnitud de los efectos que las escuelas ejercen sobre el desempeño de sus estudiantes (Murillo & Hernández, 2011). En su artículo “El movimiento de investigación de Eficacia Escolar”, Murillo (2003) sintetiza los fundamentos, la historia y algunas de las aportaciones más importantes de este movimiento, afirmando que “ha llegado a convertirse en la línea de investigación pedagógica que está aportando la mejor información para optimizar los niveles de calidad y equidad educativas” (p. 1). Tradicionalmente, esta área de estudio ha focalizado su atención en los efectos que las instituciones educativas tienen en los resultados cognitivos de los estudiantes, tales como su rendimiento en matemáticas, lengua o ciencias. A lo largo del tiempo, se ha acumulado un considerable volumen de investigaciones dedicadas a este tema (Reynolds & Teddlie, 2002; Scheerens & Bosker, 1997). Algunos de los estudios más emblemáticos de este movimiento se enumeran a continuación:

- *Modelo de cinco factores de* Edmonds (1979). De acuerdo con este enfoque, las escuelas efectivas se caracterizan por tener un liderazgo sólido, fomentar un ambiente de altas expectativas en cuanto al rendimiento estudiantil, mantener una atmósfera ordenada pero no rígida, ser tranquilas sin llegar a ser opresivas, y priorizar la adquisición de destrezas y habilidades básicas, alineando todas las actividades escolares con este objetivo principal. Además, llevan a cabo una evaluación continua y regular del progreso de los alumnos.
- *Junior School Project*, cuyos resultados se publicaron en el libro *School Matters* (Mortimore et al., 1992). En este trabajo, los investigadores se propusieron el objetivo de examinar si la eficacia de los centros educativos y las aulas varía cuando se controla la diversidad de habilidades de los estudiantes al ingresar, así como identificar los factores que influyen en la eficacia de los centros o aulas. Los factores que han sido identificados como eficaces son: liderazgo con propósito, implicación de la subdirección y de los docentes, consistencia entre docentes, sesiones estructuradas, enseñanza intelectualmente desafiante, ambiente centrado en el trabajo, atención reducida a pocos temas en cada sesión, máxima comunicación entre profesores y alumnos, utilizar instrumentos de forma habitual para la autoevaluación del trabajo docente y para planificar actividades posteriores, implicación de las familias y un clima del aula positivo.
- *Louisiana School Effectiveness Studies* (LSES, por sus siglas en inglés), es un importante programa de investigación que se desarrolló en el estado de Louisiana, Estados Unidos, durante la década de 1980 (Stringfield & Teddlie, 1988). Los estudios que lo componen se centraron en analizar los factores que influían en el rendimiento académico de los estudiantes, así como en identificar las características de las escuelas más efectivas, llegando a la conclusión de que las escuelas con un liderazgo fuerte y un enfoque en la mejora continua tendían a tener mejores resultados estudiantiles.
- *Fifty Ways to Leave a Child Behind: Idiosyncrasies and Discrepancies in States' Implementation of NCLB* (Davidson et al., 2015). Este estudio analiza las disparidades en la implementación de la Ley de *No Child Left Behind* (NCLB) entre los diferentes estados de Estados Unidos, destacando las deficiencias en la equidad y calidad educativa.

Las expectativas y la preocupación por la aplicación de los resultados de estos estudios dentro del marco del movimiento de Eficacia Escolar han provocado que desde los primeros momentos se realizaran múltiples revisiones de las investigaciones llevadas a cabo que ofrecen una síntesis de buenas prácticas en la educación (Murillo, 2003). A continuación, se enumeran las revisiones más importantes:

- *The Foundations of Educational Effectiveness* (Scheerens & Bosker, 1997), realiza un análisis crítico de la base de conocimientos sobre la eficacia educativa.
- *The International Handbook of School Effectiveness Research* (Reynolds & Teddlie, 2002): Esta obra revisa la génesis y relevancia de la investigación sobre eficacia escolar, sintetizando

de forma clara y precisa el estado de la cuestión, así como examinando los modelos teóricos y metodológicos utilizados en el campo.

- *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement* (Hattie, 2008): Este estudio sintetiza más de 800 metaanálisis sobre los factores que influyen en el aprendizaje del alumnado, proporcionando una visión integral de las intervenciones educativas más efectivas.

El tema de factores asociados al rendimiento ha ganado aún más interés en la comunidad científica en las últimas décadas debido, en parte, a la disponibilidad de las bases de datos procedentes de evaluaciones a gran escala (Gamazo et al., 2017). Estas evaluaciones han contribuido a la comprensión de cómo los factores asociados a los resultados educativos varían entre diferentes contextos culturales y geográficos y ha sido un área de interés creciente en la investigación reciente (Hanushek & Woessmann, 2015; OECD, 2019b).

En la década pasada, la atención también se centró en la comprensión de cómo los factores sociales y emocionales, como el bienestar emocional y la motivación, pueden influir en los resultados educativos (Wang & Holcombe, 2010). Sin embargo, el número de estudios que han abordado la estimación de los efectos escolares en variables socioafectivos y en bienestar es verdaderamente limitado (Murillo & Hernández, 2011).

Entre los trabajos más destacables en este ámbito es necesario mencionar *Fifteen thousand hours* de Rutter (1979). Este estudio analizó las variables relacionadas con el comportamiento del alumnado como producto, mostrando de manera concluyente que las escuelas pueden marcar la diferencia. En un estudio de tres años realizado en una docena de escuelas secundarias en una gran área urbana, el equipo de Rutter encontró que algunas escuelas eran claramente mejores que otras en promover el éxito académico y social de sus estudiantes. Además, hubo diferencias claras e interesantes entre las escuelas que promueven el éxito y las que promueven el fracaso. En el estudio ya mencionado con anterioridad, *The Junior School Project* (Mortimore et al., 1992), se estudiaron las variables: Comportamiento del alumnado, Actitudes frente a la educación y Autoconcepto. Se llegó a la conclusión de que los centros educativos con más éxito en el fomento del bienestar emocional y motivacional se caracterizan por una atmósfera alegre y positiva, con menos énfasis en el castigo y más en la recompensa, donde los docentes se esfuerzan por promover el autocontrol de los alumnos y muestran interés por cada estudiante como individuo. Además, disfrutan enseñando y dedican tiempo adicional fuera de clase para preocuparse por el bienestar de los alumnos.

Más recientemente, Murillo y Hernández (2011) llevaron a cabo un estudio transversal en América Latina y España para estimar la magnitud de los efectos escolares, de aula y de país para variables no cognitivas como el autoconcepto, el comportamiento en el aula, la convivencia

social y la satisfacción con la escuela. Belfi et al. (2012) realizaron una revisión sistemática de literatura sobre la influencia de la composición de la clase en la educación secundaria en términos de habilidad y género en el bienestar escolar y el autoconcepto académico de los estudiantes. Lazarides y Buchholz (2019) estudiaron la relación entre la calidad docente percibida por los estudiantes en las aulas de matemáticas y el disfrute, la ansiedad y el aburrimiento, tanto a nivel de estudiante como de aula, estimando entre un 4% y un 10% de efectos escolares en función de la variable dependiente.

Investigaciones adicionales centradas en explorar el impacto de las escuelas en el desarrollo de variables no cognitivas han sido llevadas a cabo por Opdenakker et al. (2002), Opdenakker y Van Damme (2000) o Sammons (1999). La mayoría de estos estudios indican la baja capacidad de intervención escolar en los resultados educativos no cognitivos, atribuyendo menos del 5% de su variación a la institución educativa.

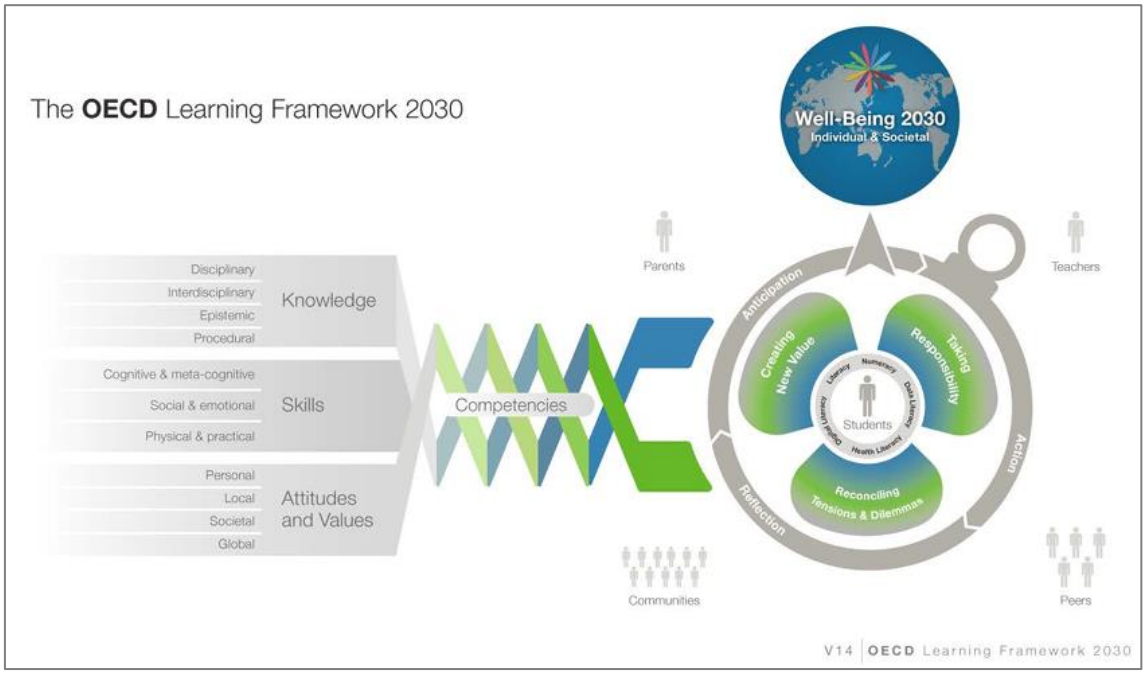
La presente investigación pretende contribuir a la línea de investigación sobre la definición de factores asociados a los resultados educativos en el contexto internacional definiendo los resultados educativos desde un enfoque más global, tal y como se describe en el siguiente apartado.

1.5. Resultados del Proceso de Enseñanza: un Enfoque Integral

En la búsqueda de una educación de calidad es fundamental adoptar un enfoque integral que considere tanto el rendimiento académico como el bienestar general de los estudiantes. Este enfoque reconoce que los resultados del proceso de enseñanza no se pueden limitar únicamente a los resultados en exámenes estandarizados, sino que debe incluir también el desarrollo emocional, social y físico de los alumnos (Chapman, 2015; Waters, 2011). En el marco de aprendizaje definido por la OCDE, la combinación de ambos conceptos se ha incorporado como la base para la educación 2030 (OECD, 2018). En la Figura 1, se presenta una "brújula de aprendizaje" diseñada de manera colaborativa por diversos actores interesados en la educación dentro del Marco de Aprendizaje 2030 de la OCDE. Esta brújula ofrece una guía comprehensiva sobre cómo los estudiantes pueden navegar a través de las complejidades de la sociedad contemporánea hacía el bienestar individual y social. Al proporcionar una visión holística del aprendizaje, la brújula destaca la importancia de adquirir no solo conocimientos académicos, sino también habilidades interpersonales, competencias emocionales y una comprensión profunda de los desafíos globales. Con un enfoque en el desarrollo integral de los

jóvenes, esta herramienta pretende empoderar a los estudiantes para que sean ciudadanos activos, responsables y comprometidos con la construcción de un mundo más justo y sostenible.

Figura 1. El Marco de Aprendizaje 2030 de la OCDE



Nota: La imagen está tomada de la publicación de la OCDE *The Future of Education and Skills 2030*, p.4. (OECD, 2018)

El rendimiento educativo no solo se entiende como obtención de buenas calificaciones en exámenes, también implica el desarrollo de competencias para la vida que preparan a los estudiantes para enfrentar los desafíos del mundo real. El aprendizaje enfocado hacía la mejora de las competencias tiene cada vez más peso, ya que es el modelo de enseñanza idóneo para formar a personas con capacidad para desenvolverse de forma eficaz en el mundo actual, un contexto de globalización y avances tecnológicos, en el que se requiere que los individuos apliquen su pensamiento reflexivo y habilidades para conectar ideas y conocimientos con el fin de afrontar situaciones cotidianas y adaptarse a la transformación constante de la sociedad (Schleicher, 2018). De acuerdo con las Recomendaciones del Consejo de la Unión Europea (Consejo de la Unión Europea, 2018), las competencias del alumnado son herramientas esenciales que permiten lograr que lo que se ha aprendido funcione en tiempo real para generar nuevas ideas, nuevas teorías, nuevos productos y conocimientos en la sociedad cambiante actual.

El grado de adquisición de competencias clave es, sin duda, un aspecto crucial de la educación, ya que proporciona una medida objetiva del dominio de los conocimientos y habilidades necesarias para el éxito en la vida adulta (Schleicher, 2018). Sin embargo, centrarse exclusivamente en los resultados puramente educativos del alumnado puede tener consecuencias

negativas como el estrés excesivo, la ansiedad y la falta de motivación (OECD, 2017a). Por ello, es importante equilibrar las expectativas académicas con el bienestar emocional de los estudiantes. El bienestar emocional y social de los estudiantes juega un papel fundamental en su capacidad para aprender y desarrollarse plenamente (Brackett & Rivers, 2014; Durlak et al., 2011). Los alumnos que se sienten seguros, apoyados y conectados con su entorno escolar tienen más probabilidades de participar activamente en el proceso de aprendizaje y alcanzar su máximo potencial. Por lo tanto, es fundamental crear un entorno escolar inclusivo y de apoyo que promueva el bienestar emocional y social de todos los estudiantes.

En el presente trabajo, el resultado, o el éxito educativo, en el modelo de factores asociados al rendimiento se analiza desde esta perspectiva integral, en la que se pretende atribuir a ambos aspectos - el bienestar estudiantil y el rendimiento medido a través del grado de adquisición de competencias clave - la relevancia que se merecen. A continuación, se define cada uno de estos conceptos dentro del marco de esta investigación.

1.5.1. Bienestar del Alumnado

Como se había comentado previamente, el bienestar de los estudiantes es un factor fundamental en el ámbito educativo, ya que influye directamente en su capacidad para aprender, crecer y desarrollarse de manera integral. Cuando los estudiantes se sienten emocionalmente seguros y apoyados, tienen un mayor rendimiento académico, participan activamente en las actividades escolares y establecen relaciones positivas con sus compañeros y maestros. La evidencia científica muestra que niveles altos de bienestar entre los estudiantes están asociados con experiencias de vida positivas y satisfactorias, mientras que niveles bajos de bienestar están asociados con lo contrario (Pollard & Lee, 2003).

Numerosos estudios han abordado aspectos como la influencia del bienestar en la participación social (Nakamura et al., 2014; Wendel-Vos et al., 2004), en el desarrollo de relaciones personales y profesionales (Pinquart & Sörensen, 2000), o en procesos relacionados con la salud o la salud mental (Verdugo & Martín, 2002). Evaluar el impacto del bienestar sobre el rendimiento académico también ha sido objetivo de diversos estudios cuyos resultados han mostrado que existe una alta correlación entre el rendimiento y el bienestar. Así, Novello et al. (1992) plantean una posible relación entre la salud y el rendimiento en la que el bienestar parece jugar un papel relevante. En esa misma línea, Berger et al. (2011) encuentran, mediante un análisis multinivel, relación entre bienestar socioemocional, bienestar, autoestima, integración social, percepción positiva del clima en la escuela y rendimiento. También Gutman y Vorhaus (2012) encontraron, en un estudio longitudinal, correlaciones significativas entre cuatro dimensiones de bienestar (emocional, comportamental, social y escolar) y el rendimiento presente y futuro. Sin embargo, El Ansari y Stock (2010) detectaron que la relación entre salud,

rendimiento educativo y bienestar (definiendo este último en términos de motivación y satisfacción con la experiencia educativa) fue recíproca.

También son numerosos los estudios que buscan una definición del concepto de bienestar. En una investigación centrada en la infancia y la adolescencia, Pollard y Lee (2003) desarrollaron una revisión sistemática donde encontraron que, a pesar de que el bienestar no se ha definido de una manera consistente y de que no existe acuerdo sobre la mejor forma de medirlo, habitualmente se abordan cinco dominios clave que suelen considerarse independientemente. Esos componentes son: físico, psicológico, cognitivo, social y económico. El dominio físico se refiere a la salud y los hábitos físicos; el psicológico a las emociones y la salud mental (frecuentemente operativizado mediante "ausencia" de indicadores negativos); el cognitivo a elementos intelectuales y relacionados con la escuela; el social a las relaciones con otros, el apoyo y las habilidades interpersonales o comunicativas, y el económico a los recursos económicos de la familia.

Un modelo similar ha sido adoptado en la evaluación del bienestar incluida en el estudio PISA 2015 que incorpora a su habitual evaluación del rendimiento ítems y escalas dirigidos a la medición del bienestar. En ediciones previas, PISA ya había evaluado constructos como el interés por la ciencia, la motivación o la autoeficacia. Sin embargo, en 2015 formula un modelo donde se incluyen indicadores de cinco dimensiones de bienestar: psicológica, social, física, material y cognitiva (Borgonovi & Pál, 2016). Siguiendo la definición del marco teórico, las variables cognitivas se centran en la percepción que tienen los estudiantes sobre sus habilidades y características al enfrentar tareas cognitivas. Estas últimas se basan en cuatro escalas: motivación instrumental, interés, disfrute y percepción de autoeficacia, todo ello referente a las asignaturas de ciencias. La dimensión física recoge aspectos relacionados con los hábitos alimentarios y las actividades deportivas que los estudiantes realizan habitualmente. La dimensión material se centra en los recursos del centro educativo (humanos, materiales, educativos), así como en los recursos en el hogar (nivel educativo y ocupacional de los padres, y las posesiones del hogar como libros, ordenadores, teléfonos, etc.). La dimensión psicológica de bienestar mide el funcionamiento psicológico a través de un ítem que evalúa expectativas del alumnado en cuanto a su futuro, y tres escalas que miden: motivación de logro (grado de ambición, percepción sobre potenciales oportunidades y competitividad); ansiedad ante el proceso de aprendizaje y evaluación, y satisfacción general en la vida mediante una escala de ítem único. Finalmente, las escalas de la dimensión social tienen por objetivo evaluar la cantidad y la calidad de relaciones interpersonales del alumnado, tanto en el ámbito educativo como en el familiar. Abarcan la percepción del alumnado sobre el grado de aceptación en la sociedad, el nivel de compromiso, el interés y la percepción de utilidad del aprendizaje cooperativo (OECD, 2017a).

En la siguiente edición de PISA, en 2018, la definición de bienestar sufrió modificaciones. Los indicadores y la composición de los dominios se ajustaron para reflejar mejor las variables que definen el bienestar estudiantil. En la dimensión psicológica, la satisfacción con la vida de los estudiantes, el sentido de significado en la vida de los estudiantes y los sentimientos de los estudiantes se utilizaron como índices para medir el bienestar subjetivo. Estas variables evalúan la percepción general de la satisfacción con la vida y el sentido de significado en la vida, así como las emociones y estados de ánimo. La autoeficacia y el miedo al fracaso informan sobre las percepciones de los estudiantes sobre sus propias habilidades generales para enfrentar circunstancias desafiantes. La dimensión cognitiva se centra en la mentalidad de crecimiento, que evalúa hasta qué punto alguien percibe sus habilidades e inteligencia como variables que pueden ser desarrollados por ellos mismos. Finalmente, la dimensión social, en línea con el área de bienestar definida en PISA 2015, refleja las percepciones de los estudiantes sobre el nivel de cooperación y competencia en las escuelas, así como la aceptación social y los niveles de acoso escolar.

1.5.2. Competencias para la Vida

En el marco de evaluaciones educativas aceptadas por la gran mayoría de sistemas educativos, las competencias en lectura, matemáticas y ciencias se establecen como competencias clave para la vida (Millar & Osborne, 1998; Rychen & Salganik, 2003). Se consideran fundamentales para el éxito en la vida cotidiana, así como para el desarrollo personal y profesional en la sociedad moderna. La capacidad de leer con comprensión, entender y aplicar conceptos matemáticos, y comprender principios científicos básicos son habilidades esenciales que trascienden las fronteras culturales y son relevantes en todos los aspectos de la vida. Además, estas áreas representan pilares básicos de la educación en otras áreas de conocimiento. La lectura es la base para el aprendizaje en todas las disciplinas (Cunningham & Stanovich, 1998), las matemáticas son fundamentales para la resolución de problemas y el razonamiento lógico (Rizki & Priatna, 2019), y las ciencias proporcionan una comprensión fundamental del mundo natural y tecnológico que nos rodea (Millar, 2006). Las habilidades en lectura, matemáticas y ciencias son esenciales para una amplia gama de carreras y profesiones en el mundo actual. Desde la medicina hasta la ingeniería, desde la economía hasta la informática, estas competencias son requeridas en diversos campos laborales y son cruciales para el éxito profesional. Por último, son habilidades críticas para la participación activa en la sociedad y la toma de decisiones informadas (OECD, 2019a). A continuación, se presenta la definición de cada una de estas competencias según los marcos de evaluación del estudio PISA.

Competencia científica se define como “la capacidad de involucrarse en temas relacionados con la ciencia y con las ideas de la ciencia, como un ciudadano reflexivo. Una persona con conocimientos científicos está dispuesta a participar en un discurso razonado sobre

ciencia y tecnología, lo cual requiere competencias para: 1) explicar fenómenos científicamente: reconocer, ofrecer y evaluar explicaciones para una serie de fenómenos naturales y tecnológicos; 2) evaluar y diseñar la investigación científica: describir y evaluar las investigaciones científicas y proponer formas de abordar científicamente las cuestiones; 3) interpretar datos y pruebas científicas: analizar y evaluar datos, alegaciones y argumentos en una variedad de representaciones y sacar conclusiones científicas adecuadas" (OECD, 2016a, p. 22). Todas estas competencias requieren un sólido conocimiento. Por ejemplo, para explicar fenómenos científicos y tecnológicos es necesario tener un conocimiento profundo del contenido científico (en PISA se seleccionan los contenidos en las áreas de geografía, biología, geología, física, química). Sin embargo, las competencias segunda y tercera van más allá de simplemente conocer datos, dependen de comprender cómo se construye el conocimiento científico y la fiabilidad de dicho conocimiento. Identificar los rasgos distintivos de la investigación científica implica conocer los procedimientos estándar detrás de los diferentes métodos y prácticas utilizadas para establecer dicho conocimiento (conocimiento procedimental) (Gott & Roberts, 2008). Por último, estas competencias requieren un conocimiento epistémico, es decir, una comprensión de los principios fundamentales de las prácticas investigadoras comunes, el estado de las afirmaciones de conocimiento generadas y la interpretación de términos clave como teoría, hipótesis y datos (Duschl et al., 2007).

La **competencia en lectura** se define como "la comprensión, el uso, la evaluación, la reflexión y el compromiso con los textos con el fin de lograr objetivos propios, desarrollar el conocimiento y el potencial personal y participar en la sociedad" (OECD, 2019a, p. 28). La comprensión del texto se basa en la construcción de su significado a partir del bagaje de conocimientos previos del lector, de una variedad de textos previamente conocidos y del contexto social y cultural. Durante el proceso de lectura y la construcción de significado, los lectores competentes emplean diversas estrategias, habilidades y procesos para localizar información, supervisar y mantener la comprensión (van den Broek et al., 1995), así como para evaluar críticamente la pertinencia y fiabilidad de la información (Richter & Rapp, 2014). Ya que los lectores interactúan con una amplia gama de textos continuos y no continuos, tanto impresos como digitales, se espera que estos procesos y estrategias varíen según el contexto y el propósito del texto (Coiro et al., 2014).

Por **competencia matemática** se entiende "la capacidad de un individuo de razonar matemáticamente y de formular, emplear e interpretar las matemáticas para resolver problemas en una amplia variedad de contextos de la vida real. Esto incluye conceptos, procedimientos, datos y herramientas para describir, explicar y predecir fenómenos. Ayuda a los individuos a conocer el papel que cumplen las matemáticas en el mundo y hacer los juicios y tomar las decisiones bien fundamentadas que necesitan los ciudadanos reflexivos, constructivos y comprometidos del siglo XXI" (OECD, 2023a, p. 22). Esta definición amplía la ya establecida

en los marcos teóricos anteriores, utilizados en PISA 2003 y PISA 2012. Sin embargo, se observa la tendencia hacia la reducción de la necesidad de realizar cálculos básicos, transitando hacia un mundo dinámico y cambiante impulsado por nuevas tecnologías. En este contexto, se alienta a los estudiantes a ser creativos, comprometidos y capaces de discernir tanto para su propio beneficio como para el de la sociedad en la que se desenvuelven. El marco actualizado sostiene que la alfabetización matemática en el siglo XXI incluye el razonamiento matemático y algunos aspectos del pensamiento computacional, entendido este último como un proceso de pensamiento que supone formular problemas y diseñar sus soluciones de una manera que puedan ser ejecutadas por un ordenador, un humano o una combinación de ambos (Wing, 2008).

1.6. Categorías de Factores Asociados a los Resultados Educativos

Existen diversos marcos conceptuales utilizados en la educación para comprender, modelar y evaluar el proceso de enseñanza y aprendizaje. Uno de los enfoques más conocidos es el modelo basado en el enfoque "contexto-proceso-producto" propuesto por Stufflebeam y Shinkfield (1987), comúnmente conocido por las siglas CIPP, es decir, Contexto, entrada (Input), Proceso y Producto. Este enfoque reconoce que el aprendizaje no ocurre en un vacío, sino que está influenciado por factores como el contexto en el que tiene lugar, los procesos de enseñanza y aprendizaje que se llevan a cabo, y los resultados observables que se producen como consecuencia.

El **contexto** se refiere al entorno en el que tiene lugar el aprendizaje. Esto incluye factores como el entorno familiar, socioeconómico y cultural del estudiante, así como el ambiente educativo en el que se encuentra, como la escuela y la comunidad en general. El contexto influye en la forma en que se reciben, procesan y aplican los conocimientos, así como en las oportunidades de aprendizaje disponibles para los estudiantes (Gutiérrez & Rogoff, 2003). Por definición, el contexto corresponde a los factores antecedentes, es decir, a las variables previas o dadas sobre los que los centros educativos tienen escasas o nulas posibilidades de manipulación o mejora. Pese a su naturaleza de factores poco modificables, tienen una importante incidencia en los resultados del aprendizaje. De hecho, los primeros trabajos empíricos sobre organizaciones escolares ya mencionados evidenciaron que los factores de contexto, por ejemplo, los estudios de la madre, eran el predictor más importante del rendimiento académico (Coleman, 1969). Múltiples investigaciones posteriores, incluyendo el estudio PISA, han confirmado esta evidencia en numerosas ocasiones. El ámbito geográfico donde se ubica el centro escolar o el contexto próximo de la institución educativa, el nivel social, económico y cultural de las familias o la nacionalidad y lengua materna del alumnado, son ejemplos de factores de contexto y entrada que están claramente asociados a los resultados educativos. Estos

factores de contexto son poco permeables a la acción del centro educativo. El cuerpo docente tiene escaso campo de acción, por ejemplo, para mejorar la titulación académica de los progenitores o las oportunidades culturales del entorno educativo (Hanushek & Kain, 1972). Por ello, lo ideal es que el efecto sobre los resultados de este tipo de factores fuese lo más limitado posible o que los centros educativos fuesen capaces de contrarrestar su posible impacto negativo sobre los resultados.

El **proceso** se refiere al conjunto de factores sobre los que los centros educativos pueden incidir para modificar sus resultados de aprendizaje. Pueden ser actividades y estrategias de enseñanza que tienen lugar en el contexto educativo. Esto incluye cómo se presentan los contenidos, las interacciones entre maestros y estudiantes, el uso de recursos educativos y las metodologías pedagógicas utilizadas para facilitar el aprendizaje. El proceso de enseñanza y aprendizaje es fundamental para el desarrollo de habilidades, la adquisición de conocimientos y la formación de actitudes y valores. El interés por este segundo tipo de factores surge como reacción a las conclusiones del informe Coleman (Coleman, 1969), que otorgaba a los procesos escolares escasa incidencia en los resultados educativos. Como se describía en el apartado anterior del presente trabajo, frente a esta conclusión surgen los primeros estudios de eficacia escolar y mejora educativa, dando lugar a un movimiento teórico-práctico de Mejora de la Escuela con la idea central de que "la escuela debe ser el centro del cambio" (Hargreaves, 2005; Murillo, 2002). Las investigaciones encuadradas en este movimiento por la eficacia y la mejora educativa durante las últimas décadas han identificado un conjunto de procesos educativos claramente asociados a buenos resultados. De esta forma, el clima de relaciones personales, los métodos de enseñanza y la gestión del aula, la relación familia-escuela, las expectativas académicas y la valoración positiva de la escuela o el papel de los equipos directivos se han mostrado como procesos claves para la mejora de la calidad educativa. Por tanto, los estudios basados en modelos de factores asociados que se enmarcan en el movimiento sistémico tienen como principal preocupación la identificación de los procesos educativos responsables de la mejora escolar (Murillo, 2003).

El **producto** hace referencia a los resultados observables del proceso de enseñanza y aprendizaje. Incluye logros académicos, como el dominio de habilidades y conocimientos específicos, y aspectos socioemocionales, como el desarrollo de habilidades para la resolución de problemas, la colaboración y la autoestima. Los productos del aprendizaje pueden ser evaluados mediante diferentes tipos de evidencia como pruebas estandarizadas, proyectos de clase, desempeño en tareas y observaciones de comportamiento. Tradicionalmente el producto escolar más estudiado en las investigaciones de factores asociados han sido las medidas de rendimiento escolar entendidas bien como tasas de éxito o repetición, o bien como puntuaciones en alguna prueba objetiva elaborada para tal fin. Actualmente, existe una corriente cada vez más

mayoritaria dentro de los estudios de evaluación de sistemas educativos que entiende los resultados educativos en sentido amplio y no solo cercenados a resultados de tipo cognitivo.

Existen otros enfoques similares en la clasificación de factores asociados al aprendizaje. Algunos autores clasifican los factores de la escuela en dos grupos de variables: contexto y clima (O'Connell & McCoach, 2008). Las variables de contexto se refieren a aquellos factores que no pueden modificarse fácilmente por los agentes educativos; no están relacionados con ninguna estrategia o programa escolar. A menudo dependen de la legislación educativa, las características demográficas de la comunidad local o el trasfondo histórico de la escuela. Estos factores, a su vez, pueden clasificarse en el entorno físico de la escuela (por ejemplo, tamaño, ubicación, recursos), las características de los estudiantes (por ejemplo, situación socioeconómica, estado migratorio), y las características de los docentes (por ejemplo, educación y formación profesional, experiencia laboral, situación de empleo). Por otro lado, las variables de clima son aquellas características del ambiente de aprendizaje controladas por la comunidad educativa (por ejemplo, gestión y liderazgo escolar, organización instruccional, nivel de autonomía en la designación de currículos y recursos, clima disciplinario). Reynolds y Teddlie (2002) resaltaron la importancia de distinguir entre factores de contexto y de clima en la evaluación de la efectividad escolar; esta distinción permite identificar factores que pueden ser modificados por las escuelas para aumentar su efectividad. Otros autores clasifican los factores asociados a logros educativos según el nivel al que pertenecen: el nivel de estudiante o el nivel de centro educativo (Gamazo et al., 2017).

1.7. Descripción de Factores Asociados a Resultados del Proceso de Enseñanza

Una vez definidas las variables entendidas como resultados del proceso de enseñanza (producto), en el presente apartado se describen las variables utilizadas en esta tesis como variables explicativas, aquellas que representan los factores asociados a los resultados del proceso de enseñanza (entrada/contexto y proceso). Las variables se agrupan siguiendo la categorización basada en la taxonomía del enfoque sistémico, entrada/contexto-proceso (Jornet et al., 2012; Murillo et al., 2007), combinada con la clasificación según el nivel al que pertenece, alumnado/centro educativo (Gamazo et al., 2017).

1.7.1. Variables Predictoras Asociadas al Alumnado

1.7.1.1. Variables de Entrada/Contexto

El primer grupo de variables son las variables de entrada/contexto asociadas al alumnado. Como se comentaba con anterioridad, estos factores se encuentran fuera del alcance del centro

educativo, no obstante, no pueden ser obviados dadas las fuertes conexiones que demuestran tener con los resultados educativos.

1.7.1.1.1. Género

Numerosos estudios han explorado las conexiones entre el género del estudiante y su rendimiento académico, así como su bienestar, revelando la importancia de la variable *género* como predictora de resultados educativos (Karakolidis et al., 2016; Özdemir, 2016; Stoet & Geary, 2013). En términos de rendimiento, se observa que existen diferencias entre géneros en diversas áreas del conocimiento. En general, las niñas tienden a sobresalir en materias relacionadas con el lenguaje, mientras que los niños a menudo destacan en matemáticas y ciencias (Gamazo et al., 2017). Estas diferencias pueden deberse a una combinación de factores biológicos, sociales y culturales, así como a las expectativas y estereotipos de género presentes en la sociedad y el entorno escolar (Eccles, 2011; Hyde & Mertz, 2009; Nosek et al., 2009; Pomerantz et al., 2002).

Además del rendimiento académico, el bienestar emocional y psicológico de los estudiantes también está influenciado por el género. Se ha observado que las niñas tienden a reportar niveles más altos de ansiedad y estrés en comparación con los niños, lo que puede afectar su capacidad para concentrarse y aprender (McLean & Anderson, 2009; Twenge, 1997; Zahn-Waxler et al., 2008). Adicionalmente, los roles de género tradicionales pueden influir en la forma en que los estudiantes perciben sus propias habilidades y limitaciones, lo que a su vez puede impactar en su autoestima y motivación (Eccles & Wigfield, 2002).

El estudio PISA recoge la información acerca del género del estudiante a través de los cuestionarios de contexto o extrayendo esta información a partir de la documentación administrativa recogida durante el trabajo de campo. Dado el importante impacto que ejerce, la variable *género* ha sido utilizada como variable control en los estudios de la presente tesis doctoral.

1.7.1.1.2. Nivel Social, Económico y Cultural de las Familias

El nivel social, económico y cultural de las familias emerge como un predictor fundamental del rendimiento académico y el bienestar emocional de los estudiantes. Numerosas investigaciones han demostrado consistentemente que los niños provenientes de entornos socioeconómicos más favorables tienden a tener un rendimiento académico más alto (Cordero et al., 2014; Gamazo et al., 2017; Sirin, 2005; Suárez-Álvarez et al., 2014) y experimentan niveles más altos de bienestar emocional en comparación con aquellos que proceden de contextos desfavorecidos (Duncan & Magnuson, 2012; Reiss, 2013). Esto se debe, en parte, a que las familias con mayores recursos económicos tienen la capacidad de proporcionar un

ambiente enriquecido con acceso a materiales educativos de calidad, apoyo académico adicional y oportunidades extracurriculares, lo que fomenta el desarrollo integral del estudiante desde primera infancia. Además, el nivel educativo y cultural de los padres puede influir en las expectativas que tienen para sus hijos, así como en su apoyo emocional y motivacional, lo que a su vez impacta en la autoestima y la perseverancia académica de los estudiantes (Fan & Williams, 2010).

El estudio PISA mide el nivel socioeconómico y cultural del alumnado a través del índice denominado "*Índice Social, Económico y Cultural*" (ESCS). ESCS se construye a partir de una serie de variables que reflejan el estatus socioeconómico y cultural de los estudiantes. El proceso de construcción del ESCS generalmente implica la aplicación de técnicas de análisis de componentes principales al conjunto de datos recopilados, en combinación con las técnicas psicométricas de la TRI. Estas variables incluyen aspectos como el nivel educativo y ocupacional de los padres, la cantidad de libros en el hogar y la posesión de bienes materiales (OECD, 2017b, 2020a). El índice ESCS también ha sido utilizado como variable control en los estudios del presente trabajo.

1.7.1.1.3. Estatus Inmigrante

Otra de las variables control que suele estar presente en las investigaciones de factores asociados al rendimiento es el *estatus inmigrante* del estudiante, debido al impacto significativo que puede tener en su rendimiento escolar y bienestar (Karakolidis et al., 2016; Özdemir, 2016). Los estudiantes inmigrantes pueden enfrentar una serie de desafíos únicos que van desde las barreras lingüísticas y culturales hasta la adaptación a un nuevo entorno escolar y social. La falta de dominio del idioma del país de acogida puede dificultar la participación activa en el aula y el acceso a los recursos educativos, lo que a su vez puede afectar negativamente su rendimiento académico. No es sorprendente, por tanto, que los estudiantes nativos obtengan sistemáticamente mejores resultados académicos (OECD, 2019b).

Además, la adaptación a una nueva cultura y sistema educativo puede generar estrés emocional y ansiedad, lo que puede impactar en su bienestar psicológico y emocional (Motti-Stefanidi & Masten, 2013; Sirin, 2005). Sin embargo, los estudiantes inmigrantes también pueden mostrar una notable resiliencia y determinación para superar estos obstáculos, especialmente cuando reciben apoyo adecuado por parte de la escuela, la comunidad y sus familias, lo que puede facilitar su integración, mejorar su rendimiento escolar y promover su bienestar general (Gabrielli et al., 2022).

El estudio PISA recoge información sobre el origen inmigrante de los estudiantes. En base a esta información se genera un índice simple que identifica al estudiantado nativo, y al estudiantado inmigrante de primera generación (tanto el estudiante como sus progenitores han

nacido en un país distinto al país en el que se está realizando la prueba) y de segunda generación (el estudiante ha nacido en el país donde se realiza la prueba, pero sus progenitores han nacido en otro país). Las investigaciones previas apuntan al estatus migratorio como a una variable relevante, pero solo para los estudiantes inmigrantes de 1ª generación (Gamazo et al., 2017). En la presente investigación el origen inmigrante de primera generación se utiliza como variable control en los modelos de factores asociados.

1.7.1.2. Variables de Proceso

En este apartado se describen las variables de proceso, refiriéndose a aquellos factores asociados al estudiante que surgen o tienen lugar durante el proceso de enseñanza y aprendizaje, por ejemplo, la motivación del alumnado o el conocimiento y uso de estrategias de aprendizaje eficaces. Estos factores pueden ser modulados a nivel del centro educativo a través de diversas prácticas y metodologías utilizadas en el aula.

1.7.1.2.1. Motivación Intrínseca y el Gusto por las Áreas de Evaluación

Existe un amplio consenso entre los investigadores al situar la motivación intrínseca de los estudiantes como un factor crucial con gran influencia en los resultados educativos de los estudiantes (Suárez-Álvarez et al., 2014; Veas et al., 2017). Cuando los estudiantes están intrínsecamente motivados, es decir, cuando se sienten impulsados por su interés y deseo personal de aprender, tienden a comprometerse más activamente en las actividades escolares y a perseguir metas académicas de manera más persistente (Wigfield & Cambria, 2010). Esta motivación está asociada con un mayor rendimiento académico, ya que los estudiantes muestran una mayor disposición para explorar y comprender los conceptos, así como para enfrentar desafíos académicos con determinación y resiliencia (Vaknin-Nusbaum et al., 2018).

Numerosos estudios han demostrado que los estudiantes que tienen un interés genuino en la materia que están estudiando tienden a mostrar un mayor desempeño en este área de conocimiento (García Crespo et al., 2019; García-Crespo et al., 2019, 2021; Harackiewicz et al., 2000; Hidi & Ann Renninger, 2006; Vaknin-Nusbaum et al., 2018).

Los estudiantes están intrínsecamente motivados para aprender ciencias cuando desean hacerlo no debido a lo que podrán lograr al dominar nuevos conceptos científicos, sino porque encuentran placentero aprender ciencias y trabajar en problemas científicos (Ryan & Deci, 2009). El *disfrute de la ciencia* afecta a la disposición de los estudiantes para dedicar tiempo y esfuerzo a actividades relacionadas con la ciencia, la elección de asignaturas optativas, la autoimagen de los estudiantes y el tipo de carreras a las que aspiran y eligen seguir (Nugent et al., 2015).

El *gusto por la lectura*, a su vez, está asociado con un mayor rendimiento en todas las áreas de conocimiento (Guthrie et al., 2000; Mol & Bus, 2011). Los lectores empedernidos tienen una mayor comprensión lectora, un vocabulario más amplio, una mejor capacidad de expresión escrita y una mayor capacidad de análisis y pensamiento crítico.

Es importante reconocer que la motivación de los estudiantes no solo está relacionada con su rendimiento académico, sino también con su bienestar emocional (Reeve, 2012; Wang & Eccles, 2013). Los estudiantes que experimentan un sentido de competencia, autonomía y conexión con el aprendizaje tienden a sentirse más satisfechos y comprometidos con la escuela, lo que contribuye a su bienestar general.

PISA 2015 y PISA 2018 recogieron indicadores sobre el gusto de los estudiantes por las ciencias y por la lectura, respectivamente. A partir de estos indicadores, se construyeron dos índices derivados, el *disfrute de las ciencias* y el *disfrute de la lectura*, que han demostrado tener una fuerte relación con el nivel competencial alcanzado (OECD, 2016b, 2019b).

1.7.1.2.2. Motivación Instrumental

Junto con la motivación intrínseca, la motivación extrínseca, es decir, la motivación impulsada por recompensas externas o presiones sociales, también puede influir en el rendimiento y bienestar de los estudiantes. Es otra variable motivacional en la que se centra PISA: la *motivación instrumental*, comprendida como un tipo de motivación extrínseca que impulsa a los estudiantes a realizar actividades específicas con el fin de obtener recompensas externas o evitar castigos. En el contexto de PISA, la motivación instrumental en ciencias se refiere al impulso de aprender ciencias porque los estudiantes perciben que es útil para ellos y para sus futuros estudios y carreras (Wigfield & Eccles, 2000). En PISA 2015, los países que experimentaron aumentos en la motivación instrumental de sus estudiantes para aprender ciencias también observaron aumentos en la motivación intrínseca (disfrute de las ciencias) entre 2006 y 2015.

1.7.1.2.3. Uso de Estrategias de Aprendizaje Eficaces

Cuando los estudiantes emplean estrategias de aprendizaje que les permiten organizar, comprender y recordar la información de manera más efectiva, tienden a lograr mejores resultados académicos (Pressley & Harris, 2009; Weinstein et al., 2000). Estas estrategias pueden incluir técnicas de estudio como el subrayado, la elaboración de resúmenes y la elaboración de mapas conceptuales, así como enfoques de aprendizaje activo que fomentan la participación activa y la reflexión sobre el material de estudio. Además, el uso de estrategias de aprendizaje eficaces puede aumentar la confianza y la autoeficacia de los estudiantes, ya que les proporciona las herramientas necesarias para enfrentar los desafíos académicos con mayor

seguridad (Schunk & Pajares, 2005). En términos de bienestar, el dominio de estas estrategias puede reducir el estrés y la ansiedad asociados con el estudio, ya que los estudiantes se sienten más capacitados y preparados para enfrentar las demandas académicas.

El marco de evaluación de PISA 2018 abarcó dos escenarios de evaluación de las estrategias de aprendizaje en el contexto de la competencia lectora, la materia principal del estudio. Ambas estrategias se relacionan con la metacognición: a) resumir, y b) comprender y recordar. Se pidió a los estudiantes que calificaran las estrategias de lectura en relación con su utilidad para abordar una tarea de lectura, una evaluación que también fue realizada en paralelo por un grupo de expertos a través de comparaciones múltiples dos a dos. Esta evaluación produjo una jerarquía de todas las estrategias para cada tarea, clasificadas de más a menos útiles, con el acuerdo de al menos el 80% de los expertos. Basándose en esta puntuación, se crearon reglas para construir una puntuación para cada estudiante en función de la frecuencia con la que elegían una estrategia más útil en lugar de una menos útil. Las puntuaciones finales asignadas a cada estudiante para cada tarea oscilaron entre 0 y 1 y pueden interpretarse como la proporción del número total de puntuaciones que estuvieron de acuerdo con el orden jerárquico de los expertos. Puntuaciones más altas indican más elecciones convergentes con las evaluaciones de los expertos. A partir de esas puntuaciones, el estudio PISA construyó dos índices: las *estrategias de comprensión y recordatorio* y *las estrategias de resumen* (OECD, 2020a).

1.7.2. Variables Predictoras Asociadas al Centro Educativo

1.7.2.1. Variables de Entrada/Contexto

Las variables de entrada/contexto a nivel de centro educativo son aquellos factores atribuibles a la institución educativa que no son modulables por dicha institución, por ejemplo, su titularidad, que depende del tipo de financiación que percibe (centros públicos, privados), o el tamaño del centro o de la clase, que suele depender de la demanda escolar y/o de la legislación educativa vigente.

La *titularidad* escolar es determinante en la clasificación de resultados educativos prácticamente en todos los países de la OCDE, no obstante, no es la fuente de la financiación lo que determina los resultados, sino el nivel socioeconómico y cultural de los estudiantes de los centros de diferente titularidad, siendo el nivel promedio de ESCS del centro el factor explicativo determinante (Perry & McConney, 2010). Los centros de titularidad privada suelen agrupar a los estudiantes con un nivel de ESCS muy elevado y, por tanto, suelen alcanzar resultados educativos significativamente más elevados que los centros públicos. En la presente tesis, la variable control a nivel de centro educativo es el ESCS promedio de la institución, calculado como el promedio de ESCS de sus estudiantes.

El *tamaño de la escuela* ha sido estudiado en relación con el éxito escolar, medido en términos de mejora en las calificaciones de los estudiantes (Bloom et al., 2010). Se confirmó que la reducción del tamaño de la escuela mejora las condiciones y resultados de los estudiantes, incluso en situaciones de desventaja económica. El metaanálisis realizado por Hattie (2008) también sostiene que la reducción del tamaño de la escuela es un factor determinante para mejorar el rendimiento estudiantil. El estudio PISA suele recoger la información acerca del tamaño del centro educativo a través del cuestionario de contexto dirigido al director/a, en el que se recoge el número total de niños y niñas que cursan la etapa de educación obligatoria.

Por otro lado, el *tamaño* reducido de la *clase* también ha demostrado impactar positivamente en el rendimiento académico (Faubert, 2012). Aunque no hay evidencia concluyente sobre este tema, Hanushek (2000) afirma que el impacto de la reducción del tamaño de la clase en general es pequeño y es probable que beneficie solo a los estudiantes con bajo rendimiento. En PISA la información acerca del tamaño de la clase también se recoge en el cuestionario de director/a (OECD, 2017b).

1.7.2.2. Variables de Proceso

En este apartado se describen las variables de proceso que se encuentran bajo el control directo del centro educativo. Estas variables abarcan los aspectos internos y dinámicos de una institución educativa. Están relacionadas con el funcionamiento interno del centro y cómo este afecta el proceso educativo, al aprendizaje de los estudiantes y a su bienestar general. Este grupo de variables son de especial importancia dentro del enfoque de factores asociados al rendimiento, dado que constituyen los mecanismos de acción directa capaces de fomentar la mejora de resultados del proceso de aprendizaje y, a la vez, contrarrestar o potenciar el impacto de las variables de entrada/contexto descritas anteriormente.

1.7.2.2.1. Estrategias y Prácticas Docentes

En las investigaciones destinadas a identificar los principales factores que determinan el rendimiento educativo existe un consenso sobre la importancia crucial del papel desempeñado por los docentes (Hanushek & Rivkin, 2012; Rivkin et al., 2014). Sin embargo, aún persiste la falta de acuerdo respecto a los aspectos específicos que tienen mayor incidencia en los resultados académicos (Campbell et al., 2012; Hattie, 2008).

Al hablar de las estrategias, prácticas o métodos docentes, se hace referencia a una amplia gama de procesos y actividades que incluyen desde la organización del aula y la utilización de recursos disponibles, hasta las estrategias diseñadas para fomentar el aprendizaje de los estudiantes, que a su vez se tienen que adaptar al contexto del aula (Abd Razak & Shafaei, 2016).

En la literatura sobre métodos de enseñanza, se distinguen dos modelos principales: el clásico o tradicional, donde el profesor tiene un papel central impartiendo conocimientos y resolviendo ejercicios, y el moderno, centrado en el estudiante mediante actividades grupales y aplicaciones a la vida real (Zemelman et al., 2005). Recientes estudios de la OCDE proponen una clasificación similar, identificando las siguientes estrategias: la *instrucción dirigida por el docente* y la *enseñanza basada en la indagación*. Mientras que la primera refleja los métodos tradicionales, la otra está asociada a enfoques modernos, destacando el aprendizaje activo por su enfoque constructivista que fomenta la participación estudiantil y el uso de tecnología, y la activación cognitiva por promover la autonomía estudiantil y el desarrollo de habilidades como el pensamiento crítico y la toma de decisiones (Donné et al., 2016).

Gil Izquierdo et al. (2018) obtuvieron evidencia empírica que respalda el papel de las estrategias de enseñanza directa en los datos españoles en PISA 2015, señalando que estas estrategias conllevan una mejora significativa en el rendimiento educativo. En contraste, las estrategias basadas en la investigación, que promueven el aprendizaje activo y la activación cognitiva para incrementar la participación estudiantil o fomentar el pensamiento crítico, no han demostrado tener un impacto significativo en el rendimiento e, incluso en algunos casos, pueden producir resultados inferiores. Sin embargo, estas estrategias de aprendizaje activo parecen tener un efecto positivo más notable en el bienestar, las actitudes y la motivación de los estudiantes (Donné et al., 2016).

1.7.2.2.2. Apoyo del Profesorado

El apoyo brindado por los docentes, tanto a nivel académico como emocional, puede influir significativamente en el desempeño estudiantil y su bienestar general (Roorda et al., 2011; Wentzel, 2009). Cuando los profesores demuestran interés en el progreso y desarrollo de sus alumnos, ofrecen orientación y retroalimentación constructiva, y crean un ambiente de confianza y apoyo emocional, los estudiantes tienden a sentirse más motivados y comprometidos con su aprendizaje (Hattie, 2008). Este vínculo positivo entre el apoyo del profesorado y el rendimiento académico se traduce también en un mayor bienestar emocional, ya que los estudiantes se sienten respaldados y valorados, lo que contribuye a su autoestima y satisfacción personal dentro del entorno escolar.

En el contexto del estudio PISA, tanto en 2015 como en 2018, se construye un índice compuesto, denominado *Apoyo del profesorado*, en base a las respuestas de los estudiantes a las afirmaciones sobre el interés del profesor por el aprendizaje de cada alumno o la proporción de ayuda adicional. En los países de la OCDE, la relación entre el apoyo del profesorado y el rendimiento se hace positiva al descontar el efecto del estatus socioeconómico de las escuelas y los estudiantes (OECD, 2017a).

En cuanto a la relación de este constructo con el bienestar, existen evidencias de que los estudiantes muestran actitudes más positivas y una mayor motivación académica si los profesores les brindan apoyo, se preocupan por ellos y los ayudan cuando lo necesitan (Ricard & Pelletier, 2016).

Las variables descritas en este apartado se han utilizado como variables predictoras de resultados del proceso de enseñanza a lo largo de la presente tesis. Para medir su impacto en las variables dependientes, así como para describir la conexión entre ellas, se han utilizado diversas técnicas metodológicas que se describen en detalle en el siguiente apartado.

1.8. Modelos Metodológicos de Análisis

La investigación sobre los factores asociados al rendimiento y la eficacia escolar enfrenta una complejidad inherente debido al gran número de variables involucradas y a las interconexiones entre ellas (Tejedor, 2003). Esta complejidad ha motivado la aplicación de una amplia gama de técnicas estadísticas para abordar este campo de estudio.

Las metodologías utilizadas por excelencia en las investigaciones de factores asociados son las técnicas estadísticas agrupadas bajo la denominación Modelos Jerárquicos Lineales (MJL), también llamados Modelos Multinivel. Estas técnicas de análisis permiten discernir la variabilidad aportada por cada nivel de agregación presente en los datos jerárquicos. Su popularidad comenzó con la publicación de un artículo clave de metodología de investigación sobre Eficacia Escolar (Aitkin & Longford, 1986); en él se demostró la clara superioridad de los Modelos Multinivel sobre cualquier otra aproximación metodológica. Este hecho generó una nueva fase en la investigación en este ámbito, a partir de la cual la mayoría de las investigaciones se realiza mediante esta aproximación (Murillo, 2003).

La aplicación de los Modelos Jerárquicos Lineales se recomienda en situaciones donde los datos exhiben una estructura anidada, como sucede en las evaluaciones a gran escala, donde los estudiantes están organizados en estructuras de nivel superior (Gamazo et al., 2016, 2017; Joaristi L. & Azpillaga V., 2014; Lenkeit, 2013; Martínez et al., 2009; Murillo Torrecilla & Hernández Castilla, 2011).

Las ventajas de la metodología multinivel residen en su capacidad para estimar la magnitud de los efectos escolares y analizar sus características, así como para identificar los factores asociados al logro académico (Aitkin & Longford, 1986; Goldstein, 2010; Hill & Rowe, 1996; Murillo, 2008; Reynolds & Teddlie, 2002).

El uso de regresiones lineales múltiples también es común en los modelos de factores asociados al rendimiento, ya que permite examinar cómo múltiples variables predictoras se

relacionan con una variable de interés, como el rendimiento académico. En estos modelos, el rendimiento se considera la variable dependiente, mientras que los factores asociados, como el nivel socioeconómico, el género, el tipo de escuela, entre otros, se consideran variables predictoras. En los modelos de factores asociados al rendimiento, de eficacia escolar o de valor añadido, son especialmente útiles ya que permiten ajustar las puntuaciones de los estudiantes en función de sus puntuaciones previas y de este modo aislar el efecto de las características de los estudiantes o de la escuela (Jakubowski, 2008; Ladd & Walsh, 2002; Lockwood et al., 2003).

Otro ejemplo de técnicas cuantitativas empleadas en las investigaciones sobre factores asociados al rendimiento son los modelos de ecuaciones estructurales. Estos modelos posibilitan la identificación de relaciones entre variables predictoras y variables dependientes, y la inclusión de variables latentes o dimensiones (mediante análisis factoriales confirmatorios). Estos constructos, que no pueden ser medidos directamente, son explorados a través del análisis de otras variables observables (Castro & Lizasoain, 2012).

Las técnicas de minería de datos también son apropiadas para el análisis de datos procedentes de grandes evaluaciones, dado que posibilitan la extracción de información relevante, como patrones o relaciones significativas entre variables, a partir de bases de datos que contienen una gran cantidad de información (Castro & Lizasoain, 2012; Martínez Abad & Chaparro Caso López, 2017). Estas técnicas permiten la identificación de patrones en los datos sin proponer suposiciones previas o modelos iniciales, y con una intervención mínima por parte del investigador (Xu, 2005). Por lo tanto, la naturaleza de algunos algoritmos de minería de datos, en comparación con otras técnicas multivariadas clásicas, puede promover un progreso significativo en la identificación de factores asociados con la efectividad escolar, orientando la toma de decisiones y el funcionamiento del sistema educativo a niveles macro, meso y micro (Bronfenbrenner, 1979). A pesar del potencial que estas técnicas estadísticas puedan tener, su uso en el establecimiento de modelos de predicción del rendimiento en la educación obligatoria es esporádico (Hung et al., 2012; Martínez Abad & Chaparro Caso López, 2017; Oskouei & Askari, 2014; Şara et al., 2015), y su uso para la exploración de evaluaciones a gran escala es bastante limitado (Asensio Muñoz et al., 2018; Kılıç Depren et al., 2017; Liu & Whitford, 2011).

Con el avance de la investigación, los modelos de factores asociados se han vuelto más sofisticados incorporando enfoques innovadores, por ejemplo, se emplean los métodos mixtos que combinan métodos cuantitativos y cualitativos para comprender mejor la complejidad de los procesos educativos (Creswell & Plano Clark, 2007), la modelización en base a las estructuras de redes (Fonseca-Pedrero, 2018) o técnicas econométricas, adaptadas a los contextos educativos (Cordero & Pedraja, 2019; Schlotter et al., 2011).

En la presente tesis doctoral se han explorado diversos métodos de análisis de datos seleccionados o combinados para una mejor modelación de relaciones entre variables objeto de estudio.

1.8.1. Regresión Lineal Múltiple

La regresión lineal es un método estadístico utilizado para modelar la relación entre una variable dependiente y una o más variables predictoras, basada en la suposición de existencia de una relación lineal entre las variables predictoras y la variable dependiente. Se pretende encontrar el modelo de mejor ajuste, que represente esta relación.

La formulación matemática del modelo de regresión clásica se presenta a través de la siguiente ecuación:

$$y_i = \beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j} \, (\dots) + \beta_n x_{nj} + e_j$$

Donde,

y_i es la variable dependiente del sujeto i, por ejemplo, el rendimiento académico de un estudiante.

β_0 es el intercepto cuando los valores asignados a las variables predictoras tienen valor 0.

$\beta_1, \beta_2 \dots \beta_n$ son los coeficientes de regresión que expresan el efecto de las variables predictoras (puntos de ganancia o de pérdida) sobre el resultado. Por ejemplo, β_1 es el efecto del sexo del estudiante sobre el resultado; β_2 es el efecto del nivel socioeconómico y cultural sobre el resultado; y β_n es el efecto de cualquier otra variable considerada en la predicción del resultado.

$x_{1j}, x_{2j} \dots x_{nj}$ son los valores asignados a las variables predictoras. Estos valores pueden expresar cualquier valor numérico. Por ejemplo, x_{1j} = 0 para los hombres y x_{1j} = 1 para las mujeres; x_{2j} = puntuación en escala continua con media 0 y desviación típica 1 que resume el nivel socioeconómico y cultural del alumnado; x_{nj} los valores que hipotéticamente se puedan asignar a cualquier otra variable que permita predicir el resultado del estudiante.

e_j es el residuo o error de estimación, es decir, la diferencia entre el resultado efectivamente alcanzado por el estudiante y el esperado en función de las variables predictoras: sexo, nivel socioeconómico y cultural y cualquier otra incluida en la ecuación de predicción.

Para valorar la capacidad de predicción del modelo de regresión se calcula el coeficiente de determinación (R^2). En concreto, esta medida estadística indica la proporción de la

variabilidad en la variable dependiente que es explicada por el modelo de regresión lineal. En otras palabras, R^2 proporciona una medida de la calidad del ajuste del modelo a los datos observados. R^2 varía entre 0 y 1. Un valor de R^2 cercano a 1 indica que una gran proporción de la variabilidad en la variable dependiente puede ser explicada por el modelo. Un valor de R^2 cercano a 0 indica que el modelo no explica mucha variabilidad en la variable dependiente y puede no ser adecuado para los datos.

$$R^2 = 1 - \frac{ss_{res}}{ss_{tot}}$$

Donde:

ss_{res} es la suma de los cuadrados de los residuos (la diferencia entre los valores observados de la variable dependiente y los valores predichos por el modelo).

ss_{tot} es la suma total de los cuadrados (la diferencia entre los valores observados de la variable dependiente y su media).

1.8.2. Modelo Jerárquico Lineal

El Modelo Jerárquico Lineal, también conocido como Modelo de Ecuaciones de Estimación General o Modelo de Ecuaciones Mixtas, es una herramienta analítica utilizada en la investigación educativa y en diversas disciplinas para examinar las relaciones entre variables en los datos que tienen una estructura anidada o jerárquica (Goldstein, 2010; Raudenbush et al., 2011; Snijders & Bosker, 1999), por ejemplo, estudiantes agrupados en clases, clases en escuelas, y escuelas en distritos en el contexto educativo; empleados agrupados en equipos, y los equipos en departamentos u unidades organizativas en el contexto laboral; o encuestados agrupados en distritos electorales, y los distritos agrupados en regiones o estados en el contexto de ciencias sociales. El MJL permite modelar y analizar la variabilidad que puede existir en diferentes niveles jerárquicos, por ejemplo, en contextos educativos permite considerar la variabilidad entre estudiantes dentro de una misma clase, entre clases dentro de una escuela, y así sucesivamente. Modelando estas relaciones entre niveles, esta técnica estadística permite obtener una comprensión más profunda de cómo factores individuales y contextuales interactúan entre sí.

La agrupación jerárquica o anidada de unos elementos dentro de otros tiene implicaciones significativas para el estudio de los fenómenos sociales (Leeuw & Meijer, 2008). En este sentido, los individuos que comparten estructuras jerárquicas de orden superior tienden a mostrar una mayor similitud entre sí. Por lo tanto, sus rasgos, competencias, conductas y desempeños son más homogéneos en comparación con aquellos que no comparten dichas estructuras. Un ejemplo ilustrativo es el alumnado de un mismo grupo escolarizado en un

entorno y organización de aula comunes. Este grupo trabaja con contenidos y recursos didácticos similares, compartiendo un estilo de enseñanza docente específico (Murillo et al., 2007). A largo plazo, los estudiantes de esta aula tenderán a desarrollar actitudes y competencias más similares que aquellos que asisten a aulas diferentes donde el clima, los contenidos y el estilo de enseñanza difieren. Por ende, cualquier análisis riguroso que busque explicar la interacción entre los factores del aula y las actitudes y competencias individuales, así como la relación de estas variables con los resultados educativos, debe tener en cuenta esta estructura anidada o multinivel de la realidad (Gamazo et al., 2017).

Los MJL destacan al identificar y descomponer en distintos niveles los factores que contextualizan los resultados educativos. Este enfoque permite estimar el porcentaje de la variabilidad atribuible a factores individuales como habilidades, intereses, motivaciones, hábitos de trabajo, actitudes hacia el aprendizaje o influencias familiares, entre otros. Se espera que estos factores individuales expliquen gran parte de las diferencias.

Los MJL también destacan al reproducir y modelar de manera más efectiva la complejidad de los fenómenos sociales. Esto se debe a que establecen relaciones entre datos provenientes de patrones complejos de variabilidad medidos en diferentes niveles anidados. En otras palabras, los MJL analizan la interacción entre variables de distintos niveles y, por ende, permiten abordar preguntas de investigación que quedan fuera del alcance de las aproximaciones clásicas, donde los datos, ya sea agregados o segregados, se presentan en un único nivel. Así, mediante los MJL es posible examinar, por ejemplo, la influencia que una metodología docente específica (variable de aula) tiene en el aprendizaje de alumnos con diversos niveles de comprensión de las explicaciones (variable individual). Esto facilita la identificación de metodologías de enseñanza-aprendizaje que beneficien especialmente a los alumnos con mayores dificultades de comprensión.

Los MJL son modelos de regresión en varios niveles. En un modelo más sencillo de dos niveles (por ejemplo, estudiante y centro educativo) el intercepto del modelo clásico puede tomar distintos valores en el segundo nivel ya que los centros educativos obtienen diferentes promedios de puntuación en las materias evaluadas, por lo que la ecuación se formula del siguiente modo:

$$y_{ij} = \beta_{0j} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \varepsilon_{ij}$$

$$\beta_{0j} = \beta_0 + \mu_{0j}$$

Donde,

y_{ij} es el resultado del estudiante i en la escuela j

β_{0j} es el promedio de y de la escuela j-ésima

$\beta_1 x_{1ij}$ tienen el mismo significado e interpretación que en el modelo clásico.

ε_{ij} es el error de estimación del nivel de estudiante que se distribuye normalmente con varianza constante e igual σ_{e0}^2

β_0 es el "gran promedio" de *y* para el conjunto de la población

μ_{0j} es el efecto aleatorio asociado a la escuela j-ésima y se supone distribuido con media 0 y varianza igual a $\sigma_{\mu 0}^2$.

Igualmente, los centros educativos, además de interceptos diferentes en el nivel 2, pueden presentar pendientes o coeficientes de regresión de distinta inclinación en las variables predictoras. Por ejemplo, dentro de cada centro educativo el efecto del nivel socioeconómico y cultural sobre las puntuaciones del alumnado puede tener un impacto diferente. En este caso las ecuaciones del modelo serían:

Nivel 1

$$y_{ij} = \beta_{0j} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \varepsilon_{ij}$$

Nivel 2

$$\beta_{0j} = \beta_0 + \mu_{0j},$$

$$\beta_{1j} = \beta_1 + \mu_{1j},$$

$$\beta_{2j} = \beta_2 + \mu_{2j}$$

Con:

$$\begin{bmatrix} \mu_{0j} \\ \mu_{10j} \\ \mu_{20j} \end{bmatrix} \sim N(0, \omega_\mu) : \omega_\mu = \begin{bmatrix} \sigma_{\mu 0}^2 & \square & \square \\ \sigma_{\mu 10} & \sigma_{\mu 1}^2 & \square \\ \sigma_{\mu 20} & \sigma_{21}^2 & \sigma_{\mu 2}^2 \end{bmatrix}$$

$$[e_{0ij}] \sim N(0, \omega_e) : \omega_e = [\sigma_{e0}^2]$$

En el análisis multinivel se sigue una estrategia que consiste en definir modelos de complejidad creciente, incluyendo en cada análisis mayor número de variables que den cuenta o expliquen un porcentaje de las variaciones o diferencias en los resultados de la evaluación cada vez mayor.

En el presente trabajo, siguiendo las indicaciones de Hox (2013), los modelos multinivel se han estimado en varios pasos:

Paso 1: Modelo nulo. Se trata de un modelo bruto, sin variables predictoras, diseñado con la finalidad de estimar la cantidad total de varianza (varianza total) y determinar cómo se distribuye dicha varianza entre los estudiantes y las escuelas. El modelo nulo opera como un punto de referencia, desde el cual es factible evaluar la contribución a la explicación de la varianza proveniente de los conjuntos de variables incorporados en los modelos subsiguientes. Además, posibilita calcular el tamaño del efecto de centro educativo sobre la variable dependiente.

Paso 2: Modelo de ajuste. Enriquece el modelo con variables de contexto a nivel de estudiante y de escuela: variables que no son maleables, que están fuera del control de las escuelas y no pueden modificarse fácilmente. Este modelo permite estimar los efectos fijos de las variables de contexto sobre la variable dependiente: el desempeño de los estudiantes en ciencias.

Paso 3: Modelo completo. Este modelo mantiene las variables del modelo anterior e incorpora todo el conjunto de variables de proceso (maleables), tanto a nivel de estudiantes como de centros educativos. Este modelo permite estimar los efectos fijos de las variables de proceso y evaluar si los efectos fijos de las variables de entrada diferían de los observados en el modelo completo.

En cada uno de los pasos es posible realizar la estimación de los componentes de la varianza del modelo atribuible a los niveles de agrupamiento. Esta estimación se realiza mediando el cálculo del Coeficiente de Correlación Intracase (ICC, por sus siglas en inglés), que representa la proporción de variación en la variable dependiente explicada por el agrupamiento (Hox, 2010; Snijders, 2014). En concreto, el ICC es la relación entre la varianza entre centros y la suma de la varianza entre centros y la varianza dentro de los centros. El ICC es una medida estadística utilizada para evaluar la relación entre las unidades de observación dentro de grupos o clusters en un análisis de datos de tipo jerárquico o multinivel. En el contexto de la investigación educativa, el ICC es especialmente relevante para comprender la influencia del entorno escolar en los resultados de los estudiantes. Se calcula como la proporción de la varianza total de la variable dependiente que puede atribuirse a las diferencias entre los grupos, en este caso, entre los centros educativos, en relación con la suma de la varianza entre grupos y la varianza dentro de los grupos. Un ICC más alto indica una mayor homogeneidad dentro de los grupos y una mayor influencia del contexto escolar en los resultados educativos, mientras que un ICC más bajo sugiere una mayor variabilidad dentro de los grupos y una menor influencia del entorno escolar en los resultados estudiantiles.

1.8.3. SEM multinivel

El modelo de ecuaciones estructurales (SEM, Structural Equation Modeling, por sus siglas en inglés) multinivel es una extensión del análisis de ecuaciones estructurales que permite examinar relaciones entre variables latentes en datos que tienen una estructura jerárquica o multinivel (Skrondal & Rabe-Hesketh, 2004). Este enfoque se basa en la misma premisa que los MJL: los datos recopilados están organizados en diferentes niveles, como individuos dentro de grupos o unidades, y se espera que las relaciones entre variables varíen entre esos niveles. La modelación estructural de datos con estructura multinivel es un campo de investigación metodológica relativamente reciente (Bauer, 2003; Depaoli & Clifton, 2015; Mehta & Neale, 2005; Rovine & Molenaar, 2000) que ha ganado popularidad gracias a su capacidad de modelar efectos que varían entre diferentes niveles de jerarquía, lo que proporciona una representación más realista de la estructura de los datos en los contextos educativos.

Los modelos de ecuaciones estructurales clásicos permiten trabajar con variables latentes no observadas. Estas variables latentes son constructos teóricos que no se pueden medir directamente, pero se infieren a través de las observaciones de variables observadas (Byrne, 2016; R. Hoyle, 1995). Estas relaciones se representan mediante ecuaciones estructurales que describen la influencia de las variables latentes en las observadas.

En los modelos SEM, de forma análoga a los modelos de regresión clásica, se establece una ecuación lineal de cada variable endógena (latente u observable) en función de una o más variables exógenas (latentes u observables) que la explican, más una medida de error. En un modelo SEM, las variables endógenas son aquellas que se consideran dependientes o resultado de otras variables en el modelo. Suelen representarse con la letra η. Estas variables son las que se predicen o explican dentro del modelo y, por lo tanto, son el foco principal del análisis. Las variables exógenas son aquellas que no son influenciadas por otras variables dentro del modelo. Son variables que se introducen en el modelo como factores causales, pero no son influenciadas por ninguna otra variable incluida en el modelo. Suelen representarse con la letra ξ.

El modelo de ecuaciones estructurales clásico se puede expresar en términos de modelos de medición y de variables latentes. En el modelo de medición los indicadores de ξ se denotan con *X* y los de η con *Y*.

Siguiendo a Muthén & Asparouhov (2008), el modelo de medición se expresa a través de la siguiente ecuación matricial:

$$Y_i = v + \Lambda\eta_i + \mathrm{KX}_i + \varepsilon_i$$

Donde,

Y_i es el vector p-dimensional de las variables endógenas del caso i;

ν es el vector p-dimensional de los interceptos;

ε_i es el vector p-dimensional de los errores de medida;

Λ es la matriz de los coeficientes de regresión de orden $p \times m$, donde m es el número de efectos aleatorios (variables latentes)

η_i es el vector $m \times 1$ de efectos aleatorios (variables endógenas);

K es la matriz de pendientes de orden $p \times q$, de q covariables exógenas X_i.

El modelo de variables latentes en SEM clásico se expresa como:

$$\eta_i = \alpha + \mathrm{B}\eta_i + \Gamma\mathrm{X}_i + \zeta_i$$

Donde,

α es el vector de orden $m \times 1$ de interceptos;

B es la matriz de orden $m \times m$ de coeficientes de regresión estructurales;

Γ es la matriz de orden $m \times q$ de q covariables exógenas X_i.

ζ_i es el vector m-dimensional de los residuos de variables latentes;

Al igual que en el caso de modelos de regresión clásicos, utilizar enfoques de estimación que ignoren la naturaleza jerárquica de los datos puede conducir una posible violación al supuesto de observaciones independientes. Las técnicas estadísticas multinivel fueron desarrolladas precisamente para controlar las dependencias que surgen en las estructuras de datos jerárquicos, ya que permiten modelar la variación entre las unidades de niveles altos y bajos (Goldstein et al., 1993; Raudenbush & Bryk, 2002).

La principal ventaja del enfoque multinivel es que permite modelar la variabilidad entre niveles. Esto significa que el modelo puede capturar tanto las relaciones generales que se aplican a todos los niveles como las variaciones específicas a cada nivel. A diferencia de los modelos separados por nivel, el SEM multinivel estima todos los parámetros conjuntamente, lo que mejora la precisión de las estimaciones al tener en cuenta la estructura jerárquica de los datos.

Los modelos SEM multinivel son una adaptación de la modelización de ecuaciones estructurales en varios niveles. Para acomodar las ecuaciones de medición y de variables

latentes, las ecuaciones presentadas anteriormente se expanden permitiendo a los elementos de varios coeficientes matriciales variar a nivel de *clusters* (niveles) (Preacher et al., 2010). El modelo de medición general de Muthén y Asparouhov (2008) toma la siguiente forma:

$$Y_{ij} = \upsilon_j + \Lambda_j \eta_{ij} + \mathrm{K}_j \mathrm{X}_{ij} + \varepsilon_{ij}$$

Donde,

j es el identificador del *cluster* (nivel). Nótese que esta ecuación es idéntica a la ecuación de medición de SEM clásico, pero con la suscripción al *cluster* tanto en las matrices de variables, como en las matrices de parámetros de regresión, indicando posibles variaciones de estos parámetros entre niveles. Al igual que Y_i, ν y ε_i, las matrices Y_{ij}, ν_j y ε_{ij} son p-dimensionales. Λ_j también es una matriz de orden $p \times m$, donde m es el número de efectos aleatorios (variables latentes) tanto entre niveles, como dentro del mismo nivel. η_{ij} es el vector $m \times 1$ de efectos aleatorios (variables latentes) y K_j es la matriz de pendientes de orden $p \times q$. X_{ij} es el vector q-dimensional de covariables exógenas.

El componente de variables latentes del modelo general se puede expresar como:

$$\eta_{ij} = \alpha_j + \mathrm{B}_j \eta_{ij} + \Gamma_j \mathrm{X}_{ij} + \zeta_{ij}$$

Donde, α_j es el vector $m \times 1$, B_j es la matriz de orden $m \times m$ de coeficientes de regresión estructurales; y Γ_j es la matriz de orden $m \times q$.

Tanto en SEM clásico, como multinivel, los residuos ε_i, ε_{ij}, ζ_i, ζ_{ij} asumen tener una distribución normal con el promedio cero con las matrices de covarianza Θ y Ψ, respectivamente. Los elementos de estas dos matrices no pueden variar entre *clusters*. Los elementos de los parámetros de las matrices ν_j , Λ_j, K_j, α_j, B_j, y Γ_j sí pueden variar entre niveles. La parte multinivel del modelo general SEM se expresa en el segundo nivel del modelo estructural:

$$\eta_j = \mu + \beta_j \eta_j + \gamma \mathrm{X}_j + \zeta_j$$

El vector η_j contiene todos los efectos variables, es decir, apila los elementos aleatorios de todas las matrices de parámetros con el subíndice j en las ecuaciones anteriores. Supongamos que existen r efectos aleatorios de este tipo. El vector μ $(r \times 1)$, las matrices β $(r \times r)$ y γ $(r \times s)$ contienen efectos fijos. En concreto, μ contiene medias de la distribución de efectos aleatorios e interceptos de ecuaciones estructurales entre niveles, β contiene las pendientes de regresión de efectos aleatorios entre ellos, y γ contiene pendientes de regresión de efectos aleatorios sobre los regresores exógenos a nivel de *cluster*.

A continuación, se detallan algunos de los índices más recomendados por la bibliografía que se utilizan para evaluar el ajuste del modelo propuesto y que han sido utilizados en la investigación basada en SEM multinivel:

RMSEA: La Raíz Cuadrada Media del Error de Aproximación o RMSEA, por sus siglas en inglés, se basa en el parámetro de no centralidad del modelo, que es la diferencia entre el estadístico $\chi 2$ y su valor esperado (que son los grados de libertad -df- del modelo). Valores pequeños de este índice serían sinónimo de buen ajuste.

GFI y AGFI: El Índice de Bondad de Ajuste o *Goodness of Fit Index* denotado por GFI como así también el ajustado AGFI, miden la proporción de varianzas y covarianzas de S predichas por la matriz reproducida $\Sigma\hat{}$, por lo cual ambos toman valores entre 0 y 1, siendo indicador de buen ajuste un valor cercano a 1. El punto de corte recomendado por la bibliografía es 0,90 (Schumacker & Lomax, 1996).

SRMR: El Cuadrado Medio Residual estandarizado o SRMR, por sus siglas en inglés, toma valores positivos ya que se basa en una media cuadrática de los residuos (coeficientes de la matriz residual) pero a partir de la matriz de correlación en lugar de la matriz de covarianzas, evitándose así los posibles efectos una diferencia de escala de las variables. Valores cercanos a 0 serían indicadores de buen ajuste.

CFI: El Índice de Ajuste Comparado, conocido como CFI, por sus siglas en inglés, es una medida utilizada en el análisis de modelos de ecuaciones estructurales para evaluar la bondad de ajuste de un modelo en relación con un modelo de referencia, generalmente el modelo nulo o un modelo teórico alternativo. El CFI varía entre 0 y 1, donde un valor más cercano a 1 indica un mejor ajuste del modelo. Se considera que un valor de CFI mayor o igual a 0,90 indica un ajuste adecuado del modelo, mientras que un valor mayor o igual a 0,95 se considera un ajuste excelente (Hu & Bentler, 1995).

1.8.4. Análisis de Redes

La metodología de análisis de redes ha ganado recientemente importancia como modelo que representa fenómenos complejos en la ciencia del comportamiento humano (Nelson et al., 2017), como la psicopatología (Borsboom, 2017) o la personalidad (Schmittmann et al., 2013). En el campo educativo este instrumento metodológico es menos común. A modo de ejemplo, se ha aplicado para comprender la influencia de la multiculturalidad en la motivación de los estudiantes (Abacioglu et al., 2019), entender el papel del interés por la ciencia en la participación estudiantil (Sachisthal et al., 2019) o para evaluar el impacto que tiene el autoconcepto y las expectativas académicas sobre los resultados en matemáticas (Álvarez-Díaz et al., 2022).

El enfoque de redes permite la representación de las interacciones entre los elementos de los fenómenos y permite comprender las estructuras y consecuencias de estas interacciones. Además, permite interpretar la relación entre diferentes elementos simultáneamente, la influencia recíproca subyacente y las interconexiones. El análisis de redes persigue dos tipos de objetivos: comprender la causa de la formación de interacciones determinantes en una población dada y descubrir cómo la interacción de los elementos influye en los resultados.

El enfoque de redes se basa en dos conceptos principales: los nodos, que representan los elementos de un modelo, y las aristas, que reflejan las conexiones entre nodos que representan sus interacciones entre pares. Una vez que se modula la red, se pueden utilizar diferentes herramientas o índices para resumir los patrones de relaciones que aparecen en ella. Los índices de centralidad de la red permiten explorar la influencia relativa de un nodo en el contexto de otros nodos (Borgatti et al., 2009) y analizar la importancia relativa del nodo dentro de la red en función del patrón de conexión (Fonseca-Pedrero, 2018). Se pueden estimar varias medidas de centralidad: centralidad de intermediación, centralidad de cercanía y centralidad de fuerza. La centralidad de fuerza se refiere a la magnitud de la asociación del nodo con los otros nodos e identifica el nodo que tiene las conexiones más fuertes. La centralidad de cercanía indica qué nodos pueden predecir mejor a otros. Se define como el inverso de la suma de la distancia de un nodo a todos los demás nodos en la red. Un nodo con una alta centralidad de cercanía se verá afectado rápidamente por cambios en cualquier parte de la red (Borgatti et al., 2009). La centralidad de intermediación se define como el número de veces que un nodo está entre dos nodos diferentes. Un nodo con un alto valor de intermediación indica que está bien conectado con el resto de los nodos de la red.

1.8.5. Diferencias en Diferencias

La última técnica estadística aplicada en la presente tesis es una versión adaptada del modelo de Diferencias en Diferencias (DiD) que persigue establecer relaciones causales entre la variable dependiente y las variables explicativas. El DiD es un método econométrico que facilita la evaluación del impacto de un programa al comparar las observaciones de individuos en grupos de tratamiento y control en dos momentos temporales: antes y después de la implementación del programa evaluado (Becchetti et al., 2013; Witte & López-Torres, 2015). En el contexto educativo, la estrategia DiD implica contrastar la diferencia en los resultados de individuos antes y después de su participación en un programa en centros educativos con grupo de tratamiento, con la diferencia en los resultados de individuos en centros educativos sin dicho programa (grupo de control) en periodos temporales equivalentes (Schlotter et al., 2011).

Una adaptación de la metodología DiD, explorada por varios investigadores (Bietenbeck, 2014; Clavel & Mediavilla, 2019; Jürges et al., 2005), permite analizar las diferencias entre los

resultados del grupo tratamiento y el grupo control en el mismo momento temporal, en las situaciones cuando se dispone de dos resultados de cada sujeto. Para ello, la variable de interés del grupo tratamiento es el resultado de los estudiantes en un área de evaluación; mientras que los resultados de los mismos estudiantes en otra área de evaluación se consideraran como datos del grupo control. La adaptación consiste, por tanto, en el cálculo de la variable dependiente como diferencia de dos medidas de resultado del mismo sujeto, con el posterior uso de métodos de análisis a elección del investigador, por ejemplo, regresiones lineales o MJL. Este enfoque permite determinar si hay relaciones de causalidad y no solo simples correlaciones entre las variables predictoras y las variables dependientes (Clavel & Mediavilla, 2019).

2. Hipótesis

La hipótesis de partida es que es posible diseñar un modelo de factores asociados al aprendizaje que permita identificar los factores que determinan la eficacia escolar y proporcionar recomendaciones prácticas sobre su mejora.

3. Objetivos

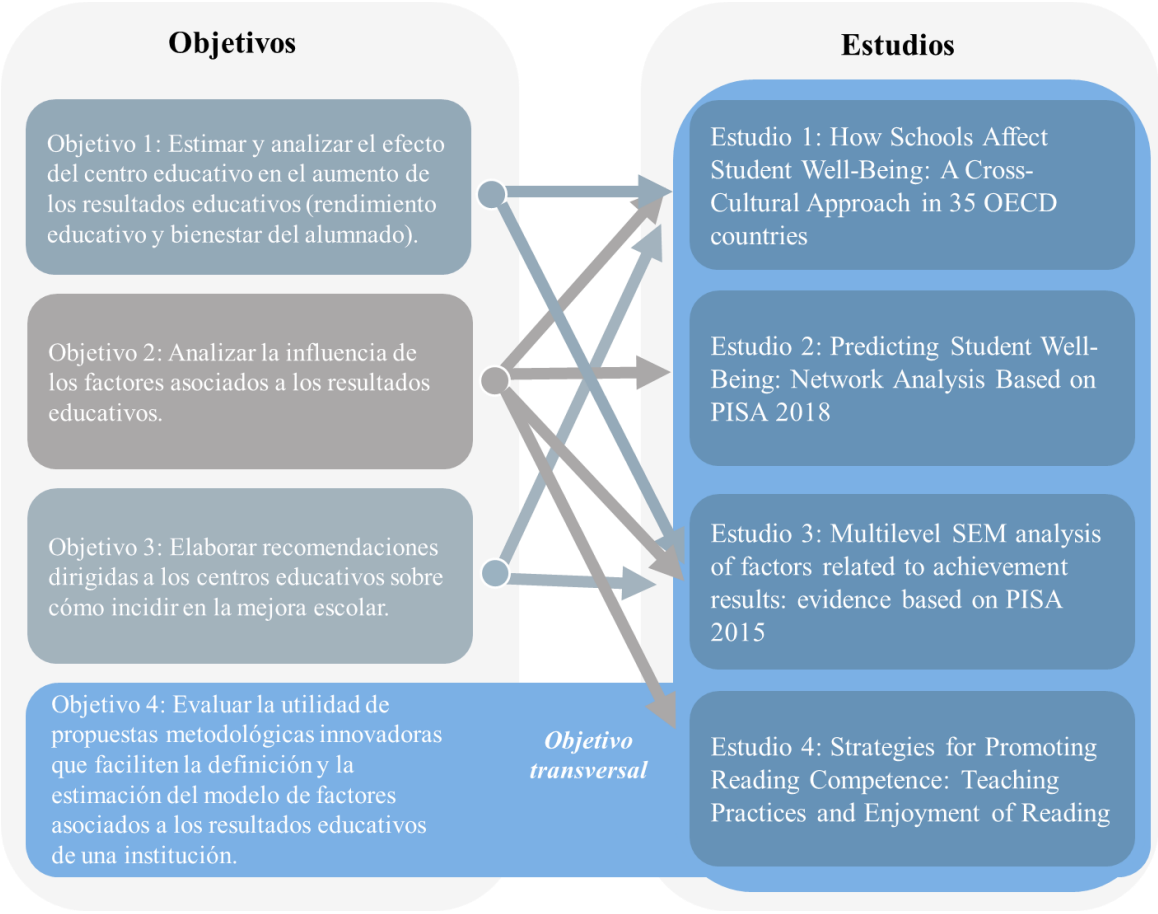
El objetivo principal de esta investigación es identificar aquellos factores que influyen en los resultados educativos de los estudiantes de una institución educativa, específicamente aquellos sobre los que el centro puede actuar para mejorar su eficacia. Con este propósito, se diseñará un modelo que identifica la influencia de un conjunto factores sobre los resultados educativos, considerados desde una perspectiva holística que integra tanto el rendimiento académico como el bienestar del alumnado. Los resultados del análisis basado en el modelo propuesto proporcionarán a las instituciones educativas herramientas prácticas, ofreciendo recomendaciones sobre métodos de enseñanza y aprendizaje que optimizan los resultados educativos de los estudiantes.

Para alcanzar el objetivo general del proyecto se plantean los siguientes objetivos específicos:

- Objetivo 1: Estimar y analizar el efecto del centro educativo en el aumento de los resultados educativos (rendimiento educativo y bienestar del alumnado).
- Objetivo 2: Analizar la influencia de los factores asociados a los resultados educativos.
- Objetivo 3: Elaborar recomendaciones dirigidas a los centros educativos sobre cómo incidir en la mejora escolar.
- Objetivo 4: Evaluar la utilidad de propuestas metodológicas innovadoras que faciliten la definición y la estimación del modelo de factores asociados a los resultados educativos de una institución.

En la Figura 2 se refleja la relación entre los objetivos de la investigación y los estudios que componen los resultados de la tesis doctoral, que se presentan en el siguiente apartado.

Figura 2. Relación entre los Objetivos y los Estudios de la Tesis Doctoral



4. Estudios

Los objetivos planteados se desarrollan en los cuatro estudios que se presentan a continuación. Tres de ellos están publicados en revisas de Factor de Impacto JCR (*Journal Citation Reports*).

En el primer estudio, *How Schools Affect Student Well-Being: A Cross-Cultural Approach in 35 OECD countries* (Govorova et al., 2020a), se evalúa el papel del centro educativo en el fomento del bienestar estudiantil en el contexto internacional de los países de la OCDE participantes en PISA 2015. Adicionalmente, se identifican los factores escolares asociados el bienestar, mediante los modelos jerárquico-lineales.

En el segundo artículo, *Predicting Student Well-Being: Network Analysis Based on PISA 2018* (Govorova et al., 2020b), se exploran diversos componentes del concepto multidimensional de bienestar estudiantil, identificando las áreas clave que desempeñan un papel central en su composición a través del enfoque de análisis de redes. Además, se investigan las relaciones entre el bienestar y los factores escolares en el contexto de los países de la OCDE participantes en PISA 2018.

En el tercer artículo, *Multilevel SEM analysis of factors related to achievement results: evidence based on PISA 2015* (Govorova et al., en revisión), se explora el papel del centro educativo en un modelo analítico SEM multinivel, cuantificando su impacto sobre los resultados del alumnado en ciencias en todos los países de la OCDE participantes en PISA 2015. Adicionalmente, los factores asociados a los resultados se clasifican según un enfoque sistémico (de entrada/contexto y de proceso) y se ordenan según la magnitud de su influencia en el rendimiento en base a un análisis comparativo entre países.

En el cuarto artículo, *Strategies for Promoting Reading Competence: Teaching Practices and Enjoyment of Reading* (Govorova et al., 2023), se analizan las relaciones entre los resultados escolares, esta vez medidos a través de un enfoque metodológico adaptado, Diferencias en Diferencias, comparando los resultados del mismo sujeto en dos áreas de evaluación, lectura y matemáticas, en PISA 2018, y los estilos y las prácticas docentes que demuestran ser eficaces en la mejora de la competencia lectora.

En los cuatro estudios, los resultados se generan y se comparan tanto a nivel individual de cada país, como a nivel del conjunto de los países de la OCDE, proporcionando un marco global de evaluación de factores asociados a los resultados educativos.

1.1. Estudio 1

Govorova, E., Benítez, I., & Muñiz M. (2020). How Schools Affect Student Well-Being: A Cross-Cultural Approach in 35 OECD countries. Frontiers in Psychology.

Factor de Impacto JCR 2020 = 2,99; Q2

El presente estudio tiene por objetivo estimar la magnitud de los efectos escolares en el bienestar de los estudiantes en los países de la OCDE, donde el efecto escolar se entiende como la capacidad de las escuelas para aumentar el bienestar subjetivo de los estudiantes, así como examinar la relación entre los factores escolares y los componentes del bienestar. La principal aportación de este artículo a la tesis doctoral consiste en un análisis comparativo de efectos escolares en el bienestar y el rendimiento, así como la identificación de los factores asociados al bienestar del alumnado de un centro educativo, con un foco especial en los factores que se encuentran bajo el control directo del mismo.

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How Schools Affect Student Well-Being: A Cross-Cultural Approach in 35 OECD Countries

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A common approach for measuring the effectiveness of an education system or a school is the estimation of the impact that school interventions have on students' academic performance. However, the latest trends aim to extend the focus beyond students' acquisition of knowledge and skills, and to consider aspects such as well-being in the academic context. For this reason, the 2015 edition of the international assessment system Programme for International Student Assessment (PISA) incorporated a new tool aimed at evaluating the socio-emotional variables related to the well-being of students. It is based on a definition focused on the five dimensions proposed in the PISA theoretical framework: cognitive, psychological, social, physical, and material. The main purpose of this study is to identify the well-being components that significantly affect student academic performance and to estimate the magnitude of school effects on the well-being of students in OECD countries, the school effect being understood as the ability of schools to increase subjective student well-being. To achieve this goal, we analyzed the responses of 248,620 students from 35 OECD countries to PISA 2015 questionnaires. Specifically, we considered non-cognitive variables in the questionnaires and student performance in science. The results indicated that the cognitive well-being dimension, composed of enjoyment of science, self-efficacy, and instrumental motivation, as well as test anxiety all had a consistent relationship with student performance across countries. In addition, the school effect, estimated through a two-level hierarchical linear model, in terms of student well-being was systematically low. While the school effect accounted for approximately 25% of the variance in the results for the cognitive dimension, only 5–9% of variance in well-being indicators was attributable to it. This suggests that the influence of school on student welfare is weak, and the effect is similar across countries. The present study contributes to the general discussion currently underway about the definition of well-being and the connection between well-being and achievement. The results highlighted two complementary concerns: there is a clear need to promote socio-emotional education in schools, and it is important to develop a rigorous framework for well-being assessment. The implications of the results and proposals for future studies are discussed.

Keywords: well-being, school effectiveness, Programme for International Student Assessment, science, hierarchical linear modeling

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INTRODUCTION

The effectiveness of an education system or a school is generally measured in terms of the impact that school interventions have on student performance, with the prevalent focus being on the cognitive elements, and mostly those associated with the requirements of the academic curriculum or competence areas. Following the definition of Murillo (2005), a school is considered effective when it achieves the maximum holistic development of every one of its students, and especially when this development is greater than might be expected considering the student's previous performance and/or the social, economic, and cultural situation of his/her family. Although a student's development is expected to be comprehensive, school effectiveness is traditionally estimated only through student attainment measures, such as the number or percentage of students who graduate (Grosskopf et al., 2014; Podinovski et al., 2014), standardized test scores in various subjects (Crespo-Cebada et al., 2014; Johnson and Ruggiero, 2014), scores on international and national assessments, or the percentage of students progressing to higher or further education (OECD, 2008c). However, it could be argued that the "results" of a school in terms of non-academic achievement should also be considered as educational objectives given that students with low levels of well-being are more likely to have a negative experience of school, as well as to suffer from depression and be involved in substance abuse or delinquency (Sun and Shek, 2010). As a result of the shared concerns of educational communities and families around the world, the latest trends aim to extend the focus of school effectiveness research beyond simple cognitive performance and also examine aspects such as well-being in the academic context. Some studies have focused on the effect of school on socio-emotional factors such as attitude to learning or academic self-concept (Opdenaker et al., 2002; Murillo and Hernández-Castilla, 2011; Belfi et al., 2012), although the results are not conclusive. Aware of the importance of socio-emotional development as an inseparable element of the integral learning process, the 2015 edition of the Programme for International Student Assessment PISA) incorporated a new instrument aimed at evaluating the socio-emotional variables related to the well-being of students, making it possible to assess school effectiveness in terms of improvements in student well-being at the international level.

Well-Being

In recent years, the importance of well-being and the quality of life concept has grown and has extended into many areas. There are numerous definitions of these, and other terms such as satisfaction and happiness, that, as Veenhoven (2000) points out, have traditionally been used interchangeably. There is, however, nowadays consensus that quality of life refers to both objective and subjective elements and reflects both the living conditions and the perceptions of individuals (Casas, 2004). Moyano-Díaz and Ramos-Alvarado (2007) also assume an integrative perspective based on a model where the quality of life measure is divided into an objective component that refers to a person's ability to access goods and services and a subjective one that incorporates the concept of subjective well-being, which, in turn, is divided into a cognitive and an affective component. In this case, the cognitive focuses on satisfaction (both global and in terms of specific domains), while the affective includes both positive and negative affects.

Assessing the impact of well-being on academic performance has also been the objective of several studies, the results of which have been equally diverse. For example, Novello et al. (1992) proposed a possible relationship between health and performance in which well-being seemed to play an important role, and, in the same vein, Berger et al. (2011) found, through a multilevel analysis, a relationship between socio-emotional well-being, well-being, self-esteem, social integration, positive perception of a school's ambience, and performance. Gutman and Vorhaus (2012) also found, in a longitudinal study, significant correlations between four dimensions of well-being (emotional, behavioral, social, and school) and performance. However, El Ansari and Stock (2010) found that the relationship between health, educational performance, and well-being, the latter operationalized in terms of motivation and satisfaction with the educational experience, was reciprocal.

However, the concept of well-being in childhood and adolescence in itself has been studied extensively (Casas, 2010). For instance, Pollard and Lee (2003) carried out a systematic review where they found that, although well-being has not been defined consistently and there is no agreement on the best way to measure it, five key dimensions are usually addressed (albeit not usually all at the same time), namely, physical, psychological, cognitive, social, and economic well-being. The physical dimension refers to health and physical habits; the psychological to emotions and mental health (often operationalized by the "absence" of negative indicators); the cognitive to intellectual and school-related elements; the social to relationships with others, support, and interpersonal or communicative skills; and the economic to economic resources of the family.

An international survey, PISA, in its addition of 2015, adopted a comprehensive model in the evaluation of well-being, which incorporates, in addition to the habitual evaluation of performance, items and scales aimed at measuring well-being. The PISA 2015 assessment formulates a model including indicators of five dimensions of well-being: psychological, social, physical, material, and cognitive (Borgonovi and Pál, 2016). The model differs from the proposals described above by incorporating in the material dimension aspects related to educational and cultural resources.

In the present study, we use the definition of well-being from the PISA theoretical framework, which describes it as "*a dynamic state characterised by students experiencing the ability and opportunity to fulfil their personal and social goals. It encompasses multiple dimensions of students' lives, including: cognitive, psychological, physical, social and material. It can be measured through subjective and objective indicators of competencies, perceptions, expectations and life conditions*" (Borgonovi and Pál, 2016).

Furthermore, the OECD has published recently the unified framework for the assessment of social and emotional skills (Kankaraš and Suárez-Álvarez, 2019), one of the fundamental

pillars of well-being, which reiterates the importance of socio-emotional development of individuals, crucial for students' maturity. The OECD defines these skills as "...individual capacities that can be (a) manifested as consistent patterns of thoughts, feelings and behaviors, (b) developed through formal and informal learning experiences, and (c) important drivers of socioeconomic outcomes throughout the individual's life" (OECD, 2015).

School Effectiveness

School effectiveness has been examined in hundreds of studies since the publication of the Coleman Report in 1966 (Coleman et al., 1966). The conclusions of this report highlighted the low impact of school factors on student performance in comparison with the strong effect exerted by family socioeconomic context, which educational institutions were ill-equipped to counter. That said, Coleman did also offer the first estimations of school effects, finding that the educational institution explains from 5 to 9% of the variance in mathematics results. Since then, a significant amount of work has been carried out that aims to identify the various factors related to performance and to quantify the magnitude of school effects on students' results (MacBeath and Mortimore, 2001; Hanushek and Luque, 2003; Scheerens and Demeuse, 2005). Teddlie et al. (2000), in the *International Handbook of School Effectiveness Research*, summarized the most important evidence in this field, concluding that there is great variation in estimates of school effectiveness between countries and depending on the methodological approach taken. In general, 5–35% of the variance in academic achievement results between schools is explained by educational policies and practices, a school's atmosphere, and learning climate, depending on the study involved (Martínez-Arias, 2009).

Studies that focus on school effectiveness in terms of the promotion of non-cognitive variables are much less common, although there are some notable exceptions. Murillo and Hernández-Castilla, 2011 performed a cross-country study in Latin America and Spain to estimate the magnitude of school, classroom, and country effects for non-cognitive variables such as self-concept, classroom behavior, social coexistence, and students' satisfaction with their school. Belfi et al. (2012) conducted a literature review of the influence of class composition (ability and gender) in secondary education on students' school well-being and academic self-concept. Lazarides and Buchholz (2019) studied the relationship between student-perceived teaching quality in mathematics classrooms and enjoyment, anxiety, and boredom, at both student and classroom levels, and estimated that these parameters accounted for 4–10% of school effects depending on the variable. Other studies in this area include those by Grisay (1996); Opdenakker and Van Damme (2000), Opdenaker et al. (2002); Sammons (1999), and Vandenberghe et al. (1994), all of which report schools' minimal impact on non-cognitive educational results and attribute less than 5% of variation to the educational institution.

The present study has two main objectives. The first is to identify the well-being components that significantly affect student academic performance. The second consists in estimating the magnitude of school effects on the well-being of students in the OECD countries, where school effect is understood as the ability of schools to increase students' subjective evaluation of their well-being. In addition, the relationship between socio-emotional variables and student- and school-level factors is examined.

METHOD

Sample

The PISA database developed by the OECD is the main source of information used in this study. PISA aims to evaluate the knowledge and skills acquired by students at the end of compulsory education in OECD member countries (35 countries at the time of the 2015 PISA report) and in non-member countries that have joined the project. The test systematically evaluates three areas of knowledge, reading, mathematics, and science. PISA evaluations are organized in such a way that in each cycle (PISA evaluations are carried out every 3 years), one of the evaluation areas is examined in depth. PISA 2015, the sixth edition of the study, focused on science achievement. In the present study, the full data set from all the OECD countries has been used, which comprises data collected from 248,620 15-year-old students. The summed data of all OECD countries were used to obtain the total OECD results, and the individual country data sets were employed for cross-country analysis. **Table 1** reflects sample configuration by country (sample size and percentage of girls), along with the country abbreviation used throughout the study.

Instruments

The cognitive test in PISA 2015 aimed to evaluate the level of acquisition of competences in science, reading, and mathematics, and the student questionnaire collected information about the students themselves, their family background, and school and learning environment. Additionally, school principals completed a questionnaire about the school, its resources, and management practices, and in some countries, optional teacher and parent questionnaires were also used. In this study, only the data relating to the student and school questionnaires as well as the performance test results were analyzed since the teacher and parent data are not available for many OECD countries.

The cognitive performance scale in PISA has become a worldwide reference as it is based on internationally agreed-upon theoretical frameworks. PISA uses the concept of competences, which in this context refers to the ability of students to extrapolate what they have learned and apply their knowledge and skills in real-life situations, as well as their ability to analyze, reason, and effectively communicate their findings and interpret and solve problems in different situations. The full PISA cognitive performance test comprises 528 questions about science, mathematics, reading, problem solving in collaboration, and financial competence and in total constitutes 13 h of tests. However, the test is constructed using a matrix design such that each student only answers a specific and limited combination of questions, resulting in a test that lasts approximately 2 h. Since the PISA 2015 edition

focused on science, this field of study was evaluated in greater detail, and hence, the number of items evaluating this area was higher than for other areas, a total of 184 items, which equates to about 6 h in terms of test time, although each student only answers a (different) subset of these questions (for more details on the design, see the PISA 2015 Theoretical Framework: OECD, 2016a).

The student questionnaire collected demographic data of the students and their perceptions of their school environment, their learning experience, the processes and practices employed by the school, and students' behavior. Based on students' self-reports, a number of instruments were constructed: simple indexes (i.e., gender, age, or repetition of the same school grade) and complex indexes (economic, social, and cultural status (ESCS), an index of the disciplinary climate in the classroom, index of instrumental motivation, etc.).

TABLE 1 | Sample configuration.

Abbreviation	Country	Total	% of girls
AUS	Australia	14,530	49
AUT	Austria	7,007	49
BEL	Belgium	9,651	49
CAN	Canada	20,058	50
CHL	Chile	7,053	50
CZE	Czech Republic	6,894	50
DNK	Denmark	7,161	50
EST	Estonia	5,587	50
FIN	Finland	5,882	49
FRA	France	6,108	51
DEU	Germany	6,504	49
GRC	Greece	5,532	49
HUN	Hungary	5,658	50
ISL	Iceland	3,371	52
IRL	Ireland	5,741	49
ISR	Israel	6,598	56
ITA	Italy	11,583	50
JPN	Japan	6,647	50
KOR	Korea	5,581	48
LVA	Latvia	4,869	50
LUX	Luxembourg	5,299	51
MEX	Mexico	7,568	50
NLD	Netherlands	5,385	50
NZL	New Zealand	4,520	50
NOR	Norway	5,456	50
POL	Poland	4,478	49
PRT	Portugal	7,325	50
SVK	Slovak Republic	6,350	48
SVN	Slovenia	6,406	45
ESP	Spain	6,736	51
SWE	Sweden	5,458	50
CHE	Switzerland	5,860	48
TUR	Turkey	5,895	50
GBR	United Kingdom	14,157	49
USA	United States	5,712	50
OECD total		248,620	50

In terms of the new element added to the PISA study in 2015, that is, the assessment of both subjective and objective measures of student well-being, as mentioned earlier, five dimensions were examined in order to consider well-being as a multidimensional element.

The cognitive dimension comprises students' self-beliefs about their acquisition of subject-specific skills. As science was the main domain in PISA 2015, the questions regarding self-beliefs related to this area of knowledge. The constructs measured were: *science self-efficacy*, *broad interest in science*, *interest in broad science topics*, and *instrumental motivation to learn science*.

The psychological dimension encompassed psychological functioning in relation to educational aspects such as *students' career and educational expectations*, measured in terms of the *expected job* and *the highest level of education* each student aspired to, *achievement motivation*, and *test and learning anxiety*, along with the *overall satisfaction with life*.

The physical dimension in PISA 2015 measured two aspects of students' lifestyle: *the amount and frequency of physical activity* and *eating habits*. Specifically, students were asked if they exercised or did any sport before or after going to school, how many days per week they had physical education classes in school, and how often they were engaged in moderate or vigorous physical activities outside school. Students also reported whether they ate breakfast before going to school and dinner in the evening after school.

The assessment of the social well-being dimension was particularly important, as the quality of 15-years old relationships with teachers and peers is strongly linked to subjective well-being perception. PISA 2015 assessed five aspects of social well-being: *students' sense of belonging at school*; *social learning experiences*, assessed through the value given to and enjoyment of cooperative learning; *the relationship with their teachers*, assessed through the perception of teachers' unfair treatment of students; *the relationship with their peers*, as measured by the constructs *engagement with peers* and *bullying*; and *the relationship with their parents*, assessed through the scales *parental support* and *engagement with parents*.

Lastly, the material dimension investigated both the material resources available in the students' households and the infrastructure of their school. The material conditions at home focused on *parental occupation status* and *physical resources at home*, data that also contributed to the computation of ESCS. Moreover, the students were asked if they *worked for pay* or *worked in households* before or after school. Information about the quality of the material environment of the school was collected through the questionnaire directed at school principals, which sought to quantify *human resources* in terms of the professional profile of the teachers employed by the school and any staff shortages, *material resources*, measured as the availability of *physical educational resources* and *computer availability*, and lastly, the *extracurricular activities* offered by the school. **Table 2** describes the well-being model based on the OECD well-being framework.

The original version of the student questionnaire can be found in Annex A of the PISA 2015 Theoretical Framework (OECD, 2016a), while the items of the specific well-being

TABLE 2 | Well-being model dimensions.

Dimension	Constructs
Cognitive dimension	Enjoyment of science
	Instrumental motivation in science
	Science self-efficacy
	Interest in broad science topics
Material dimension	Parental occupation
	Physical resources at home
	Shortage of educational material
	Shortage of educational staff
	Index proportion of all teachers fully certified
	Total number of all teachers at school
Physical dimension	Eating breakfast/dinner
	Exercise or practice sport outside of school
Psychological dimension	Overall life satisfaction
	Achievement motivation
	Students' career and educational expectations
	Test and learning anxiety
Social dimension	Belongingness at school
	Relationship with teachers: teacher fairness
	Collaboration and teamwork dispositions: enjoy cooperation
	Collaboration and teamwork dispositions: value cooperation
	Bullying

scales and constructs are collated in "A Framework for the Analysis of Student Well-Being in the PISA 2015 Study" (Borgonovi and Pál, 2016).

Procedure

The students participating in PISA 2015 took a computer-based test, with assessments lasting a total of 2 h for each student. They also answered a background questionnaire, which took around 35 min to complete. The data collected were processed and published by OECD.

To achieve the objectives of our study, we used OECD data to perform a two-step analysis. Firstly, the well-being model configured through the dimensions or components that significantly impact students' performance in an international context was identified. As a preliminary step, each dimension of the proposed model was analyzed individually, discarding variables until the model adequately fitted the data. Then, the well-being-performance model was constructed by introducing science performance (the major domain of the 2015 edition of PISA) as the dependent variable. Science performance was estimated as the mean of the 10 plausible values, the estimators of student proficiency used in PISA. The proposed well-being model was configured for the whole sample of the OECD students.

Secondly, the magnitude of school effects in terms of the various measures of well-being were estimated at the international and country level. With this purpose, the gross variance of the well-being indicators accounted for by clustering as well as the variance adjusted by students' characteristics were assessed.

In addition, the relationships between student/school-level factors and the well-being indicators at the international and country level were analyzed. With this purpose, the previous model was enriched with the predictor variables related to school characteristics.

Data Analyses

During the first step, the well-being model was evaluated using confirmatory factor analysis (CFA), where the latent variables were those represented by student responses to the student questionnaire. The estimation method employed was maximum likelihood with robust standard errors. The fit of the model was analyzed according to different criteria: the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR), taking into account the usual criteria as set out in Hu and Bentler (1999): CFI and TLI should be greater than 0.95, RMSEA should be below 0.06, and SRMR below 0.08. Then, the multiple regressions for the OECD countries as a whole and for individual countries were used to compute the standardized beta weights and the percentage of variance in academic achievement as a function of the studied variables. CFA was carried out using the *lavaan* package of R software (Rosseel, 2012), and multiple regressions using the *rms* package (Harrell, 2019).

The second step aimed to measure, at the OECD level and the individual country level, school effectiveness in the promotion of the well-being dimension, as well as those variables identified in step 1 as being important in relation to performance. At the country level, the PISA data have a hierarchical structure, where the individuals at level 1 (students) are nested in clusters at level 2 (schools). It is generally accepted that school effectiveness studies require multilevel techniques, such as those developed by Aitkin and Longford (1986), to be employed both in order to estimate the magnitude of school effects and to analyze the impact of student- and school-related factors (Aitkin and Longford, 1986; Hill and Rowe, 1996; Kennedy and Mandeville, 2000; Goldstein, 2003; Murillo, 2008; Gamazo et al., 2018). In this work, therefore, hierarchical linear modeling was used to estimate school effects on well-being indicators (Snijders and Bosker, 2012) whereby the two-level technique was applied in the cross-country analysis, the first level corresponding to students and the second to schools.

The estimation of the variance components of the model allows the calculation of the intraclass correlation coefficient (ICC), which represents the proportion of variation in dependent variables that is accounted for by clustering (Snijders and Bosker, 2012), i.e., ICC, is the ratio of the between-school variance to the sum of the between-school and within-school variance. ICC was calculated in two phases.

Phase 1. Null Model Estimation

In the first phase, gross school effects were estimated through the null model, which contained only the dependent variables and the constant. In this configuration, the model has random effects at both levels without taking into account any control variables. The null model is usually established as the starting point of multilevel

analysis. It makes it possible to obtain the "gross" school effects, assessed through the ICC, i.e., those effects that are not adjusted for contextual variables (Lee, 2000; Hayes, 2006).

Phase 2. Estimation of the Model Incorporating Adjustment Variables

There is a consensus that school effects cannot be measured in terms of "gross" results but should be adjusted by relevant factors related to student progress (Goldstein et al., 1993; Mortimore et al., 1994; Goldstein and Thomas, 1996; Gray et al., 1996). To this end, in the second phase, the model was enriched with the control variables (**Table 3**), and the adjusted school effects measured in terms of ICC were estimated.

The ESCS index at the student level and the mean ESCS at the school level were incorporated in the model. These indicators have continuously been demonstrated to be strong predictors of school outcomes in all OECD countries (Perry and McConney, 2010a,b; Cordero et al., 2014; Suárez-Álvarez et al., 2014; OECD, 2016b; Gamazo et al., 2018). In PISA, the ESCS index is constructed from three components: *the occupational status of the parents*, *the educational level of the parents* (selecting in both cases the data for the parent with the higher level), and *home possessions*.

The impact of student-level background information, like gender and immigration status, has also been widely studied, the results underlining the importance of gender as a predictor of achievement (Stoet and Geary, 2013; Karakolidis et al., 2016; Özdemir, 2016). The model used in this work also included information about repetition of the same grade. Although its benefits are not compared between OECD countries here (Jacob and Lefgren, 2004, 2009; Manacorda, 2012), this strategy is widely used in some countries, like Spain and Portugal. For categorical variables like gender and immigrant status, dummy variables were generated (as many as the number of categories of the original variable minus one).

At the last stage of the study, with the purpose of assessing the relationship between student and school factors related to well-being, the complete model was configured whereby the predictor variables from the previous step were widened to include school factors such as school type, class size, or teaching methodology. There is evidence that supports the notion that these factors influence educational outcomes. For instance, the meta-analysis by Hattie (2009) suggests that reduced class size is a determining factor for improving student achievement, along with a reduced teacher–student ratio (Nath, 2012).

The model was also enriched with the variables that evaluated teaching strategies and teacher support, concepts that have recently gained interest in the academic field (Hattie, 2009; Nath, 2012; Gil et al., 2018) with respect to measuring their effects on student well-being. The OECD classifications distinguish between teacher-directed and student-centered instruction methodologies. Teacher-directed instruction, assessed through the scale *teacher-directed science instruction*, is focused on the role of teacher leading and managing the activities taking place in the classroom. Student-centered instruction, referred to as *inquiry-based science teaching and learning practices*, is associated with the teacher facilitating students' own learning by allowing them time to find solutions to problems on their own before the teacher confirms or demonstrates the solution (Hoad et al., 2007; Rowe, 2007; OECD, 2009).

Teacher support is also gaining importance (OECD, 2016b; Ricard and Pelletier, 2016). Following the PISA measurement construct, teacher support consists in the teacher showing an interest in every student's learning separately, giving extra help when needed, helping students with their learning, continuing to work on a teaching point until all students understand the material, and giving students an opportunity to express their opinions.

The school-level variables, i.e., teaching methodology and teacher support, were calculated as the across-school average of these student-level indexes, constructed on the basis of student responses to the context questionnaires following PISA methodology (OECD, 2017b). The predictor variables of the complete model are shown in the **Table 4**. The package lme4 of R software was used for multilevel modeling (Bates et al., 2015).

TABLE 3 | Control variables.

Level	Variable
Student level	Economic, social, and cultural status
	Gender
	Immigration status
	Grade
School level	School-level economic, social, and cultural status

RESULTS

Relationship Between Student Performance and Well-Being

As a preliminary step to data analysis, for each dimension of the proposed well-being model, a CFA was performed on the summed data for all OECD countries. The cognitive dimension, represented by the four constructs explained above, was the only one that achieved appropriate model fit according to the criteria

TABLE 4 | Predictor variables.

Level	Variable
Student level	Economic, social, and cultural status
	Gender
	Immigration status
	Grade
School level	School type
	Student–teacher ratio
	School size
	Class size
	Teacher-directed science instruction (school level)
	Inquiry-based science teaching and learning practices (school level)
	Teacher support of students' choices in a science classes (school level)

of Hu and Bentler (1999). The material dimension, defined as the economic resources of a student's household, represented through the *home possessions* index and the index of parental occupational, was also confirmed. Although psychological, social, and physical dimensions, assessed through the respective OECD scales, did not exhibit construct solidity, individual scales aimed at assessing these dimensions were introduced into the well-being-performance model in order to capture whether, and how, subjective non-cognitive well-being indicators predict performance in science.

Figure 1 presents the final well-being-performance model, which is the one that achieved the highest fit values. **Table 5** indicates the values obtained for the CFA. In the model representing the relationship between well-being and performance, the cognitive dimension was finally reduced to three scales: *enjoyment of science*, *instrumental motivation in science*, and *science self-efficacy*. In the psychological dimension, the variables *achievement motivation* and *test anxiety*, considered individually, acted as good predictors of science performance. The material dimension, measured through the level of *parents' occupation* and *home possessions* of students' families, was strongly related to performance. Finally, although four social dimension variables (*belongingness at school, teacher fairness, enjoy cooperation*, and *value cooperation)* were demonstrated to have a significant impact on science achievement, the model that included all four of them did not fit the data well. However, the variable *enjoy cooperation* contributed positively to the final model. The variables of the physical dimension did not provide reliable information about the well-being-performance model, probably due to their dichotomous nature.

Multiple regression (**Table 6**) indicated that well-being variables explained around 22% of the variance related to students' achievement in science.

It can be observed that in the regression model performed for the overall OECD sample, the greatest weight corresponded to the material well-being dimension. Nevertheless, the impact of cognitive well-being is also both high and constant across countries: on average, an increase of 1 point in terms of cognitive well-being would result in an increment of 18 points on the PISA science achievement scale. In six countries (Australia, Canada, Finland, Iceland, Ireland, and Korea), the cognitive variables are able to predict achievement as much as, or in some cases better than, economic background does. Test anxiety was found to reduce science performance by up to 12 points, with the strongest negative relationship observed in Finland. These results are also constant across countries, excepting Korea, where higher test anxiety corresponds to higher performance in science. *Achievement motivation* and *enjoy cooperation* both also relate positively to the cognitive results in most of the countries, although their impact is weaker.

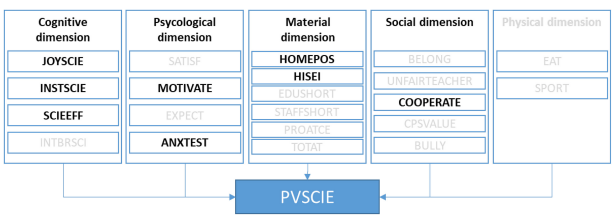

FIGURE 1 | Confirmed well-being/performance model. Source, Prepared by the authors, based on Programme for International Student Assessment (PISA) Well-being Framework.

TABLE 5 | Model fit test statistics of well-being-performance model.

	χ^2	CFI	TLI	RMSEA	SRMR
Total OECD	144701. 688***	0.957	0.953	0.038	0.036

****Significant at $p < 0.01$; CFI, comparative fit index (CFI); TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.*

School Effectiveness in Well-Being Promotion

Once the well-being components that were strongly related to performance were identified, we studied the school effects on the well-being components that can be modulated by the school. These effects on science cognitive scores are also presented.

Table 7 summarizes the school effects for the null model and for the model adjusted for student background and ESCS information. Consistent with previous research, the results indicate that the school seems to have only a weak influence on student well-being, although there is some variation depending on the country analyzed and on the predictor variable considered. In the null model, the total OECD school-level variation in science performance was around 39%, while it barely reached 9% for the well-being components, indicating that the school's role turns out to be much less important in promoting students' well-being. School effects accounted for 9% of variation in the cognitive well-being dimension, 8% of test anxiety, and 5% of enjoyment of cooperation. The model adjusted to incorporate the control variables did not result in any significant differences in terms of school effects, explaining only 1% of variation for enjoyment of science and enjoyment of cooperation variables, while the school-level variation in science performance was reduced up to 25%.

Figure 2 reflects cross-country school effects for the cognitive dimension and for the psychological and social variables (for the country-level results and for the variables that compose the cognitive well-being dimension, please refer to **Supplementary Material**). In comparison with the rest of the variables, the role of the school in cognitive well-being promotion is systematically higher than other dimensions in OECD countries. Adjusted school effects in Italy and Japan were around 10% in terms of cognitive well-being. Italy, along with Belgium, also showed higher variability in students' perception of achievement motivation at the school level. Enjoyment of cooperation is the component of social well-being where schools had less impact, a result that is consistent across countries, with Switzerland being the only country where it exceeded 5%. Schools also do not seem to play any great part in test anxiety reduction. Italy was the only country where any great amount (10%) of

TABLE 6 | Regression coefficients.

Abbreviations	Country	R^2	Beta				
			COGWB	MATWB	MOTIVATE	ANXTEST	COOPERATE
Total OECD		0.224	17.88***	31.44***	0.41***	−12.24***	4.35***
AUS	Australia	0.238	28.73***	25.69***	5.25***	−8.85***	2.00***
AUT	Austria	0.247	16.41***	34.56***	2.28***	−16.02***	1.74***
BEL	Belgium	0.256	20.07***	38.00***	−5.73***	−10.12***	7.98***
CAN	Canada	0.197	21.77***	21.22***	5.15***	−11.67***	1.39***
CHL	Chile	0.241	4.93***	29.52***	5.95***	−18.01***	8.50***
CZE	Czech Republic	0.317	14.69***	42.68***	6.47***	−15.94***	8.46***
DNK	Denmark	0.280	21.76***	26.05***	12.41***	−14.40***	1.83***
EST	Estonia	0.273	16.64***	22.74***	9.65***	−17.89***	5.65***
FIN	Finland	0.262	24.39***	23.68***	11.72***	−20.38***	NS
FRA	France	0.279	22.00***	36.99***	NS	−10.44***	9.44***
DEU	Germany	0.184	18.03***	39.22***	1.14***	−12.93***	6.59***
GRC	Greece	0.247	18.66***	27.13***	9.35***	−11.37***	5.10***
HUN	Hungary	0.295	3.26***	43.61***	7.54***	−12.87***	10.52***
ISL	Iceland	0.229	17.16***	14.48***	12.56***	−16.23***	2.30*
IRL	Ireland	0.220	27.45***	23.42***	7.55***	−13.31***	−1.19***
ISR	Israel	0.258	13.11***	29.54***	2.64***	−6.88***	−0.50*
ITA	Italy	0.277	15.98***	30.97***	−1.58***	−9.20***	9.08***
JPN	Japan	0.214	23.89***	24.37***	5.71***	−1.80***	−0.88***
KOR	Korea	0.130	25.08***	25.06***	11.60***	1.12***	−1.35***
LVA	Latvia	0.180	10.80***	23.41***	11.15***	−18.23***	12.67***
LUX	Luxembourg	0.168	17.35***	39.38***	NS	−16.33***	6.02***
MEX	Mexico	0.209	4.68***	17.17***	8.64***	−12.43***	5.16***
NLD	Netherlands	0.341	23.29***	36.80***	6.69***	−1.71***	4.89***
NZL	New Zealand	0.192	27.67***	29.33***	3.61***	−15.71***	1.71***
NOR	Norway	0.173	24.57***	24.94***	9.03***	−11.76***	3.42***
POL	Poland	0.198	12.96***	28.40***	9.91***	−15.64***	7.03***
PRT	Portugal	0.228	18.02***	30.10***	13.50***	−15.43***	−1.87***
SVK	Slovak Republic	0.247	11.03***	34.18***	11.21***	−9.54***	14.63***
SVN	Slovenia	0.197	17.10***	33.63***	6.97***	−12.89***	10.96***
ESP	Spain	0.287	20.62***	24.50***	10.44***	−16.14***	5.24***
SWE	Sweden	0.224	22.96***	29.19***	6.33***	−9.23***	2.95***
CHE	Switzerland	0.201	18.54***	39.44***	2.06***	−13.14***	4.49***
TUR	Turkey	0.226	10.87***	26.58***	4.36***	−5.14***	6.19***
GBR	United Kingdom	0.188	27.71***	28.21***	−0.37***	−6.30***	1.99***
USA	United States	0.182	18.35***	26.93***	0.26***	−10.71***	2.21***

****Significant at $p < 0.01$; *significant at $p < 0.1$; NS, not significant. COGWB, cognitive well-being; MATWB, material well-being; MOTIVATE, achievement motivation; ANXTEST, test and learning anxiety; COOPERATE, enjoy cooperation.*

variation in this dependent variable was accounted for by school nesting. In Iceland and Germany, no school variation in test anxiety was observed.

Student and School Factors Related to Performance

Finally, the impact of student and school factors on well-being variables was assessed. The results for science performance are presented in order to reflect the differences in the influence of these factors on achievement results and well-being. **Table 8** shows the estimates of multilevel modeling on each dependent variable for the overall OECD sample. **Table 9** identifies the number of countries where the factors are significantly positively related to the dependent variables.

ESCS has traditionally been positively related to performance, a tendency that, in this work, persists when well-being variables are taken into account. Students with higher ESCS exhibited higher cognitive well-being, with the strongest impact being on their perception of self-efficiency in science. More advantaged students also had higher achievement motivation and were more resistant to stress as a result of exams. This relationship was reproduced at the individual country level.

At the OECD level, girls demonstrated lower levels of cognitive well-being along with higher levels of test anxiety, although they enjoyed cooperation more than their male classmates and had higher levels of achievement motivation. At the individual country level, these results were repeated, except for achievement motivation, where, in 9 countries, no clear relationship with gender was observed, while in 14 countries, boys were more highly motivated to achieve academically.

Once ESCS was controlled for, students with immigrant backgrounds reported higher motivation to achieve than non-immigrant students. They also demonstrated higher levels of cognitive well-being, especially for enjoyment of science and

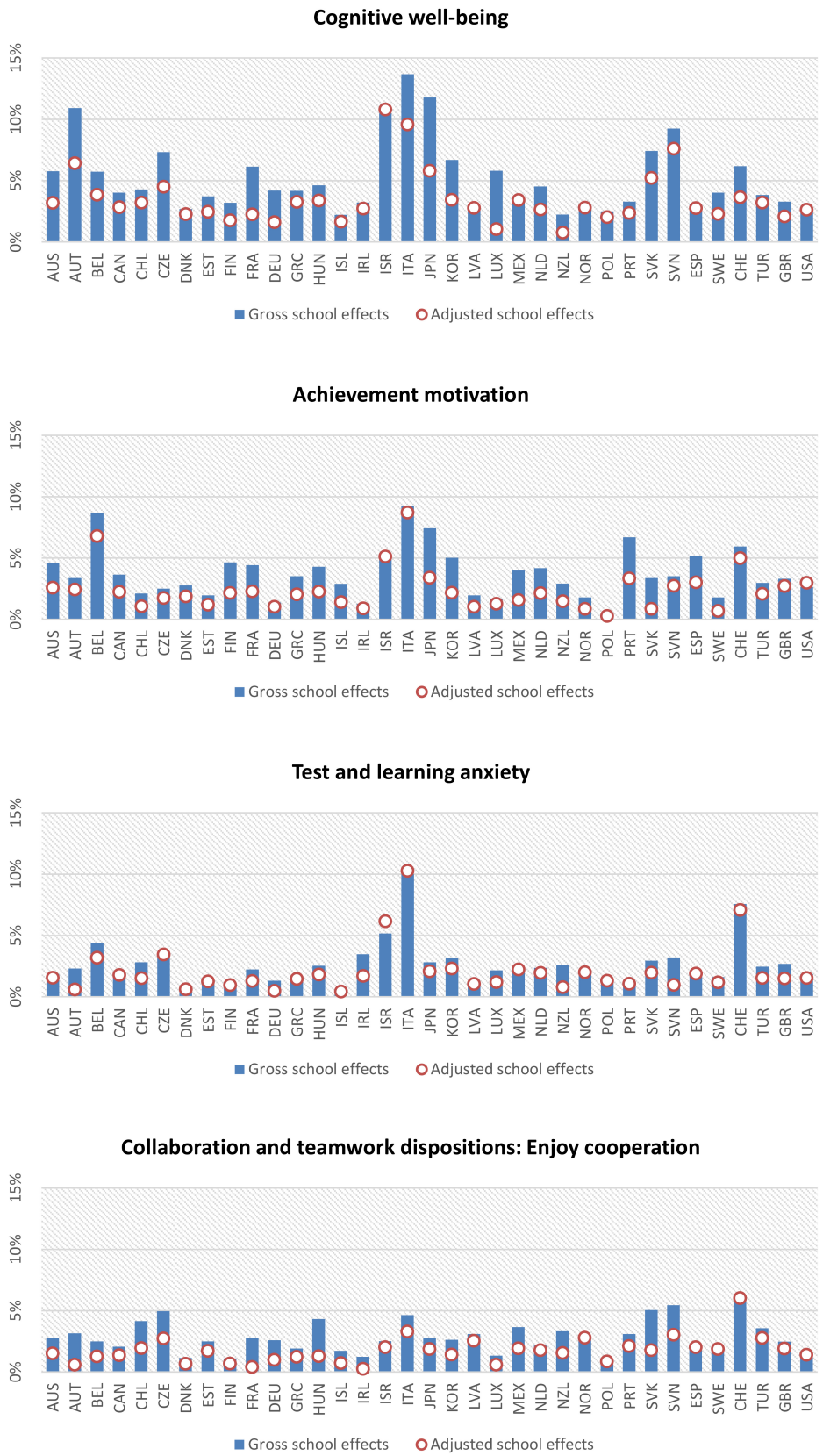

FIGURE 2 | Country-level school effects in terms of intraclass correlation coefficient (ICC).

TABLE 7 | School effects in terms of ICC.

	SCIE	COGWB	JOYSCIE	SCIEEFF	INSTSCIE	MOTIVATE	ANXTEST	COOPERATE
Gross school effect								
Total OECD school effect	39.0%	9.0%	9.0%	5.0%	7.0%	3.0%	8.0%	5.0%
Min school effect	5.0%	2.2%	2.1%	1.7%	0.5%	0.5%	0.6%	1.0%
Max school effect	62.1%	13.7%	10.7%	7.2%	12.6%	9.3%	10.0%	6.3%
Net school effect								
Total OECD school effect	25.0%	9.0%	8.0%	5.0%	7.0%	3.0%	8.0%	4.0%
Min school effect	3.6%	0.8%	0.9%	0.4%	0.3%	0.3%	0.4%	0.3%
Max school effect	41.5%	10.8%	8.6%	3.9%	11.8%	8.7%	10.3%	6.0%

ICC, intraclass correlation coefficient; SCIE, science performance; COGWB, cognitive well-being; JOYSCIE, enjoyment of science; SCIEEFF, science self-efficacy; INSTSCIE, instrumental motivation in science; MOTIVATE, achievement motivation; ANXTEST, test and learning anxiety; COOPERATE, enjoy cooperation.

instrumental motivation. On the other hand, being an immigrant was associated with higher test anxiety.

At the school level, the influence of school characteristics, along with teaching methods and teacher support, on the students' subjective well-being was assessed. Although public schools consistently performed worse than private schools even after controlling for ESCS, this tendency was reversed in terms of students' perception of their cognitive well-being. In public schools, students tended to demonstrate higher levels of self-efficiency and science enjoyment. Nevertheless, they were less motivated to achieve and more prone to feeling anxious about exams. The school and class size seemed to have a very low impact on students' perception of well-being both at the OECD and at the individual country level.

Teaching methodology, measured as the use of teacher-directed or inquiry-based instruction, and teacher support are strongly and positively related to the well-being indicators, while they have an opposite effect in relation to science performance: the more frequent use of inquiry-based teaching and higher teacher support are associated with a decrease in science performance of around 25 points on the PISA scale. However, more inquiry-based instruction, when students are given opportunities to explain their ideas, spend time in the laboratory doing practical experiments, or are required to discuss science questions, increases students' perception of self-efficiency and promotes intrinsic motivation by increasing science enjoyment. Furthermore, it reduces exam anxiety and raises achievement motivation. The positive relationship between inquiry-based teaching and the cognitive well-being dimension is confirmed individually in 17 OECD countries.

Enjoyment for science is higher when the teacher regularly explains scientific ideas, a whole class discussion takes place with the teacher, and the teacher addresses students' questions and practically explains an idea. Teacher-directed instruction also increases students' positive predisposition toward cooperation. The positive impact of teacher-directed methodologies on cognitive well-being and cooperation is observed in 19 separate OECD countries.

Teacher support was the school-level variable that demonstrated the strongest relationship with student well-being in the model proposed. Showing an interest in every student's learning, giving extra help when students need it, and continuing with explanations until all students understand the material turn out to be extremely important for the promotion of achievement motivation and for positive predisposition toward cooperation. In addition, these practices reduce test anxiety in 7 of the 10 OECD countries where teacher support is significant.

DISCUSSION

The aim of the study was twofold. On the one hand, the present study sought to reach a global definition of well-being across the countries assessed for the PISA 2015 report and to assess its relationship with performance. On the other, we focused on ascertaining the impact of school effects on student welfare and identifying those factors positively related to well-being in the educational context.

The results evidenced the complexity of the well-being concept and the need for further research on its definition. Of the four dimensions described in the original model, only the cognitive dimension was confirmed as having an impact across all countries in PISA 2015. In the evaluation of the material dimension, only student-level variables contributed positively to the model, while school environment and resources did not demonstrate any significant effect once the students' economic background was taken into account. Psychological and social dimensions were found to be multifaceted concepts represented by a variety of individual variables but not confirmed as solid constructs. Finally, the physical dimension did not provide reliable information with respect to the construct definition.

Consequently, in the well-being-performance model, well-being was finally defined by the cognitive and material dimensions, along with the individual psychological and social variables *achievement motivation*, *test anxiety*, and *enjoyment of cooperation*, i.e., the variables that were found to be good predictors of performance in science. The results showed that student well-being significantly impacts student performance. Higher cognitive well-being is associated with better achievement results, increasing science performance by up to 22 points on the PISA scale. In six countries, the promotion of cognitive well-being was even demonstrated to counteract the effect of socioeconomic background. Lower *test anxiety* is also linked to better results, along with *enjoyment of cooperation*.

Nevertheless, currently, school interventions do not appear strong enough to make an impact on subjective well-being.

TABLE 8 | Estimation of fixed effects and random effects of the complete model for the overall OECD sample.

	PVSCIE	COGWB	JOYSCIE	SCIEEFF	INSTSCIE	MOTIVATE	ANXTEST	COOPERATE
Student level								
ESCS	19.65***	0.17***	0.15***	0.22***	0.08***	0.14***	−0.06***	0.09***
GENDER_girl	−8.08***	−0.13***	−0.13***	−0.20***	−0.02***	0.02***	0.45***	0.21***
IMMIG_yes	−18.29***	0.10***	0.13***	0.03**	0.09***	0.19***	0.08***	0.06***
School level								
SCHLTYPE_pub	−11.63***	0.04***	0.03***	0.06***	0.01	−0.08***	0.03***	−0.05***
STRATIO	0.00	0.00***	0.00**	0.00**	0.00***	0.00***	0.00	0.00***
SCHSIZE	0.00	0.00	0.00***	0.00***	0.00	0.00***	0.00	0.00***
CLSIZE	0.46***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
TDTEACH_S	52.59***	0.18***	0.29***	0.06***	0.10***	0.05**	0.04***	0.17***
IBTEACH_S	−27.20***	0.17***	0.13***	0.24***	0.07***	0.09***	−0.07***	0.04***
TEACHSUP_S	−24.97***	0.23***	0.21***	0.09***	0.28***	0.33***	0.21***	0.05***
Random effects								
σ2	5248.41(71%)	0.88(95%)	1.15(96%)	1.44(97%)	0.94(96%)	0.81(87%)	0.87(94%)	0.94(97%)
τ00 (CNTSCHID)	2116.7(29%)	0.05(5%)	0.05(4%)	0.05(3%)	0.04(4%)	0.12(13%)	0.06(6%)	0.03(3%)

****Significant at $p < 0.01$; **significant at $p < 0.05$; NS, not significant. CNTSCHID, country school ID; PVSCIE, science performance; COGWB, cognitive well-being; JOYSCIE, enjoyment of science; SCIEEFF, science self-efficacy; INSTSCIE, instrumental motivation in science; MOTIVATE, achievement motivation; ANXTEST, test and learning anxiety; COOPERATE, enjoy cooperation; ESCS, economic, social, and cultural status; GENDER_girl, gender (the student is a girl); IMMIG_yes, (the student is an immigrant); SCHLTYPE_pub, school type (the school is public); SCHSIZE, school size; STRATIO, student–teacher ratio; CLSIZE, class size; TDTEACH_S, teacher-directed science instruction (school level); IBTEACH_S, inquiry-based science teaching and learning practices (school level); TEACHSUP_S, teacher support of students' choices in science classes (school level).*

School effects explain barely 5% of the variation in well-being perception within schools, and school-level variation is highest for the cognitive well-being dimension, accounting for up to 9% of school effects on average across all the OECD countries. These results are consistent with previous studies (Murillo and Hernández-Castilla, 2011; Lazarides and Buchholz, 2019) and provide further evidence in support of these effects both in the across-OECD context as well as for each member country. Our results highlight that some countries, like Italy and Switzerland, are more successful with school-level interventions, while others, like Poland and Iceland, have a very limited school-level influence on well-being. There may be multiple reasons for this low school-level impact on well-being, the most likely being a lack of socio-emotional education within schools, the low availability of tools and policies for well-being improvement, or the limited time dedicated to achievement in non-academic aspects of learning (Murillo and Hernández-Castilla, 2011), although it is becoming more common to introduce school practices aimed at the promotion of cognitive, social, and emotional well-being and stress reduction (Jennings et al., 2013; Schonert-Reichl et al., 2015). Research findings provide evidence to support the notion that the implementation of such methods improves attention deficits, reduces stress, and promotes self-regulation among adolescents (Albrecht et al., 2012; Carboni et al., 2013).

The student and school factors associated with higher levels of cognitive well-being, motivation, and cooperation were also assessed. At the student level, the socioeconomic background was again a good predictor of student well-being, which clearly makes it difficult for schools to combat its substantial influence. However, on the positive side, the analysis provides evidence that teachers employing a methodology that combines the traditional teacher-led approach with more innovative practices based on inquiry and teamwork seems to be a powerful tool for improving non-cognitive educational achievement. Science teaching and learning practices that include experimentation and critical thinking increase students' self-efficacy in science and reduce test anxiety. These insights are especially important given that student-oriented teaching methods seem to be negatively linked to academic achievement (Gil et al., 2018). A classic teacher-directed approach, where the teacher leads class discussions and explains ideas, is associated with higher levels of science enjoyment and better predisposition toward cooperative working. These results support the idea of the importance of an adaptive pedagogy that brings together innovation and teacher-directed instruction, rather than teachers opting exclusively for either one of these approaches (Rowe, 2007; OECD, 2008b).

Teacher support of pupils at the school level was initially negatively related to science performance in the multilevel model proposed here. This was probably due to the fact that teachers at schools in disadvantaged areas report supporting students in their learning more frequently than teachers in schools in more advantaged areas, as is also the case for teachers in rural as opposed to urban schools (OECD, 2017a). Schools in disadvantaged and rural areas tend to perform worse in the PISA assessments, and therefore, their students are in greater need of teacher support. Nevertheless, in this study, teacher support turned out to be the strongest predictor of student well-being, i.e., when the teacher works to ensure the students' complete understanding of the problem, provides extra help when it is required, and aims to integrate learning, students report higher subjective well-being. Previous research (Ahmed et al., 2014) has also shown that student-perceived teacher support is negatively related to student anxiety and boredom at the student level, and positively related to

TABLE 9 | Cross-country summary of fixed effects (number of countries with significant and positive impact).

Variable	SIG	ESCS	GENDER_girl	IMMIG_yes	SCHLTYPE_pub	SCHSIZE	STRATIO	CLSIZE	TDTEACH_S	IBTEACH_S	TEACHSUP_S
COGWB	SIG (N°)	35	34	18	5	0	7	4	19	17	17
	POSITIVE (N°)	35	3	13	3	0	3	4	19	17	15
JOYSCIE	SIG (N°)	33	25	16	6	6	9	7	29	12	17
	POSITIVE (N°)	33	2	15	2	0	6	6	28	10	15
SCIEEFF	SIG (N°)	35	30	13	9	7	6	5	13	18	8
	POSITIVE (N°)	35	1	12	3	0	4	3	11	18	4
INSTSCIE	SIG (N°)	31	19	14	5	3	6	3	4	14	17
	POSITIVE (N°)	31	7	14	3	0	4	2	3	14	16
MOTIVATE	SIG (N°)	34	26	22	12	7	3	6	12	6	10
	POSITIVE (N°)	34	12	21	4	0	2	4	9	3	8
ANXTEST	SIG (N°)	28	35	15	6	5	4	7	4	7	10
	POSITIVE (N°)	0	35	13	4	0	1	5	3	2	3
COOPERATE	SIG (N°)	33	34	12	9	10	4	11	20	4	13
	POSITIVE (N°)	33	34	9	3	0	1	7	19	1	12

SCIE, science performance; COGWB, cognitive well-being; JOYSCIE, enjoyment of science; SCIEEFF, science self-efficacy; INSTSCIE, instrumental motivation in science; MOTIVATE, achievement motivation; ANXTEST, test and learning anxiety; COOPERATE, enjoy cooperation; ESCS, economic, social, and cultural status; GENDER_girl, gender (the student is a girl); IMMIG_yes, (the student is an immigrant); SCHLTYPE_pub, school type (the school is public); SCHSIZE, school size; STRATIO, student–teacher ratio; CLSIZE, class size; TDTEACH_S, teacher-directed science instruction (school level); IBTEACH_S, inquiry-based science teaching and learning practices (school level); TEACHSUP_S, teacher support of students' choices in science classes (school level).

enjoyment and negatively related to anxiety at the classroom level (Lazarides and Buchholz, 2019).

In the 21st century, the era of knowledge and innovation, the school has gained great importance in the development and learning of individuals, as well as it having become an extraordinarily complex and multidisciplinary facility. On the one hand, the purpose of schools is to promote knowledge acquisition, but on the other, they must help children build confidence and develop a variety of learning strategies for the future (OECD, 2008a). This research aims to contribute to the growing concern about students' quality of life and happiness and to emphasize the importance of a comprehensive approach to education where socio-emotional development is integrated in a schools' day-to-day functioning.

The principal limitation of the study lies in the need for improvement in the instruments available for assessing well-being in an educational context. Although the OECD provides a solid framework for the measurement of well-being, some dimensions, like physical well-being, still need to include reliable and unidimensional scales. Moreover, it should be taken into account that instruments based on self-reporting will never achieve the same level of sensitivity in measuring latent constructs such as those involved in well-being as do academic achievement tests (Murillo and Hernández-Castilla, 2011).

The results of this research should be considered with cautions, as there is no evidence of causality for the relationships observed. The reciprocal relationship between well-being and performance should be taken into account. For instance, previous research has shown that higher levels of achievement are positively related to enjoyment (Ma, 1997) and reduce exam anxiety (Ma and Xu, 2004). In addition, the impact of student and family characteristics should not be forgotten, as they are connected to the achievement and behavior of students at school, as García-Crespo et al. (2019) indicate. Nevertheless, the conclusions regarding teaching methodology are more consistent, although it would be interesting to study the persistence of the positive impact of teachers' interventions with respect to students with different academic profiles (low/average/high academic performance, etc.). Future research within our research team will focus on expanding on the results obtained in this work by extending the analysis to primary education data, where it is expected that school involvement in socio-emotional variables is more common and efficient.

DATA AVAILABILITY STATEMENT

This study was based on the public data available on the OECD web page: http://www.oecd.org/pisa/data/2015database/.

ETHICS STATEMENT

The study did not require ethics approval. The data collection was performed on behalf of the OECD following the standards

for the protection of privacy and the processing of personal data (http://www.oecd.org/internet/ieconomy/oecdguidelinesontheprotectionofprivacyandtransborderflowsofpersonaldata.htm).

AUTHOR CONTRIBUTIONS

EG prepared the data set for analysis, conducted the analysis, and was involved in writing the manuscript. IB and JM supervised the analysis and participated in writing the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00431/full#supplementary-material

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1.2. Estudio 2

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El objetivo del presente estudio es, por un lado, explorar el concepto de bienestar en el contexto educativo, analizando los elementos que lo componen y profundizando en la naturaleza de las interacciones entre dichos elementos, y, por otro lado, evaluar las relaciones entre las dimensiones del bienestar y los factores escolares como el clima escolar y las prácticas docentes. La principal aportación de este artículo a la tesis doctoral consiste en la aplicación de una metodología de análisis innovadora – análisis de redes – en el contexto de una investigación de factores asociados al bienestar. Esta metodología permite una comprensión más profunda de las áreas centrales del bienestar estudiantil y su conexión con los factores escolares.

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Article

Predicting Student Well-Being: Network Analysis Based on PISA 2018

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Abstract: The latest trends in research extend the focus of school effectiveness beyond students' acquisition of knowledge and skills, looking at aspects such as well-being in the academic context. Although the concept of well-being itself has been defined and measured in various ways, neither its dimensions nor the relationships between the components have been clearly described. The aim of the present study was to analyse how the elements of well-being interact and determine how they are influenced by school factors. To do that, we conducted a network analysis based on data from the Programme for International Student Assessment (PISA) 2018 international assessment. Our results demonstrated that cognitive, psychological, and social well-being variables form a solid welfare construct in the educational context, where students' resilience and fear of failure, along with their sense of belonging, play central roles. Although the influence of school factors on student well-being is generally low, teaching enthusiasm and support promote positive school climates which are, in turn, crucial in reducing bullying.

Keywords: well-being; bullying; network analysis; PISA 2018; teaching style

1. Introduction

One of the main priorities of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) strategy on education is the promotion of children and young people's well-being [1]. The Convention on the Rights of the Child established four general principles that should be uniformly and universally adhered to: non-discrimination; the best interests of the child; the right to life, survival, and development; and respect for the views of the child [2]. Despite that, statistics in the educational arena indicate that these principles are a long way from being reality. In primary education, the data are extremely worrying. According to the International Association for the Evaluation of Educational Achievement (IEA) assessment, 29% of 4th grade students reported that they suffered bullying each month and 14% reported being bullied on a weekly basis [3]. In addition, the 2018 Programme for International Student Assessment (PISA) reported that the average percentage of frequently bullied students reached 8% in secondary education across countries members of the Organisation for Economic Co-operation and Development (OECD). Furthermore, 9% of 15-year-old students reported always being sad and around 6% reported being miserable and scared. More than 30% of students felt that their teachers did not understand them and did not listen to their points of view, and only about two thirds of students reported that they were satisfied with their lives [4]. These data suggest that there is still work to be done in terms of improving children's rights and that there are numerous factors influencing children's experiences. In this regard, well-being in the educational context, the school environment, and experiences in the school context seem to be important in understanding the situation

and encouraging changes that improve students' lives. Ultimately, "children and young people spend so much of their childhoods in this context" [5].

Students' well-being is an objective that the school must set as a priority, since it is increasingly considered as an indicator of the quality of the teaching-learning process. The well-being concept is complex, as it englobes a variety of elements like physical and mental health, the happiness and satisfaction of students' lives, and socialization and interaction with peers and teachers, among others. The present research aims to assess how these elements are related to each other and which of them play a central role in school-related quality of life. We hope that our work contributes to a better understanding of the role that students' well-being plays in the school context. This will allow us, on the one hand, to design actions and projects to improve the effectiveness of educational systems and, on the other, to improve the overall quality of life of students, which will ultimately lead to an improvement in their education.

1.1. Well-Being in the Educational Context

The OECD defines well-being as a dynamic state characterized by students experiencing the ability and opportunity to fulfil their personal and social goals [6]. The promotion of student well-being is already an important item on the agenda in education. Taking that idea, Chapman [7] points to four reasons for justifying the inclusion of well-being as a relevant variable. Those reasons are based on the importance of well-being for health, educational achievement, socialization and social values, and the development and formation of the human mind.

What happens in school is key to understanding whether students enjoy good physical and mental health, how happy and satisfied they are with different aspects of their lives, how connected to others they feel, and the aspirations they hold for their future [8–10]. For instance, a positive class atmosphere where effort is encouraged and rewarded and in which children are accepted and supported by their teachers regardless of their intellect and temperament can have a positive effect on student well-being [11,12]. As Slee and Skrzypiec [13] describe, interventions in school for enhancing student well-being are focused on improving relationships, resilience, and the school climate and reducing bullying. However, the connection between these variables and the reported well-being is not clear.

Nor is the concept of well-being clear. Despite many studies working on defining well-being, it is not static. Currently, there are many theoretical approaches differing in the elements that make up well-being and the key focus of the construct, as summarized by McLellan and Steward [14]. There are also several studies collecting qualitative data about students' perceptions of well-being. For instance, in a project in New South Wales students defined well-being through feelings such as happiness or the absence of sadness, harmonious social relationships, and being a moral actor in relation to oneself or behaving well towards others [15]. Another qualitative study in Australia indicated that self-esteem, self-respect, and self-confidence were central to student well-being [5].

In the international context, definitions of well-being try to cover the full concept by including elements common to students from different countries and cultures and usually by including indicators related to students´ school-lives which depend on their personal and family lives. For instance, the definition formulated by the Organisation for Economic Co-operation and Development (OECD) indicates that student well-being refers to the psychological, cognitive, material, social, and physical functioning and capabilities that students need to live a happy and fulfilling life [16].

Based on that definition, in the 2015 edition of PISA the framework for the analysis of student well-being described the construct according to five domains [6]: (1) cognitive well-being, which includes variables related to student knowledge and abilities for resolving everyday issues; (2) psychological well-being, which includes perceptions of the students about their own lives, their engagement with school, and their plans for the future; (3) physical well-being, which refers to students' health and their habits related to sports and eating; (4) social well-being, which evaluates

how students perceive their relationships within and outside of school; and (5) material well-being, which refers to the available resources for meeting students' needs.

However, the analysis of the student responses to the well-being scales in PISA 2015 demonstrated that the proposed structure of the well-being concept could not be confirmed, as some of the domains were not unidimensional and some of the indicators included in the domains were not relevant to student welfare [17]. Therefore, the subsequent edition of PISA in 2018 incorporated some changes to the definition of well-being. Based on the same framework, the indicators and the composition of the domains were adjusted in order to better reflect variables defining student well-being. In the present study, the model of well-being is based on both PISA editions.

Figure 1 illustrates the proposed well-being model which is configured according to data collected in PISA 2018. The model evaluated in the present research includes three well-being dimensions: the social dimension as defined in PISA 2015 and the psychological and cognitive dimensions as defined in PISA 2018. In the psychological dimension, students' life satisfaction, sense of meaning in life, and feelings are used as indexes for measuring subjective well-being [18]. These variables evaluate the general perception of life satisfaction and sense of meaning in life as well as emotions and moods. Self-efficacy and fear of failure inform about students' perceptions of their own general abilities to deal with challenging circumstances [19,20]. The cognitive dimension focuses on the growth mindset, which evaluates the extent to which someone perceives their abilities and intelligence as variables that can be developed [21]. Finally, the social dimension reflects students' perceptions about the level of cooperation and competitiveness at schools, as well as social acceptance and levels of bullying.

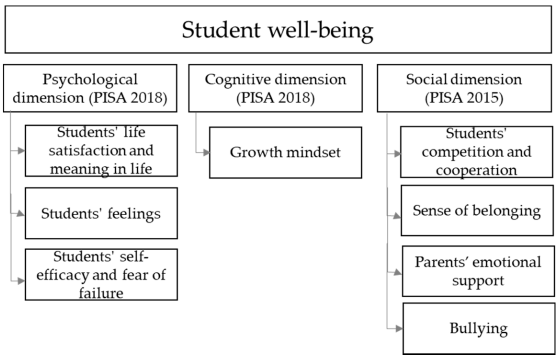

Figure 1. Well-being model based on Programme for International Student Assessment (PISA) 2018 and PISA 2015. This figure has been prepared by the authors and is based on figures presented in the PISA 2018 Results, Volume III (OECD, 2019), and the PISA 2015 well-being framework [6].

Reports produced using PISA 2018 and 2015 data provide important information about how these variables of student well-being behave and how the values for each of them relate to performance. However, in order to more deeply understand the concept of well-being in students, we would need to know how the domains and indicators from each domain relate to the others. In addition, knowing how these components connect to variables related to the school and teachers' activities would help to formulate policies focused on increasing students' well-being.

1.2. Network Analysis in Education

From a methodological perspective, the structure of well-being and other psychological variables can be studied by following various approaches. For instance, exploratory and confirmatory factorial analyses and other clustering methods provide information about groups of items measuring the same dimension. Furthermore, information about the strength of the relationships between variables can be estimated through correlation or regression indices. Nevertheless, these procedures cannot illustrate connectivity in such a way that changes in the structure indicate meaningful differences.

Networks have recently been gaining importance as models that represent complex phenomena in human behavioural science [22], such as psychopathology [23,24] and personality [25–27]. In the educational field, for example, network analysis has been applied to learn about the influence of multiculturality on student motivation [28] and understand the role of interest in science in student involvement [29].

The aim of the present study was to describe the concept of well-being in the educational context. To do that, we first analysed the elements making up the concept of well-being itself and the nature of the interactions between those elements. Following that, we assessed the relationships between well-being dimensions and school factors, such as school climate and teaching practices. After proposing a model illustrating relationships between well-being and school factors, we compared the network models representing the relationships between well-being and school factors between groups.

2. Methods

2.1. Sample

We based our analysis on the data collected in PISA 2018, the latest edition of the international student assessment that aims to provide information about the ability of 15-year-old students to face the challenges in their future lives. PISA measures students' capacity to use their knowledge and skills in reading, mathematics, and science and to apply them to real life situations. The OECD organizes PISA assessments every three years. In PISA 2018, 37 OECD countries and 47 associated countries and economies participated in the study. The advantage of PISA data is that, along with performance measurement, it offers a variety of contextual data which enables in-depth studies on the different students' factors, including well-being. In recent years, the OECD has prioritized not only the research on students' performance but also the assessment of well-being and social and emotional skills, creating comprehensive frameworks for their definition and measurement.

Table 1 reflects the sample configuration for the OECD and for subgroup samples used in this study. For high and low performing subsample configurations, the students were classified according to their performance in PISA. The average performance of each student in the three domains measured in PISA—reading, mathematics and science—was estimated and the students were classified according to their total performance in the top and bottom quartiles. The students from the highest performance quartile were considered high performers and students from the lowest quartile were considered low performers. This approach is commonly used in the OECD secondary analysis and publications based on PISA data for the measuring of the gap between the highest and lowest-performing students in a specific domain in order to compare the learning outcome parity [30].

Table 1. International sample configuration.

	Total	Percentage of Total
Total OECD *	294,527	-
Female	146,674	50%
Male	147,851	50%
High performers	73,630	25%
Low performers	73,630	25%

* Organisation for Economic Co-operation and Development.

Table 2 represents the sample configuration for each country where data was analysed separately (sample size and percentage of girls), along with the country abbreviation used throughout the study. Of the 37 OECD countries that participated in PISA 2018, we selected 26 with data available for the whole range of variables examined. The countries with missing data for any of the variables used in the network analysis were excluded.

Table 2. Country-level sample configuration.

Abbreviation	Country	Total	% Girls	Abbreviation	Country	Total	% Girls
AUT	Austria	6802	49%	IRL	Ireland	5577	50%
CHE	Switzerland	5822	48%	ISL	Iceland	3296	50%
CHL	Chile	7621	50%	JPN	Japan	6109	51%
COL	Colombia	7522	51%	LTU	Lithuania	6885	49%
CZE	Czech Republic	7019	50%	LUX	Luxembourg	5230	50%
DEU	Germany	5451	46%	LVA	Latvia	5303	51%
ESP	Spain	35,943	50%	MEX	Mexico	7299	52%
EST	Estonia	5316	50%	NLD	Netherlands	4765	49%
FIN	Finland	5649	49%	POL	Poland	5625	51%
FRA	France	6308	49%	SVK	Slovak Republic	5965	50%
GBR	United Kingdom	13,818	51%	SVN	Slovenia	6401	47%
GRC	Greece	6403	50%	TUR	Turkey	6890	49%
HUN	Hungary	5132	51%	USA	United States	4838	49%

2.2. Instruments

The PISA 2018 assessment comprised over 15 h of testing in three main domains—reading, mathematics, science—and in a novel domain specific to each PISA (in 2018, global competence). The participating students took different combinations of test items during a 2 h assessment session. In each PISA cycle, one domain is tested in detail, taking up nearly half of the total testing time. The main area of assessment in 2018 was reading, as it was in 2000 and 2009. In most countries, the test was computer-based. In reading, a multi-stage adaptive methodology was applied in computer-based tests. The students were assigned a block of test items based on their performance in previous blocks.

Students and authorities at participating schools (e.g., school principals) also completed context questionnaires. The students' questionnaire collected information about their background context, attitudes towards learning, habits in and outside of school, opinions about school resources and teaching practices, perceptions of the learning environment, and their motivation and engagement. In PISA 2018, five additional questionnaires were offered as options: a computer familiarity questionnaire, well-being questionnaire, educational career questionnaire, parent questionnaire, and teacher questionnaire. The specific well-being questionnaire covered a wide range of variables aimed at collecting information about students' life satisfaction, social connections and activities, subjective well-being, and family support; however, only three OECD countries chose this option. In the present study, we used the data from the student questionnaire which was common to all the countries to assess well-being. This questionnaire also included a notable set of variables aimed at measuring this aspect of students' lives. The whole range of these variables was included in the network analysis. They are listed in Table 3 along with a brief description.

Table 3. Description of well-being indicators.

Dimensions	Variables	Description
Cognitive dimension	Growth mindset	This variable reflects the student's belief that their intelligence is something that can be developed over time.
Psychological dimension	Learning goals	This index is intended to reflect the level of students' ambitions in learning; whether their objective is to learn as much as possible, master the classroom material, and understand the material thoroughly.
	Motivation to master tasks	This index measures whether the student finds satisfaction in working as hard as they can and in improving their performance, if they are persistent at finishing proposed tasks or mastering material they are potentially not good at.

Table 3. *Cont.*

Dimensions	Variables	Description
	Resilience (or self-efficacy)	This index reflects the level of student perception about their self-efficacy; whether they are proud of accomplishing things and if they can easily resolve difficult situations, whether they are able to handle several things at the same time and if they believe in themselves.
	Fear of failure	Fear of failure includes the student's insecurity and lack of confidence in their abilities. Students with a higher fear of failure worry about what others think about them, are afraid that they are not talented enough, and start doubting their plans for the future when they fail.
	Meaning in life	Meaning and purpose in life, or eudaemonia, refer to students' beliefs that their lives have satisfactory meaning and that they are aware of what brings meaning to their lives.
	Positive feelings	This index reflects the frequency with which the students normally feel happy, joyful, and cheerful.
	Life satisfaction	This variable corresponds to the students' overall evaluation of their lives. Specifically, the students indicate how satisfied they are with their life as a whole these days on a 0–10 scale.
	Attitudes towards competition	This index reflects student´ competitiveness, how important competition is for the student, and if it improves their performance. Specifically, the students report whether they enjoy working in situations involving competition with others, if it is important for them to perform better than other people on a task, or if they try harder when they are in competition with other people.
Social dimension	Exposure to bullying	This index reflects how frequently students experience bullying, considering three of its expressions: being threatened by other students, being left out of things on purpose, and being ridiculed by other students.
	Student competition	This index reflects the environment of competitiveness in schools as perceived by students. Each participant reports if the students in their schools seem to value competition, if they compete with each other, and if they share the feeling that competing is important.
	Student co-operation	This index reflects the environment of co-operation in schools as perceived by students. Each participant reports if the students in their schools seem to value co-operation, if they co-operate with each other, and if they share the feeling that co-operating is important.
	Parents' emotional support	This index reflects whether students feel that their families support them emotionally. Specifically, whether their families encourage them to be confident, support their educational efforts and achievements, and support them when they are facing difficulties at school.
	Sense of belonging	The index of sense of belonging reflects students' feelings about the level of integration and social connections: if they make friends easily at school and if they feel that other students seem to like them or if, in contrast, they feel awkward, out of place, or lonely in their school.

The selection of the variables related to school factors was also determined by their availability in the PISA dataset. Therefore, we considered the whole set of variables that measure teaching practices or teaching methodology. In PISA 2018, the student questionnaire included only one variable that

provided information about the school environment from the students' perspective—disciplinary climate. The list of school level variables is presented in Table 4.

Table 4. Description of school factors.

Dimensions	Variables	Description
Teaching style	Adaptive instruction	The students perceive adaptive instruction when the teachers adapt the lesson to their class's needs and knowledge, provide individual help, or change the structure of the lesson on a topic that most students find difficult to understand.
	Teacher enthusiasm	The teacher enthusiasm variable corresponds to students' perceptions of the level of teachers' involvement in, motivation for, and enjoyment of their work. They report if it is clear to them that the teacher liked teaching and dealing with the topic of the lesson and if the teacher´s enthusiasm was inspiring.
	Teacher-directed instruction	This variable refers to the teaching practice when the teacher is the one who transmits the knowledge and controls learning processes in the classroom. In PISA 2018, this index includes students' responses about the frequency with which teachers set clear goals for their learning, ask questions to check whether they have understood what was taught, or are told what they have to learn.
	Teacher feedback	Perceived teacher feedback refers to students' opinions about the level of feedback they receive on their strengths in the subject, the areas that should be improved, and how they can be improved.
	Teachers' stimulation of reading engagement	The index of teachers' stimulation of reading engagement indicates that the teachers frequently encourage students to express their opinion about a text, help them relate the stories they read to their lives, or pose questions that motivates students to participate actively.
	Teacher support	This index summarizes the student's perceptions about the support they receive from their teachers. Specifically, it reflects whether the teacher shows an interest in every student's learning, gives extra help when needed, or continues teaching until all the students understand the subject.
School climate	Disciplinary climate	The disciplinary climate index reflects order in the classrooms and the adequacy of the learning environment. Higher values of the index indicate that in most lessons students listen to what the teacher says, there is silence and order, there is no need to wait a long time for students to quiet down, and students in general can work well.

Table 5 reflects the internal consistency of the well-being scales at the OECD level, measured with Cronbach's alpha, as well as the number of items composing each of the scales. Following the commonly used cut-off criteria (0.9 excellent, 0.8 good, 0.7 acceptable), all scales have shown acceptable values and, therefore, the internal consistency of the scales is confirmed. In the PISA Technical Report corresponding to each PISA edition, the internal consistency coefficients at the country level are also presented [31]. The variables that did not show an acceptable internal reliability were not considered for the scale construction.

Table 5. Internal consistency of the well-being variables and school factors.

Dimensions	Variables	Number of Items	Internal Consistency
Cognitive dimension	Growth mindset	1	-
Psychological dimension	Learning goals	3	0.861
	Motivation to master tasks	4	0.773
	Self-efficacy	5	0.795
	Fear of failure	3	0.815
	Meaning in life	3	0.870
	Positive feelings	3	0.828
	Life satisfaction	1	-
	Attitudes towards competition	3	0.793
Social dimension	Exposure to bullying	6	0.861
	Student competition	4	0.853
	Student co-operation	4	0.915
	Parents' emotional support	3	0.897
	Sense of belonging	6	0.769
Teaching style	Adaptive instruction	3	0.768
	Teacher enthusiasm	4	0.885
	Teacher-directed instruction	4	0.786
	Teacher feedback	3	0.874
	Teachers' stimulation of reading engagement	4	0.847
	Teacher support	4	0.883
School climate	Disciplinary climate	5	0.871

PISA uses advanced statistical and psychometric approaches for the estimation of scores of latent traits from multiple observed responses both for performance measures and context latent constructs. In order to ensure the comparability between groups in terms of the invariance of item parameters across groups of participating countries and language groups therein, the same set of estimated item parameters is held in each group surveyed [32]. In 2015, PISA adopted an innovative approach in order to evaluate if equal item parameters can be assumed across countries. With this purpose, international item and person parameters were estimated based on all the participants across all groups, and the difference between the observed item characteristic curve and the model-based item characteristic curve was calculated with the use of the root mean square deviance (RMSD) item-fit statistic. The cut-off criteria of 0.3 was established, with larger values indicating that the international item parameters were not appropriate for this group [31]. Thus, this approach quantified how well the international parameters described the observed data of each country. The item parameter estimation as well as the estimation of latent traits were conducted using Item Response Theory scaling methodology, applying the generalised partial credit model (GPCM) [33].

The original version of the student questionnaire can be found in Annex A of the PISA 2018 Assessment and Analytical Framework [34].

2.3. Data Analysis

The network approach allows the representation of interactions between the elements of the phenomena and lets us understand the structures and consequences of these interactions. It allows us to interpret the relationship between different elements simultaneously, the underlying reciprocal influence, and interconnections [24,35]. Network analysis pursues two types of hypotheses: those that seek to understand the cause of the formation of determinant interactions in a given population, and those that aim to discover how the interaction of the elements influences the outcomes [36]. In the present study, the network analysis was based on both premises; first, we studied the

relationship between the well-being variables and then we investigated the influence of school factors on these relationships.

The network approach is based on two principal concepts: nodes, which represent the elements of a model, and edges, the connections between nodes that represent their pairwise interactions. Once the network is computed, different tools or indices can be used to summarize the patterns of relationships in the network. The centrality indices of the network allow us to explore the relative influence of a node in the context of other nodes [37]. They mean that we can analyse the relative importance of the node within the network based on the connection pattern [38]. Several measures of centrality can be estimated: betweeness centrality, closeness centrality, and strength centrality. Strength centrality refers to the magnitude of the association of the node with the other nodes and which node has the strongest connections [39]. Closeness centrality indicates which nodes can better predict others. It is defined as the inverse of the sum of the distance from one node to all the other nodes in the network. A node with a high closeness centrality will be affected quickly by changes in any part of the network [37]. Betweeness centrality is defined as the number of times a node is between two other nodes. A node with a high value of betweeness indicates that it is well connected with the rest of the network nodes.

We performed the network analysis using the R-package qgraph [40], both for the overall estimation of well-being variable interactions and for the exploration of the relationships between the school factors and well-being dimensions. We also carried out a network comparison for different subgroups: girls vs. boys and high performers vs. low performers. We conducted pair-wise comparisons of the invariance of the overall network structure and the global connectivity with the Network Comparison Test (NCT) package in R [41]. The comparison of the overall network structure shows if there is a pattern in the unique interactions between the variables in the network of each individual group, and a comparison of the overall connectivity lets us see if the strength of these interactions between variables is similar [42,43].

2.4. Procedure

We performed the network analysis in two stages. First, we examined the co-occurrence of well-being variables that form part of each dimension for the whole set of OECD countries. Each variable represented an independent node grouped in three well-being dimensions. The centrality indexes were estimated for each node, measuring the importance and influence of each node over others.

In the second stage, we added the school-level variables to the well-being network: the teaching style and the disciplinary climate at school. This network was also built for the overall OECD sample and for each of 26 countries with available information. Finally, we conducted the network comparison tests for pairs of groups based on gender and performance level (distinguishing between high and low performers).

3. Results

Student Well-Being Network

The first stage of the network analysis was an analysis of the well-being dimensions as defined in PISA. Figure 2 shows the network representation of the relationship between the well-being dimensions at the OECD level. The visual inspection of a network is always a very useful first step, providing important information with minimal effort [44]. Green lines indicate positive connections and red lines negative connections. Thicker lines represent stronger connections and thinner lines represent weaker connections. A visual inspection of the network shows that the theoretical configuration of well-being dimensions is confirmed empirically; the variables making up each dimension are strongly related to each other, either positively or negatively. They are also demonstrated to be related to variables in the other dimensions, which reiterates the idea of the complexity of the well-being concept.

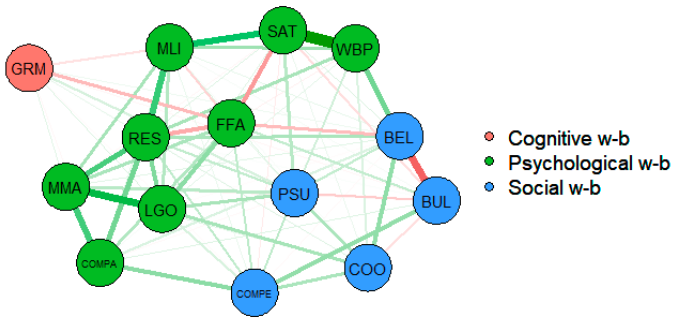

Figure 2. Network representation of the relationship between well-being dimensions, Organisation for Economic Co-operation and Development (OECD) average. GRM = growth mindset; LGO = learning goals; MMA = motivation to master tasks; RES = self-efficacy; FFA = fear of failure; MLI = meaning in life; WBP = positive feelings; SAT = life satisfaction; COM = attitudes towards competition; BUL = exposure to bullying; COMPER = student competition; COOPP = student co-operation; PSU = parents' emotional support; BEL = sense of belonging.

The figure also illustrates the strength of these interactions. In the psychological dimension of well-being, the strongest relationship is between life satisfaction and positive feelings. Life satisfaction is also strongly connected to the perception of meaning in life, which at the same time is positively related to resilience in terms of self-efficacy. Students who believe in their own capacity, especially when facing difficult circumstances, and feel that their lives have meaning and purpose are also generally more satisfied with their lives.

The interaction between learning goals and motivation to master tasks is also strong and positive, and both variables demonstrate a positive relationship with student resilience. A more positive attitude towards competition is related to higher task mastery motivation and is also linked to higher resilience. The fear of failure is negatively associated with life satisfaction and resilience in terms of self-efficacy and is also negatively connected to the sense of belonging, a variable in the social well-being dimension.

In the social well-being dimension, the sense of belonging is a strong predictor of bullying. Students who feel integrated and who do not feel awkward or out of place in their school report less exposure to bullying. On the contrary, higher levels of bullying are related to the perception of more competitive environment in schools. The students who report suffering from bullying indicate that the students in their school seem to value competition, share the feeling that competing with each other is important, and feel as though they are being compared to others.

Lastly, the only cognitive dimension variable, growth mindset, is negatively associated with the fear of failure. Students with a growth mindset reported less fear of failing than students with a fixed mindset.

Figure 3 shows the centrality indexes for the well-being network. The perception of higher self-efficacy, or resilience, is the node with the highest influence over the others. This variable has the highest strength centrality; in other words, it has strong direct connections with many nodes. It also demonstrates the highest value of closeness centrality, as the direct and indirect paths that connect it to other variables are relatively short, which means that it is more vulnerable to changes in the other variables. Fear of failure is another node with high levels of centrality and demonstrates the greatest betweenness centrality, as it lies on the shortest paths between other nodes. In line with the conclusions resulting from Figure 2, life satisfaction and a sense of belonging also have important roles in moderating the well-being network.

In the second stage of data analysis, we added school factors related to teaching style and school climate to the well-being network model in order to assess the potential impact of these factors on well-being (Figure 4). The results show that the connections between the well-being variables and teaching style are mainly weak and insignificant, although important insights can be gleaned.

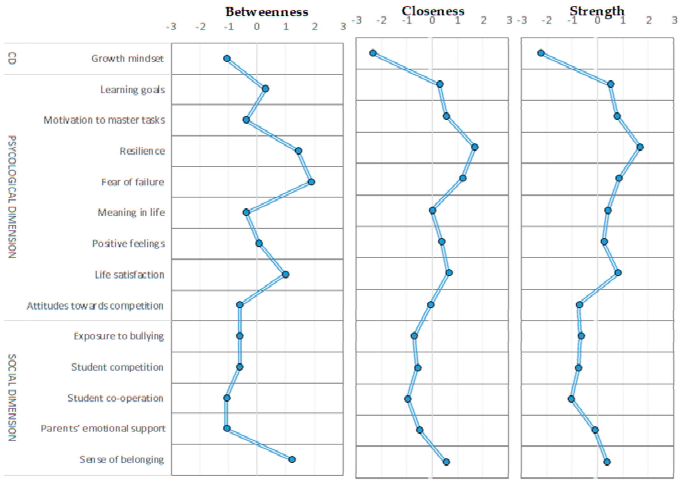

Figure 3. Centrality indexes of well-being dimensions, OECD average. CD = cognitive dimension.

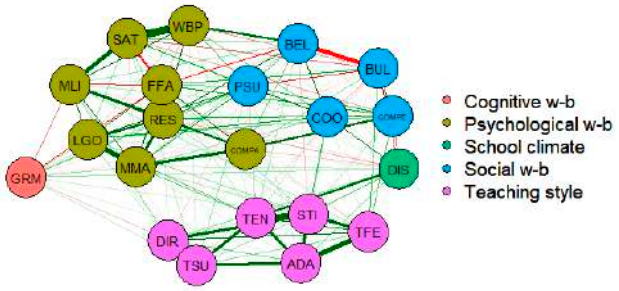

Figure 4. Network representation of the relationship between well-being dimensions, teaching style, and school climate, OECD average. GRM = growth mindset; LGO = learning goals; MMA = motivation to master tasks; RES = self-efficacy; FFA = fear of failure; MLI = meaning in life; WBP = positive feelings; SAT = life satisfaction; COM = attitudes towards competition; BUL = exposure to bullying; COMPER = student competition; COOPPE = student co-operation; PSU = parents' emotional support; BEL = sense of belonging; ADA = adaptive instruction; TEN = teacher enthusiasm; DIR = teacher-directed instruction; TFE = teacher feedback; STI = teachers' stimulation of reading engagement; TSU = teacher support; DIS = disciplinary climate.

The teaching style variables, considered as an individual network, form a well-defined set of elements with positive significant interactions between nodes. Higher teacher enthusiasm is strongly connected to more frequent teacher activities that stimulate reading engagement. The teaching style based on individual help and adapting lessons to class needs and knowledge is usually accompanied by students perceiving more feedback about their performance and areas for improvement. Teacher-directed instruction is highly correlated to the perception of teacher support. Through teacher enthusiasm and reading engagement stimulation the teaching style impacts the school environment as measured by the perception of the disciplinary climate. The higher the educator engagement and involvement, the lower the frequency of occasions when there is noise and disorder in language lessons, when students cannot work well, or when they do not pay attention to what the teacher says. At the same time, the students who report positive a disciplinary climate also perceive a less competitive environment along with higher co-operation levels between peers. In the previous stage of data analysis, high levels of competitiveness were shown to be associated with more frequent bullying, while in contrast, fellowship and support between peers reduced bullying exposure rates, leading to the conclusion that teaching style can actually moderate student well-being more directly through a positive disciplinary climate.

Figure 5 shows the centrality indexes for the variables making up the proposed network models. The values are presented for the OECD average, as well as for the population subgroups—female and male students—and high and low performers.

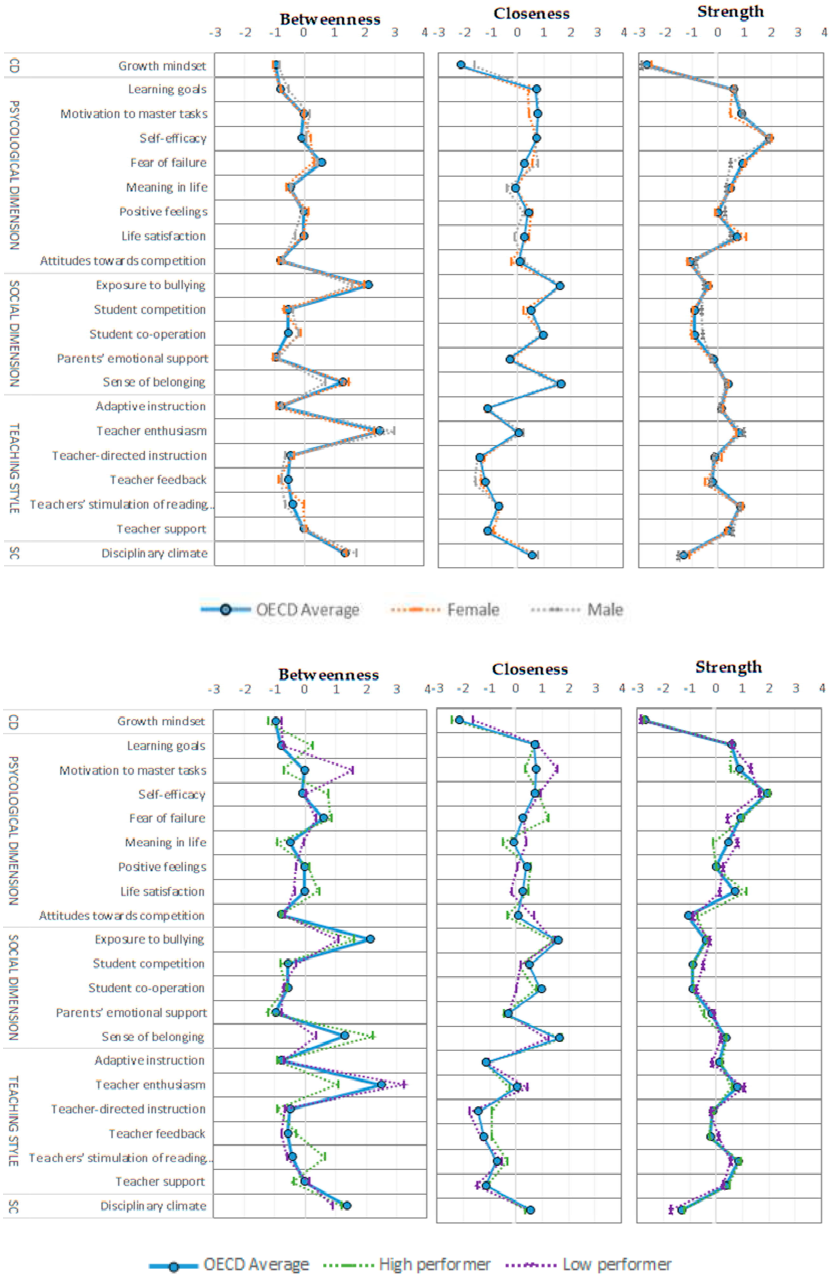

Figure 5. Centrality indexes of well-being dimensions, teaching style and school climate, OECD average, female and male students, and high and low performers. CD = cognitive dimension; SC = school climate.

In the enriched network model, along with the variables with high levels of centrality observed in the first stage of data analysis (exposure to bullying, sense of belonging, and resilience), teacher enthusiasm stands out as the teaching style factor with most influence on the rest of the nodes. In other words, teacher enthusiasm improves students' perceptions of adaptive teaching, individual approach, and cognitive stimulation.

There is practically no variation in the strength of interactions between network elements for the female and male subpopulations, whereas the centrality indexes are less homogeneous for high

and low performers. Thus, a sense of belonging is relatively more important for high-performers' well-being, while motivation to master tasks is more significant for the well-being of low performers.

In order to provide an objective measurement of potential network invariance for gender and performance samples, we carried out a network comparison test. The results (Table 6) showed that the pattern of unique interactions between indicators in the network was not completely identical across subpopulations, as the overall network structure invariance was not supported.

Table 6. Results of pair-wise Network Comparison Test (NCT) for network structure and global connectivity invariance.

	Network Structure	Global Connectivity Invariance
Network for female subpopulation–network for male subpopulation	0.12 **	0.27 **
Network for top performers–network for low performers	0.20 **	0.21 **

Note. Network structure invariance: M-statistic, network global connectivity invariance: S-statistic; ** = significantly different network structure, global connectivity if $p < 0.05$.

Lastly, in order to check how the interactions between the set of elements in the proposed networks varied between countries, we configured networks for each of 26 countries with available information. Figure 6 shows comparisons of the centrality indexes by country. Each dot represents the centrality indexes for each country. We see that the distribution of strength centrality indexes for each variable are relatively homogeneous between countries, whereas the distribution of betweeness centrality is more variable. This means that while the strength of direct connections between nodes is relatively more similar between countries, the moderating roles of the variables in terms of vulnerability and intermediation do not follow the same patterns in all of them.

Figure 6. Centrality indexes of well-being dimensions, teaching style, and school climate at country level. CD = cognitive dimension; SC = school climate.

4. Discussion

The aim of the study was twofold. On the one hand, we sought to explore the overall interactions between the well-being variables assessed in PISA 2018, and on the other, we examined the connections between school climate and teaching style and student welfare. The network approach allowed us to visualize the well-being model as an integrated system and represent the complex interactions between welfare concepts, highlighting the most influential elements.

Student resilience in terms of self-efficacy was a central area in the psychological dimension of the well-being network. In PISA, the resilience or ability of a living being to adapt to a disruptive agent or an adverse situation or state [45] is measured through students' perceptions about their self-efficacy in general competences. Students who believe in their abilities in spite of adversities are also highly motivated, persistent, and enjoy working hard. These observations are in line with previous studies, highlighting that resilient students are self-confident, autonomous, and demonstrate high levels of self-control [46,47]. They are ambitious and satisfied with their lives, reporting that their life has satisfactory meaning. Among the OECD countries, greater self-efficacy was also associated with higher performance in reading, especially between countries performing below the OECD average [4]. Moreover, resilient students are less likely to be afraid of failure.

Fear of failure is another well-being element with a high level of centrality. It is related to less life satisfaction and a lower growth mindset. The students who do not believe that their effort in learning is a source of their success are more prone to doubt plans for their future or to feel incompetent and untalented when they fail. Previous research has already shown that fear of failure is associated with high levels of worry and somatic anxiety and low levels of optimism, and can have significant impacts, such as the experience of embarrassment, the loss of self-esteem, or being uncertain about the future [20]. It is especially worrying that in the OECD countries, many 15-year-olds expressed a fear of failure. Around 56% of students agreed or strongly agreed that when they fail they worry about what others think about them, and 55% were afraid of not being talented enough when they fail [4].

These data show the importance of promoting student self-esteem, resilience, and self-efficacy, both in general and specific competences, along with the use of strategies that reduce anxiety and the fear of failure. Several student and school factors have been shown to have an impact on resilience; these include ambitious educational aspirations, valuing learning and instrumental motivation, student beliefs about their teachers' confidence in their abilities [48], and higher reading confidence [49]. Yeager and Dweck [50] stated that, to be resilient, students need to be taught strategies to overcome challenges rather than self-esteem boosting or trait labelling. Some teacher strategies that have been shown to have a positive impact on motivational-affective outcomes include subject domain-specific activities for processing information (e.g., mathematics problem solving, science inquiry), social experiences (e.g., cooperative learning, student discussion), time for learning, and regulation and monitoring (e.g., providing feedback and support, teaching students self-regulation strategies, and monitoring) [51]. At the country level, policies based on grouping students according to their socioeconomic background are negatively associated with the percentage of resilient students, while teacher support plays an essential role in encouraging self-efficacy [52]. At the same time, the fear of failure can be reduced by enhancing a growth mindset in students. Setting challenging goals and providing opportunities for equal competences or content acquisition, along with designing learning environments accordingly, can be a successful teaching strategy [4].

The central element of the social well-being network is the sense of belonging. It is strongly connected to psychological well-being variables, positive thinking, and cooperation, and negatively related to the fear of failure. However, most importantly the greater the perception of a sense of belonging, the lower the frequency of exposure to bullying. When students feel accepted, included, and respected by the community, they are less likely to suffer from bullying. A sense of belonging is also associated with higher academic performance [4,53]. Previous research has shown that supportive student–teacher relationships had a positive impact on the sense of belonging [54], although in the

current study we did not see any significant interactions. Nevertheless, the negative influence of a competitive school environment on student engagement was confirmed.

The school-level factors measured in terms of teaching style did not demonstrate significant direct impacts on student well-being. These results are in line with previous studies demonstrating low school effects on student welfare [17,55]. Nevertheless, the network modelling showed the importance of a positive disciplinary climate that improves student–peer cooperation while the perception of competitiveness decreases. These two factors in turn reduce the frequency of bullying at school.

Large-scale assessments show that the promotion of student welfare in the educational context is still pending for most OECD countries. It has been widely agreed that schools' roles go well beyond the acquisition of cognitive knowledge and competences. Student perceptions of the school environment are key for understanding the source of students' fears and anxieties and the level of students' social engagement. Appropriate teaching styles and strategies can contribute to the improvement of this environment. Defining and designing them should be undertaken by the educational community along with academic curriculum development.

Lastly, the comparison of network structures across subpopulations showed that the unique interactions between well-being and school variables differ for female and male students, high and low performers, and at the country level. These results suggest that the design of intervention policies should be based on the particular network models of each subpopulation that will make it possible to precisely locate the main elements that could be strengthened.

The present paper provides evidence on the composition of the well-being concept related to student and school factors. That contribution is relevant, as it allows understanding the relative weight of educational variables on students' lives. Educational policies and practices will benefit of the results of the present study, as they will have guidelines for working on those dimensions which can help to improve the experiences of students in the school. The model proposed helps to learn about priorities when focusing on students´ well-being beyond their performance.

The main limitation of the study lies in the fact that the configuration of the network model is conditioned by the availability of the reduced set of well-being measures in the PISA 2018 questionnaires. For instance, the cognitive dimension is presented through only one variable, whereas in previous PISA cycles several constructs, such as enjoyment of learning and instrumental motivation, made up a solid cognitive well-being dimension. Moreover, some other important well-being components, such as the physical dimension, were not assessed. Future research will aim to configure an integral and comprehensive well-being model in the educational context and focus on comparing the interactions between well-being indicators between populations of different ages and socioeconomic characteristics.

5. Conclusions

This research aims to provide evidence on the complex interactions between well-being components and the school context, applying the novel approach of social network analysis. Well-being networks for OECD countries and an extended well-being–school environment network were constructed. Student resilience and fear of failure were shown to be the most influential elements in the psychological well-being dimension, whereas the sense of belonging played a central role in social well-being. Although teaching style did not seem to directly impact well-being, it affected the disciplinary climate, which in turn moderated competitiveness and cooperation and therefore influenced rates of bullying.

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1.3. Estudio 3

Govorova, E., Muñoz-Fernández N., Sánchez-Martín M. & Benítez, I. (2023). Multilevel SEM analysis of factors related to achievement results: evidence based on PISA 2015.

El presente estudio tiene por objetivo estimar la magnitud de los efectos escolares en el nivel de adquisición de competencias básicas de los estudiantes en los países de la OCDE, identificar los factores estudiantiles y escolares relacionados con el rendimiento de los estudiantes en ciencias en todos los países de la OCDE. La principal contribución de este artículo a la tesis doctoral radica en la construcción de un modelo sólido de factores asociados a los resultados escolares en un contexto internacional. Esta construcción se lleva a cabo mediante la aplicación de una metodología de análisis poco común, el SEM multinivel, que contribuye, por un lado, a la estimación de la magnitud de los efectos escolares y, por otro, a la clasificación de dichos factores según su naturaleza sistémica (de entrada/contexto y de proceso).

The current global political, economic and social situation, characterized by an increasing lack of resources and high competition levels in the public and private sectors, has turned the debate about the efficiency and effectiveness of education into a hot topic in many countries and economies (Duru-Bellat & Suchaut, 2005; Raitano & Vona, 2016; Sulis et al., 2019). While the purpose of governmental educational authorities is to promote equity and quality in education with a moderate economic cost, educational institutions increasingly demand tools for effective teaching, effective management, and the effective optimization of school resources in order to improve their capacity to promote student performance. As defined by Lockheed and Hanushek (1994), school effectiveness corresponds to the direction and magnitude of gain in student achievement related to a specific set of resources or factors measured in nonmonetary terms, such as classroom organization and the teacher's years of teaching experience (Kalkan et al., 2020). The size of the school-level effects on student performance is then considered to be an estimate of school effectiveness (Chen et al., 2017; Sanfo, 2020).

Due to societal demand, the availability of data from large-scale assessments and the increasing availability of methodological instruments and sophisticated data analysis software (Chapman et al., 2016), over the past two decades, studies on school effectiveness and the factors related to student achievement have gained in importance (Creemers & Kyriakides, 2015; Muijs et al., 2014; Wrigley, 2013). The Coleman report ushered in a change in research by focusing on the impact of factors in both the school and family contexts over the results of standardized tests (Coleman et al., 1966). According to that report and additional studies, there is empirical evidence supporting the claim that the individual learning differences between students, originating from their sociodemographic and personal characteristics and economic background, determine the largest share of the performance pie (Jiang et al., 2021; Vermetten et al., 2001; Zusho, 2017). Nevertheless, numerous studies, originating in the effective school movement, confirm that the country-level educational model and school-level factors can counteract the influence of individual inequalities. For instance, Bryk et al., (2010) identified a comprehensive set of school practices related to school leadership, professional capacity, parental involvement, student-centered learning climates, and instructional guidance that are able to promote improvement. Vanlaar et al., (2016) identified effective teaching, which encompasses the use of practices such as time management, modeling, high-quality interactions between the teacher and his or her students, and effective approaches to dealing with misbehavior as an important aspect in reducing inequity in student performance, with a particularly high impact on underachieving student groups.

Large-scale assessments (LSAs) have also gradually incorporated an evaluation of the factors associated with student performance to identify the different elements and good practices

that characterize schools whose students achieve high performance (OECD, 2016b). LSAs such as the Program for International Student Assessment (PISA) developed by the Organization for Economic Cooperation and Development (OECD) not only have become an effective tool for policy accountability but have also played an important role in national policymaking (Rautalin, 2018).

PISA has systematically applied multivariate statistical analysis based on linear hierarchical models (or multilevel models) to estimate variation in student performance. This methodology, introduced into the educational field by Aitkin (1986), is the most important in evaluating school effectiveness and the school-level factors related to higher achievement. Its advantage lies in its better modeling of the nested nature of student assignments (Bryk & Raudenbush, 1992; Creemers & Scheerens, 1994; Goldstein, 1995). PISA applies a multilevel methodology to a three-level model in which students are clustered in schools and schools are clustered in countries or economies. Among OECD countries, 10% of the variation in science performance observed among students is attributable to differences in performance across countries and economies, 28% is attributable to differences in performance across schools, and 62% is attributable to differences in performance among students within schools (OECD, 2016b). These data reinforce the idea that the identification of school-level factors associated with student performance is a key component of educational research on school effectiveness (Creemers & Kyriakides, 2015; Muijs et al., 2014; Rutter & Maughan, 2002), as the detection of these factors would make it possible to increase student achievement by 28% on average.

Student- and School-Level Factors Related to Academic Achievement

There are different classifications of the school-level factors that affect student performance. Some authors classify school characteristics into two groups of variables: context and climate (O'Connell & McCoach, 2008). Context variables refer to those factors that cannot be easily modified by education agents; they are unrelated to any school strategy or program. They often depend on educational legislation, the demographic characteristics of the local community, or the school's historic background. These factors, in turn, can be classified into the physical school environment (e.g., size, location, resources), student characteristics (e.g., socioeconomic background, immigration status), and teacher characteristics (e.g., education and professional training, work experience, employment status). On the other hand, climate variables are those characteristics of the learning environment controlled by the educational community (e.g., school management and leadership, instructional organization, autonomy level in curriculum and resources designation, disciplinary climate). Reynolds and Teddlie (2000) remarked on the importance of distinguishing between context and climate factors in the

evaluation of school effectiveness; this distinction makes it possible to identify factors that can be modified by schools to increase their effectiveness, as it is possible to modify only climate factors.

The taxonomy of Murillo-Torrecilla and Bernal (2007) is based on a similar approach focused on the nature of performance-related factors, but that taxonomy names them differently. Input variables include students' gender, socioeconomic background, immigration status or school characteristics, whereas process variables cover elements such as instruction methodology, methods for stimulating students' expectations and motivation, and the school climate.

Other authors have divided these factors according to the level to which they belong: the student level or the school level (Gamazo et al., 2018). At the student level, the impact of students' personal and contextual variables has been widely studied. For instance, the impact of economic, social and cultural status (ESCS) on cognitive variables has been traditionally assessed within the PISA study, as well as ESCS's possible role in mediating the effects of other factors. ESCS has been continuously demonstrated to be a strong predictor of academic performance in all OECD countries (Cordero Ferrera et al., 2014; Gamazo et al., 2018; OECD, 2016b; Suárez-Álvarez et al., 2014). In addition, Sirin (2005) found in a meta-analysis that there is a medium-high positive relationship between a student's socioeconomic level and his or her academic performance.

Variables related to student background, such as gender or immigration status, have also been widely explored, highlighting the relevance of gender as a predictor of achievement (Karakolidis et al., 2016; Stoet & Geary, 2013; Özdemir, 2016). These authors have found that girls are frequently better at reading, whereas boys perform better in math. In addition, immigrant students exhibited lower performance than nonimmigrant students. On the other hand, the benefits of grade repetition are not supported (Jacob & Lefgren, 2004; Manacorda, 2008). Some authors conclude that grade repetition can lead to self-esteem or adaptation problems (Frey, 2005). Nevertheless, this strategy is widely used in some countries, such as Spain and Portugal, when students demonstrate that they have not reached a minimum standardized level of knowledge or, at the earliest ages, when the student demonstrates learning problems due to immaturity or poor social skills (Jimerson & Ferguson, 2007).

At the school level, the average socioeconomic and cultural level of the school has also been studied as a contextual factor and has turned out to be the most relevant factor at the school level (Perry & McConney, 2010a; Perry & McConney, 2010b). The schools that group students with high ESCS levels together tend to perform significantly better. Moreover, there is evidence that supports the influence of other factors on student achievement, such as the teacher-student ratio (Nath, 2012)—that is, the number of students to each teacher in a school—or the school type, with impacts on achievement differing between public and private schools (OECD, 2016b),

although these factors are highly correlated with the school ESCS average. School size has been studied in relation to school failure, measured in terms of improved student grades (Bloom et al., 2010). Reduced school size has been confirmed as improving the conditions and outcomes of students, even in situations of economic disadvantage. The meta-analysis by Hattie (2009) supports the finding that school size reductions are a determinant of improvements in student achievement. Small class sizes have also been demonstrated to positively impact academic achievement (Faubert, 2012). Although there is no conclusive evidence on this topic, Hanushek (2000) affirmed that the impact of an overall class size reduction is small and is likely to benefit only underperforming students.

Finally, teaching strategies are one of the process factors that have recently gained attention in the academic field (Gil Izquierdo et al., 2018; Hattie, 2009; Nath, 2012). The OECD classifications distinguish between direct and student-centered instructions. Direct instructions are focused on the role of teachers, who lead and manage the activities taking place in the classroom, whereas student-centered instructions are associated with teachers facilitating students' own inquiries, for instance, by providing time to find solutions to problems on their own before demonstrating the solution (OECD, 2009; Rainer et al., 2007). Gil et al. (2018) obtained empirical evidence supporting direct teaching strategies in Spanish data from PISA 2015. According to the authors, this type of strategy leads to a significant improvement in educational performance. In contrast, inquiry-based strategies that encompass active learning and cognitive activation and that are focused on increasing student engagement or stimulating critical thinking do not have a significant impact on achievement and sometimes even lead to worse results. Nevertheless, these active learning strategies seem to have a more prominent positive effect on student attitudes and motivation (Donné et al., 2016).

Teacher support has also become more relevant in recent years. Across OECD countries, teacher support is unrelated to student performance in science, but this relation becomes positive on average across OECD countries and in 27 individual countries and economies after accounting for the socioeconomic status of schools and students (OECD, 2017a). In addition, if teachers provide support to students, take care of students and help them when they need it, students exhibit more positive attitudes and higher academic motivation (Ricard and Pelletier, 2016).

As discussed before, there is much evidence on the impact of both context and climate factors on student performance. Nevertheless, most studies have analyzed a limited group of factors (e.g., teaching strategies) for a specific student sample (e.g., at a specific country level). The present study contributes to the discussion about the factors related to school effectiveness from a global perspective (by using an international sample) and jointly includes a wide variety of analytical variables. Specifically, the aim of the present paper is to identify the student- and

school-level factors related to student performance in science in all OECD countries in order to formulate common pedagogical strategies and identify comprehensive practical implications for the educational community to increase students' academic performance regardless of students' individual context backgrounds. To do so, we analyzed data from 34 countries collected within the 2015 PISA study by using multilevel structural equation modeling. Specifically, this research is based on data from PISA 2015, a LSA that evaluates reading, mathematics, and science literacy among 15-year-olds. It is conducted by the OECD every 3 years. PISA collects cognitive and contextual data on more than 500,000 students and provides aggregate national results for international comparison and to inform policy discussions. The results of this study were interpreted by dividing the variables affecting student achievement into two groups: context variables, which are those that are not under the direct control of the educational authorities, and climate variables, which are variables that can be modified by schools (O'Connell & McCoach, 2008). The results were used to formulate conclusions about potential key variables in order to provide useful information for developing educational policies.

Method

Sample

The responses of 243,321 students from 34 countries participating in the PISA study in 2015 were extracted from the public dataset published by the OECD (https://www.oecd.org/pisa/data/2015database/)1. Table 1 presents the list of countries included in the evaluation, the number of students and the sample characteristics in terms of gender.

Table 1. Sample Description

Code	Country	Observations	% of boys	Code	Country	Observations	% of boys
AUS	Australia	14530	50,40%	**ISL**	Iceland	3371	48,50%
AUT	Austria	7007	50,50%	**ISR**	Israel	6598	49,00%
BEL	Belgium	9651	50,80%	**ITA**	Italy	11583	49,70%
CAN	Canada	20058	49,90%	**JPN**	Japan	6647	50,40%
CHE	Switzerland	5860	52,10%	**KOR**	Korea	5581	52,20%
CHL	Chile	7053	50,30%	**LVA**	Latvia	4869	50,10%
CZE	Czech Republic	6894	51,30%	**MEX**	Mexico	7568	50,70%
DEU	Germany	6504	50,90%	**NLD**	Netherlands	5385	49,80%
DNK	Denmark	7161	50,20%	**NOR**	Norway	5456	50,60%
ESP	Spain	6736	49,90%	**NZL**	New Zealand	4520	50,30%
EST	Estonia	5587	51,00%	**POL**	Poland	4478	50,90%
FIN	Finland	5882	51,80%	**PRT**	Portugal	7325	50,50%

[1] The data for Luxemburg were excluded because of a lack of information on a variety of analyzed variables.

FRA	France	6108	49,60%	**SVK**	Slovak Republic	6350	51,50%
GBR	United Kingdom	14157	50,80%	**SVN**	Slovenia	6406	51,70%
GRC	Greece	5532	52,00%	**SWE**	Sweden	5458	50,50%
HUN	Hungary	5658	50,10%	**TUR**	Turkey	5895	50,00%
IRL	Ireland	5741	51,30%	**USA**	United States	5712	50,00%
Total OECD						243321	50,50%

Instruments

In the PISA assessment, the students respond to approximately two hours of test questions and provide answers to a 30-minute student questionnaire. The cognitive assessment evaluates three competence areas: science, reading and mathematics, along with one innovative domain specific to each PISA edition (in PISA 2012, it was financial literacy; in PISA 2015, it was collaborative problem solving; in PISA 2018, it was global competence; and in PISA 2022, it will be foreign languages). The PISA framework is based on the concept of literacy, which includes students' capacity to extrapolate from what they have learned and apply their knowledge and skills in real-life situations. In each PISA edition, one of the main cognitive areas is the major focus (in PISA 2012, it was mathematics; in PISA 2015, it was science; in PISA 2018, it was reading; and in PISA 2022, it will be mathematics again). This means that two-thirds of the testing time is dedicated to the major domain assessment, which includes a more extensive cognitive test instrument. On the other hand, the student questionnaire captures the individual and contextual variables related to students' backgrounds. Specifically, it includes various scales assessing general and specific noncognitive outcomes. In addition, the background questionnaires include specific scales related to the major competence area.

In addition to student-level assessment instruments, the principals or designated representatives of the participating schools provide information on their school's characteristics by completing a school questionnaire. In this study, we selected students' responses to the student questionnaire and to the cognitive assessment for science as well as the responses of school principals to the school questionnaire. PISA also includes teacher and parent questionnaires, which were excluded from this study because they were not administered in all the countries involved. Table 2 presents the list of variables included in the research and their classification according to their nature (O'Connell & McCoach, 2008) and level (Gamazo et al., 2018). Student-level variables were extracted from the students' context questionnaire, school-level variables were combined based on the school principals' responses to the school questionnaire, and student-level variables were computed as the mean value at the school level. For example, school-level ESCS was estimated as the average ESCS of the individual students enrolled in a school. The supplementary materials contain the full list of variables that represent each construct.

Table 2. Variables´ Classification

Label	Variable	Classification
PVSCIE	Science performance	Dependent variable
Student level variables		
GENDER	Gender	Context factor
GRADE	Grade	Context factor
IMMIG	Immigration status	Context factor
ESCS	Economic, social and cultural status	Context factor
JOYSCIE	Enjoyment of science	Climate factor
INSTSCIE	Instrumental motivation in science	Climate factor
SCIEEFF	Science self-efficiency	Climate factor
COOPERAT	Enjoyment of cooperation	Climate factor
CPSVALUE	Value of cooperation	Climate factor
BELONG	Sense of belonging	Climate factor
DISCLISC	Disciplinary climate in science lessons	Climate factor
School level variables		
ESCSSL	Economic, social and cultural status (school level average)	Context factor
LEADPDSL	Professional development	Climate factor
RESPRESS	Responsibility over resources assignation	Climate factor
IBTEACHS	Inquiry-based science teaching and learning practices (school level average)	Climate factor
SCHSIZES	School size	Climate factor
TEACHSUP	Teacher support (school level average)	Climate factor
TDTEACHS	Teacher-directed science instruction (school level average)	Climate factor
CLSIZESL	Class size	Climate factor
RESPCURS	Responsibility over curriculum	Climate factor
SCHAUTSL	School autonomy	Climate factor
TEACHPAR	Teacher participation	Climate factor
EDUSHORT	Shortage of educational resources	Climate factor
STAFFSHO	Shortage of staff	Climate factor
STRATIOS	Student ratio	Climate factor
LEAD	Educational leadership	Climate factor
LEADCOMS	Curricular development	Climate factor
LEADINST	Instructional leadership	Climate factor
LEADTCHS	Teachers participation	Climate factor
REPEATSL	% of repeaters (school level average)	Context factor
IMMIGSL	% of immigrants (school level average)	Context factor

Procedure and Data Analysis

The data analysis was conducted in three steps. First, the factorial invariance of the student-level constructs across countries was assessed. Constructs that did not meet the invariance assumption were excluded. Second, multilevel structural equation modeling was conducted for

the overall OECD sample. The levels were analyzed in the following order: a null model (i.e., without any explanatory variables), an adjusted model (including context factors) and a complete model (including context and climate factors). Finally, the complete model was applied to each individual country to assess whether the conclusions for the overall OECD sample were valid for each OECD member country. The next subsections describe this process in detail.

Factorial Invariance

To ensure the comparability of the data from different countries, we first tested for factorial invariance with a multiple-group confirmatory factor analysis (CFA) analysis in which all the countries were included. The maximum likelihood (ML) estimation method was employed, breaking the analysis down into three stages (Muthén & Muthén, 2011): 1) a configural model, in which the intercepts, factor loadings, and residual variances were estimated freely across countries and the factor means were fixed at zero in all countries; 2) a metric model, in which the factor loadings were constrained to be equal across countries, whereas the intercepts and residual variances were estimated freely and the factor means remained fixed at zero in all countries; 3) finally, a scalar model, in which intercepts and factor loadings were constrained to be equal across countries; the residual variance was estimated freely, and the factor means were fixed at zero in one country and were free in the others. Confirming configural invariance is necessary for the subsequent tests to be meaningful (Vandenberg & Lance, 2000). In this regard, the configural model was refined by assessing the modification indices (MIs) and expected parameter change (SEPC) until a good model fit was obtained. The invariance of each latent variable, listed in Table 2, was assessed separately.

The evidence for invariance by country was tested by evaluating the increment of the comparative fit index (ΔCFI) between the nested models. As usual, the null hypothesis of invariance would be accepted if the ΔCFI between the nested models was ≤ .01. In contrast, if the ΔCFI between the nested models was > .01, the null hypothesis would not be accepted (Cheung & Rensvold, 2002). In this last case, we tested for partial invariance by relaxing some factor loading or intercept (for metric or scalar invariance, respectively) across countries (Vandenberg & Lance, 2000). For this test, we checked for an MI higher than 10. Taking into account the fact that 34 countries were compared, MIs were ordered from highest to lowest. The factor loading or intercept (for metric or scalar invariance, respectively) with the highest MI was relaxed in all countries.

Multilevel SEM

Once the equivalence across groups was confirmed, we conducted a multilevel analysis. Specifically, we used a multilevel structural equation model, which combines both multilevel regression modeling and structural equation modeling (Skrondal & Rabe-Hesketh, 2004).

As the PISA data have a hierarchical structure in which the individuals at level 1 (students) are nested in clusters at level 2 (schools), multilevel regression modeling was used (Aitkin, 1986). Science performance, the major domain in the 2015 edition of PISA, was the dependent variable, while the set of context variables collected in the PISA background questionnaires represented the independent variables at both the individual and school levels. Most of the context student-level variables used in this study are latent constructs and reflect hypothetical elements that cannot be measured directly (e.g., disciplinary climate or sense of belonging). The structural equation approach permits us to measure these latent constructs though a set of directly observed and dependent items (Table 2 lists the constructs, and Table I in the supplementary materials relates the list of observed items to each latent construct).

Following the instructions from Hox (2013), the multilevel SEM was estimated in separate steps. First, the intraclass correlations of the variables were calculated. Intraclass correlations measure the variation in student performance accounted for by clustering (i.e., the ratio of the between-school variance to the sum of the between-school and within-school variance). The results were interpreted by considering values higher than .05 to be an indication of the existence of between-group variation and therefore a confirmation of a more complex model being recommended.

Next, the between structure was investigated in a two-level model with the within structure fully specified. The two-level SEM was applied to the overall OECD sample. This analysis was conducted in the following order:

- Null model: We ran a two-level SEM null model without any explanatory variables for the purpose of investigating the distribution of the variance between the two levels (student and school).
- Adjusted model: We enriched the model with student-level and school-level context variables—the variables that are not malleable, that are out of the control of schools and that cannot be easily modified. This model allowed us to estimate the fixed effects of the context variables on the dependent variable, student performance in science.
- Full model: This model incorporated the full set of climate variables at both the student and school levels. This model allowed us to estimate the fixed effects of

the climate variables and to assess whether the fixed effects of the input variables differed from those observed in the adjusted model.

Finally, the three models were re-estimated for each of the 34 OECD countries. The percentage of explained variance for each country in each model permitted us to assess the magnitude of the school effects in each country. The direction and significance of the fixed effects of the factors included in the complete model for each country were assessed.

The model coefficients and statistics were estimated using a full maximum likelihood procedure. In addition, the fit of the model was assessed with the usual indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR). The recommended cutoff points are .06 for the RMSEA, .95 for the CFI and TLI and .08 for the SRMR (Hu & Bentler, 1999; Weston & Gore, 2006). All analyses were conducted by using Mplus 7.0 (Muthén & Muthén, 2011)).

Results

Factorial Invariance

The factorial invariance results for the individual-level latent variables are shown in Table 3.

Table 3. Invariance Results

Latent constructs	Level	X^2	DF	RMSEA	CFI	Decision
BELONG (6 items)	Configural	51425.039	297	.157	.904	
	Configural (one error covariance was added between items 5 and 2)	29348.719	264	.126	.945	-
	Configural (two error covariance were added: items 2 and 5, and items 2 and 3)	20854.320	231	.113	.961	-
	Configural (three error covariance were added: items 2 and 5, 2 and 3, 5 and 3)	7341.633	198	.072	.987	-
	Full Metric	12181.131	358	.069	.978	Accepted
	Full Scalar	32256.227	518	.094	.940	Rejected
	Partial Scalar (intercept item 3 was released)	23348.280	486	.082	.957	Rejected
	Partial Scalar (intercepts item 3 and 5 were released)	18878.535	454	.076	.965	Rejected
	Partial Scalar (intercepts item 3, 5 and 1 were released)	**15386.299**	**422**	**.071**	**.972**	**Accepted**
COOPERAT (4	Configural	1351.470	66	.053	.991	
items)	Full Metric	2442.351	162	.045	.985	Accepted
	Full Scalar	14660.869	258	.090	.905	Rejected
	Partial Scalar (intercept item 3 was released)	9641.267	226	.077	.938	Rejected
	Partial Scalar (intercepts item 3 and 8 were released)	4674.057	194	.058	.970	Rejected
CPSVALUE (4	Configural	1065.999	66	.047	.996	
items)	Full Metric	6737.167	194	.070	.976	Rejected
	Partial Metric (Factor loading item 1 was released)	4635.893	162	.063	.984	Rejected
	Partial Metric (Factor loading item 1 and 14 were released)	2779.207	130	.054	.990	Accepted
	Full Scalar	16751.837	227	.102	.940	Rejected
	Partial Scalar (intercept item 14 was released)	9053.426	195	.081	.968	Rejected
	Partial Scalar (intercepts item 14 and 13 were released)	**4985.173**	**163**	**.065**	**.982**	**Accepted**
DISCLISC	Configural	3567.125	66	.092	.992	
(4 items)	Configural (one error covariance was added between items 4 and 2)	382.918	33	.041	.999	-
	Full metric	4052.874	161	.062	.991	Accepted
	Full scalar	18995.183	257	.108	.956	Rejected
	Partial Scalar (intercept item 1 was released)	13275.041	225	.097	.969	Rejected
	Partial Scalar (intercepts item 1 and 4 were released)	**7640.916**	**193**	**.079**	**.982**	**Accepted**
INSTSCIE (4 items)	Configural	12080.982	66	.167	.982	
	Configural (one error covariance was added between items 4 and 3)	873.408	33	.062	.999	
	Full metric	3155.911	129	.060	.996	Accepted
	Full scalar	**8143.607**	**225**	**.073**	**.988**	**Accepted**
JOYSCIE (5 items)	Configural	12400.314	165	.106	.988	
	Configural (one error covariance was added between items 4 and 5)	4521.540	132	.071	.996	-
	Full metric	6920.006	260	.062	.993	Accepted
	Full scalar	30383.757	388	.108	.969	Rejected
	Scalar partial (intercept item 3 was released)	20651.466	356	.093	.979	Rejected

	Scalar partial (intercepts item 1 and 5 were released)	**15562.347**	**324**	**.084**	**.984**	**Accepted**
Latent constructs	Level	X^2	DF	RMSEA	CFI	Decision
SCIEEFF (8 items)	Configural	24667.025	660	.075	.968	
	Full Metric	26691.157	884	.067	.965	Accepted
	Full Scalar	60417.808	1108	.091	.921	Rejected
	Partial Scalar (intercept item 4 was released)	52982.416	1076	.086	.930	Rejected
	Partial Scalar (intercepts item 4 and 8 were released)	46094.582	1044	.082	.940	Rejected
	Partial Scalar (intercepts item 4, 8 and 2 were released)	40199.534	1012	.077	.947	Rejected
	Partial Scalar (intercepts item 4, 8, 2 and 5 were released)	35581.016	980	.074	.954	Rejected

Note: The final model is presented in bold.

The cutoff points for the RMSEA indicated that the fit of the configural model with three variables (sense of belonging, disciplinary climate, and enjoyment of science) had to be improved. Some error covariances were added between items iteratively and in an exploratory fashion. When the configural model with all variables exhibited a good fit, we estimated the metric model.

Full metric invariance was accepted for sense of belonging, enjoyment of cooperation, disciplinary climate, instrumental motivation, enjoyment of science, and self-efficiency. Partial metric invariance was accepted for the value of cooperation. After full/partial metric invariance was accepted, we estimated the scalar model. Full scalar invariance was accepted for instrumental motivation. Partial scalar invariance was accepted for sense of belonging, value of cooperation, disciplinary climate, and enjoyment of science. In the case of enjoyment of cooperation and self-efficiency, partial scalar invariance was rejected. This decision was made because more than half of the items had to be relaxed to accept partial scalar invariance. As there is a lack of consensus about the number of parameters that can be relaxed to accept partial invariance, we adopted a conservative criterion following (Steenkamp & Baumgartner, 1998), who suggested that ideally, more than half of the items in a factor should be invariant.

Based on these results, the equivalence of sense of belonging, instrumental motivation, value of cooperation, disciplinary climate and enjoyment of science across countries was accepted, and in consequence, it became possible to compare the results of these individual-level predictors across countries. In contrast, enjoyment of cooperation and self-efficiency were neither equivalent nor comparable across countries. For this reason, we decided to test the multilevel SEM while excluding enjoyment of cooperation and self-efficiency as individual-level predictors.

Multilevel SEM

In the first step of the multilevel structural equation analysis, the two-level model was estimated for the whole set of OECD data. The null model, the adjusted model and the complete model were estimated separately. Table 4 presents the fixed and random effects from the three models. Positive values for the estimators indicate a positive relationship between that specific variable and student achievement. The values in bold indicate that this relationship is significant with $p < .001$. The random effects from the null model for the OECD confirm the existence of extensive and significant between-group variance (39%); therefore, the use of a two-level model is justified.

Table 4. Fixed and Random Effects of Science Performance at the Overall OECD Level

		Science performance					
		Nule model		Adjusted model		Complete model	
		Fixed effects					
		Est	Sig	Est	Sig	Est	Sig
Level 1: Students	GENDER (being a boy)	-	-	**8.51**	**<0.001**	**5.8**	**<0.001**
	REPEAT (not haven repeated grade)	-	-	**10.93**	**<0.001**	**23.4**	**<0.001**
	IMMIGRATION STATUS (being immigrant)	-	-	**-21.56**	**<0.001**	**-9.4**	**<0.001**
	ECONOMIC, SOCIAL AND CULTURAL STATUS	-	-	**17.38**	**<0.001**	**17.4**	**<0.001**
	JOY SCIENCE	-	-	-	-	**30.1**	**<0.001**
	INSTRUMENTAL MOTIVATION IN SCIENCE	-	-	-	-	0.4	NS
	VALUE COOPERATION	-	-	-	-	**-16.5**	**<0.001**
	SENSE OF BELONGING	-	-	-	-	**3.9**	**<0.001**
	DISCIPLINARY CLIMATE IN SCIENCE	-	-	-	-	**7.8**	**<0.001**
Level 2: Schools	ECONOMIC, SOCIAL AND CULTURAL STATUS	-	-	**40.41**	**<0.001**	**40.41**	**<0.001**
	% OF IMMIGRANTS	-	-	**-62.39**	**<0.001**	**-21.56**	**<0.001**
	% OF REPEATERS	-	-	-4.43	NS	8.2	NS
	TEACHER-DIRECTED SCIENCE INSTRUCTION	-	-	-	-	**22.2**	**<0.001**
	INQUIRY-BASED SCIENCE TEACHING AND LEARNING PRACTICES SCHOOL LEVEL	-	-	-	-	**-17.3**	**<0.001**
	TEACHER SUPPORT	-	-	-	-	**-14.0**	**<0.001**
	SCHOOL SIZE	-	-	-	-	**14.5**	**<0.001**
	CLASS SIZE	-	-	-	-	**1.0**	**<0.001**
	EDUCATIONAL LEADERSHIP	-	-	-	-	1.2	NS
	TEACHERS PARTICIPATION	-	-	-	-	**-7.2**	**<0.001**
	STUDENT RATIO	-	-	-	-	**-4.8**	**<0.001**
	RESPONSIBILITY OVER RESOURCES ASSIGNATION	-	-	-	-	-1.7	NS
	CURRICULAR DEVELOPMENT	-	-	-	-	**-7.2**	**<0.001**
	RESPONSIBILITY OVER CURRICULUM	-	-	-	-	**5.8**	**<0.001**
	SCHOOL AUTONOMY	-	-	-	-	2.8	NS
	INSTRUCTIONAL LEADERSHIP	-	-	-	-	-2.9	NS
Random effects (% of explained variance)							
WITHIN SCHOOLS			61%		77%		73%
BETWEEN SCHOOLS			39%		23%		27%

Note: values in bold significant at p < 0.001. NS: not significant.

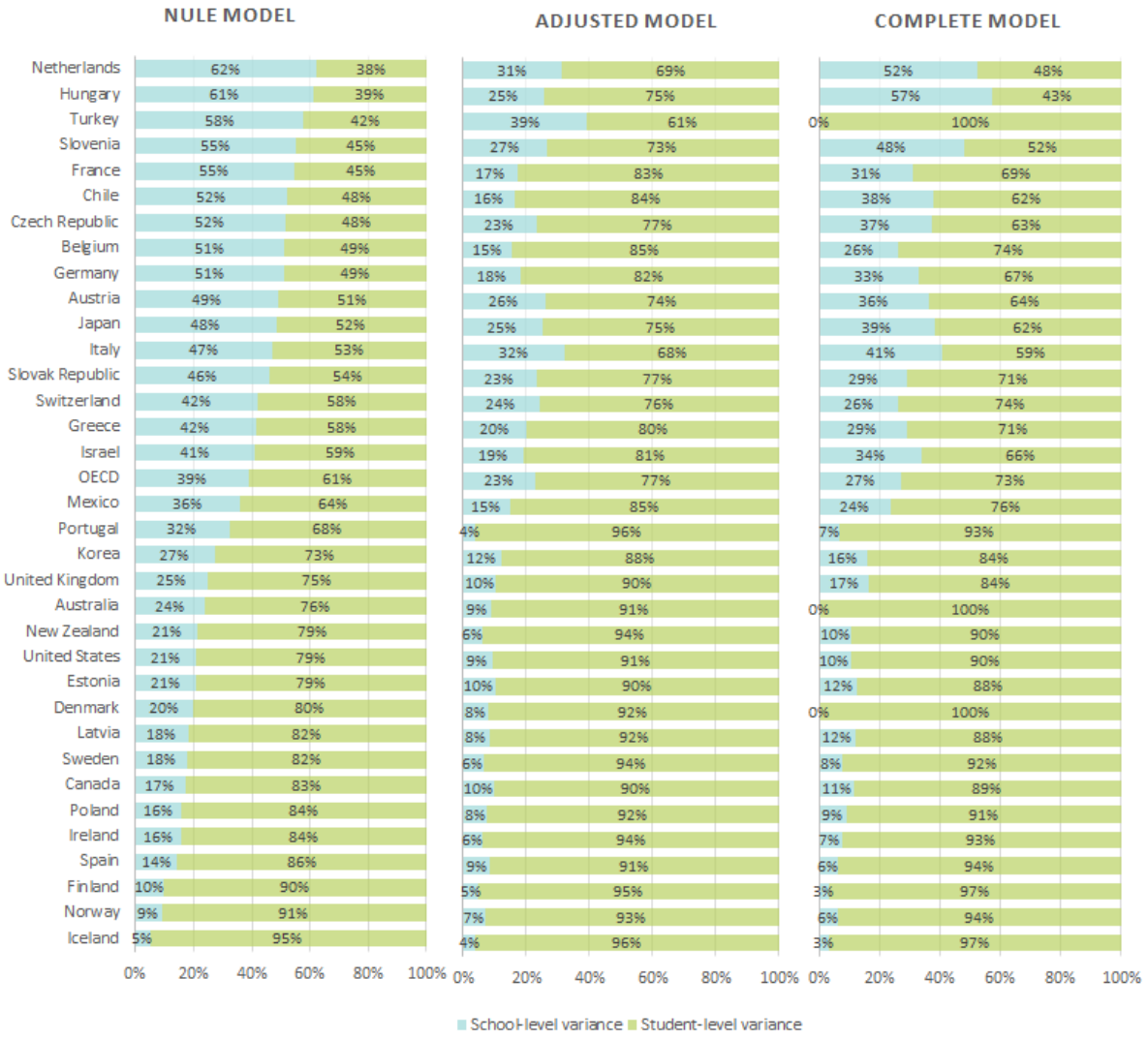
As Table 4 indicates, the adjusted model was configured as a two-level model that incorporates context variables, that is, structural factors that cannot be easily modified by education agents: the economic, social and cultural status of students' families, repetition (not having repeated a grade), and

immigration status (being an immigrant) at the student level, and school ESCS, the school average repetition rate and the percentage of immigrant students at the school level. All the context factors, except the school average repetition rate, were demonstrated to have a significant impact on student performance in science. Being an immigrant has the highest influence on science performance at the student level: native students performed 22 points higher on the PISA science scale on average. Students from more advantaged socioeconomic backgrounds performed 17 points better than disadvantaged students. At the school level, the schools with a higher percentage of immigrant students performed 62 points worse on the science scale, whereas the schools with higher percentages of advantaged students performed 40 points better than schools with a high enrollment of disadvantage students.

The complete model at the OECD level was enriched with climate variables, the aspects of the learning environment that can be controlled by the educational community. The high impact of the enjoyment of science on the science results (increasing science performance by up to 30 points on the PISA scale) at the student level is remarkable. While the influence of ESCS remained similar, enrollment in a higher grade increased in importance in the complete model. Not having repeated a grade increased science performance by 23 points. The disciplinary climate in science lessons, characterized by students' perceptions of order in the classroom and the adequacy of the learning environment, was also positively related to science scores. Another insight that can be extracted from the results of the complete model is the decrease in the impact of having an immigrant background when climate variables were taken into account. Although this impact was still significant, it was reduced by half. Regarding the variable value of cooperation, the results indicated that the students who preferred working as part of a team to working alone and who found that teamwork raises their own efficiency tended to earn lower scores in science.

At the school level, school ESCS was positively and significantly related to science performance with the same magnitude as that observed in the adjusted model (see Table 4). Nevertheless, the impact of having a higher percentage of immigrant students was considerably reduced, from 62 to 22 points. These results indicate that the promotion of climate variables can counteract the difficulties originating in migration processes. The process variables that particularly gained in importance at the school level were those related to the teaching practices used in classrooms. Schools in which the teaching strategies were based on a more active role for the teacher, who is responsible for explaining and demonstrating scientific ideas and centralizing discussions, performed significantly better in science. Furthermore, the schools in which inquiry-based teaching practices prevailed earned lower scores in science. Teacher support was associated with lower performance in science, whereas school size exhibited a positive and significant relationship with science performance. Figure 1 shows the percentage of variance explained by the multilevel SEMs at the student and school levels in each country.

Figure 1. Random Effects of Science Performance at the Overall OECD Level and Across Countries



In Figure 1, the countries are ranked according to the percentage of explained variance in the null model from greatest to least. As mentioned before, the percentage of variance can be interpreted as a measure of the effects of schools on performance. At the OECD level, in the null model, 61% of the variance in performance was observed to be at the student level. When the model was adjusted to include context factors, the student-level percentage of the variance increased to 77%. In the complete model, in which the climate variables had been introduced, the school effects gained in importance, accounting for 27% of the variance in the science results. The countries with the largest school effects in the three models were the Netherlands and Hungary. The countries where the variance in performance was mainly concentrated at the student level were Iceland, Norway and Finland.

Table 5 summarizes the results from the complete model of the factors associated with performance for each of 34 OECD countries. The detailed results for each country are presented in Table II of the supplementary materials.

Table 5. Summary of Country-Level Fixed Effects of Science Performance

		% of countries with significant impact				Number of countries with significant impact		
		N/A	Sig	Positive	Negative	Sig	Positive	Negative
Level 1: Students	JOY SCIENCE	0	100%	100%	0%	34	34	0
	ECONOMIC, SOCIAL AND CULTURAL STATUS	0	97%	100%	0%	33	33	0
	VALUE COOPERATION	0	97%	0%	100%	33	0	33
	REPEAT (not haven repeated grade)	3	100%	100%	0%	31	31	0
	GENDER	0	79%	93%	7%	27	25	2
	DISCIPLINARY CLIMATE IN SCIENCE	0	79%	100%	0%	27	27	0
	IMMIGRATION STATUS	1	76%	0%	100%	25	0	25
	SENSE OF BELONGING	1	48%	94%	6%	16	15	1
	INSTRUMENTAL MOTIVATION IN SCIENCE	0	41%	71%	29%	14	10	4
Level 2: Schools	ECONOMIC, SOCIAL AND CULTURAL STATUS	0	94%	100%	0%	32	32	0
	TEACHER-DIRECTED SCIENCE INSTRUCTION	1	48%	100%	0%	16	16	0
	INQUIRY-BASED SCIENCE TEACHING AND LEARNING PRACTICES	0	35%	0%	100%	12	0	12
	% OF IMMIGRANTS	0	29%	0%	100%	10	0	10
	TEACHER SUPPORT	0	18%	33%	67%	6	2	4
	SCHOOL SIZE	3	13%	75%	25%	4	3	1
	% OF REPEATERS	3	13%	50%	50%	4	2	2
	CLASS SIZE	1	9%	100%	0%	3	3	0
	EDUCATIONAL LEADERSHIP	0	9%	33%	67%	3	1	2
	TEACHERS PARTICIPATION	0	9%	0%	100%	3	0	3
	STUDENT RATIO	1	6%	0%	100%	2	0	2
	RESPONSIBILITY OVER RESOURCES ASSIGNATION	0	6%	50%	50%	2	1	1
	CURRICULAR DEVELOPMENT	0	6%	0%	100%	2	0	2
	RESPONSIBILITY OVER CURRICULUM	0	3%	0%	100%	1	0	1
	SCHOOL AUTONOMY	0	3%	100%	0%	1	1	0
	INSTRUCTIONAL LEADERSHIP	0	3%	100%	0%	1	1	0

The results reported in Table 5 indicate whether the impact of factors related to science performance observed at the OECD level can be reproduced at the country level. At the student level, enjoyment of science was demonstrated to be positively and significantly related to science performance in each of the 34 OECD countries. The impact of the socioeconomic status of students' families was also strong and positive in all countries except Slovenia. The negative effect of grade repetition was confirmed in 31 out of 34 countries. In three countries, Iceland, Japan and Norway, repetition practices do not exist or are used extremely rarely. In 27 OECD countries, science performance was positively related to disciplinary climate, while immigrant background negatively affected student achievement in 25 countries. The variable gender was found to have an impact on science performance in 27 countries; in all of those countries, boys performed significantly better than girls. Sense of belonging and

instrumental motivation for science predicted student performance in only half of the OECD countries; in the rest of the countries, the effects of those variables were not significant or were even negative. In almost all of the countries (33 out of 34), a negative relationship between valuing teamwork and science performance was maintained. The students who thought that teams make better decisions than individuals and are more efficient demonstrated systematically lower performance in science in 33 OECD countries.

At the school level, only the school average ESCS was positively related to science performance in almost all countries (32 out of 34). The prevalence of a teacher-directed style of teaching at the school level had a significant and positive impact in 16 countries, while inquiry-based science teaching and learning practices were negatively related to performance in 12 countries. Teacher support was found to be negatively related to student performance at the OECD level; nevertheless, at the country level, this relationship was found in only four countries. In two of those countries, the effect of teacher support was positive, and in 18 countries, no relationship was observed. The rest of the school-level variables had an effect on performance in fewer than 5 countries, and those effects were mainly small. It is remarkable that school characteristics, such as school and class size, the teacher-student ratio, a shortage of resources or a lack of school autonomy, do not seem to affect student performance when the other climate variables are taken into consideration.

Table 6 summarizes the previous results by grouping the variables showing significantly positive and negative impacts. In addition to the level and direction of the impact of variables on student achievement, the table provides relevant information for orienting educational policies by classifying variables into those that are malleable at the school level and those that cannot be controlled by schools. To identify similarities and differences across countries, Table 6 presents the number of countries in which each of the context and climate variables have a significant effect on science achievement, either positive or negative. The number of countries for which information about a specific variable was not available is also presented (indicated with N/A). Then, we provide information about the percentage and the number of countries for which the intended variable had a significant impact on student performance as well as the direction of the relation between the variable and science achievement. The variables in Table 6 are ordered from the highest to the lowest percentage of countries showing a significant effect. The variables that did not have significant fixed effects in at least one country are not presented in Table 6. These variables are teacher participation, shortage of educational resources, shortage of staff, and professional development.

Table 6. Classification of Country-Level Fixed Effects of Science Performance

Effect direction	Not malleable factors at school level (Input factors)	Malleable factors at school level (Input factors)
Positive effect in more than 20% of countries	Economic, social and cultural status (positive effect in 100% of the OECD countries) Gender (male students perform better in 79% of the OECD countries)	Enjoyment of science (positive effect in 100% of the OECD countries) Disciplinary climate (positive effect in 79% of the OECD countries) Instrumental motivation in science (positive effect in 41% of the OECD countries) Sense of belonging (positive effect in 44% of the OECD countries) Prevalence of teacher-directed science instruction (positive effect at school level in 48% of the OECD countries)
Negative effect in more than 20% of countries	Grade repetition (not having repeated a grade has positive effect in 100% of countries) Immigration status (having immigrant background has negative effect in 76% of countries)	Value of cooperation (negative effect at school level in 97% of the OECD countries) Prevalence of inquiry-based science teaching and learning practices (negative effect at school level in 35% of the OECD countries)
Mixed effects or effects in less than 20% of countries	School size (negative in 3% of countries, positive in 9% of countries) Class size (positive in 9% of countries)	Teacher support (negative in 12% of countries, positive in 6% of countries) Educational leadership (negative in 6% of countries, positive in 3% of countries) Teachers participation (negative in 9% of countries) Student ratio (negative in 6% of countries) Responsibility over resources assignation (negative in 3% of countries, positive in 3% of countries) Curricular development (negative in 6% of countries) Responsibility over curriculum (negative in 3% of countries) School autonomy (positive in 3% of countries) Instructional leadership (positive in 3% of countries)
No effect		Teacher participation Shortage of educational resources Shortage of staff Professional development

As Table 6 shows, there are some variables that are not malleable but have positive or negative effects on achievement. For instance, neither gender nor student ESCS nor immigration status are factors in which teachers or the school administration can intervene. According to the results, boys, nonimmigrants and students with high economic, social and cultural status performed better than girls, immigrant students and students with low economic, social and cultural status.

However, other variables provide information about elements that promote achievement or elements that can be improved in science. In the first group, enjoyment of science, instrumental motivation for science and disciplinary climate at the student level seem to have a positive effect on student achievement. Both enjoyment of science and instrumental motivation are related to students' perceptions of science, whereas disciplinary climate and sense of belonging are connected to the working environment in the classroom. Regarding variables with a negative impact on achievement at the student level, the result for valuing teamwork indicated that students who prefer working with others had lower achievement in science. Therefore, enjoying science is related to high-performing students, whereas valuing cooperation is not.

Furthermore, the results indicate that teacher-directed methodologies are related to high performance, whereas inquiry-based methodologies are related to low performance in science.

Among the variables with mixed effects, teacher support was the variable with highest contradictory percentages. While the effect was positive in 12% of the countries, it was negative in 6%.

Discussion

The aim of this paper was to investigate the variables related to students or to schools that affect student achievement in science in order to identify the factors that determine school effectiveness. The results from 34 countries showed that there are factors that systematically affect student performance both at the OECD and at the individual country level. The research variables were classified into context or climate factors, with a special focus on the climate factors that are under the direct control of schools and administrators (O'Connell & McCoach, 2008).

The variable that was found to have the highest impact on science performance both at the OECD level and in each of the 34 OECD countries was the enjoyment of learning science. Its positive influence even overcame the impact of socioeconomic status and immigrant background, leading to a 30-point increase on the PISA science scale. These results confirm the importance of intrinsic motivation (the drive to perform an activity because of the joy obtained from that activity) for increased academic performance (Ryan & Deci, 2009). Specifically, the enjoyment of science is determined by students' eagerness to spend time and effort on science-related activities, the choice of electives, students' self-

image and their career expectations related to science (Nugent et al., 2015). In general, inquiry-based learning in combination with daily science applications and the promotion of peer discussion increases students' intrinsic motivation to learn science (Jocz et al., 2014; Logan & Skamp, 2012). Hampden-Thompson and Bennett (2011) demonstrated that the enjoyment of learning science is associated with a higher frequency of teaching practices that involve interactions (e.g., students are given opportunities to explain their ideas), hands-on activities (e.g., students are required to design an experiment to investigate a science question in the laboratory), and applications of science (e.g., the teacher uses science to help students understand the world outside school). The results of the present study confirm the relevance of enjoying science in each OECD country and its particular impact on performance that even exceeds the impact of socioeconomic context.

The disciplinary climate is the second process variable that influences science performance. Its positive effect was observed in 79% of the examined countries and increases scores by 8 points on the PISA scale on average. The role of the teacher is a determinant of the creation of an adequate classroom environment, free of noise and disorder, where the students can concentrate on productive learning. The OECD also affirms that effective teaching, high levels of teacher well-being and perceptions of self-efficacy are only possible when the disciplinary climate in the classroom is positive (Gomendio, 2017). School principals should also be proactive in promoting constructive disciplinary policies, while educational authorities should include training on methods of managing the classroom environment in initial and continuous professional development.

Another climate factor that has an impact on science performance is students' sense of belonging at school. Although the magnitude of its impact, on average, is relatively low (approximately 4 points at the OECD level), it is significantly positive in 15 out of 34 countries. The relationship between having a sense of belonging and academic performance was stronger among students with extremely weak perceptions of belonging. On the PISA, students who reported that they felt like an outsider at school earned 22 fewer points in science than those who did not report such feelings (OECD, 2016a). Moreover, a sense of belonging plays a central role in students' overall well-being (Govorova, 2020). At the student level, self-esteem is the most important predictor of belongingness, while at the school level, supportive student-teacher relationships, an advantageous school climate and high academic expectations are responsible for shaping students' sense of belonging (Lee, 2012; Ma, 2003).

Among the variables with a negative association with academic performance, the value of teamwork stands out. The students who believe that teams make better decisions than individuals or who prefer working as part of a team to working alone because teamwork raises their own efficiency score 16.5 points lower in science. This tendency persists in 100% of the analyzed countries with data available. On the PISA, students who value teamwork also tended to perform worse in collaborative problem solving (OECD, 2017b). There is a need for further research to explain the relationships

between these variables. A possible explanation could be the diffusion of responsibility in teamwork or social loafing, which occurs when individuals demonstrate less-than-expected effort in group work (Tosuntaş, 2020), and could be a strategy preferred by low performers.

The last climate variable at the student level with a positive effect on science performance is instrumental motivation for science. Although it does not exhibit a significant impact at the OECD level, the perception of the role of science in career advancement predicts science performance in 10 out of 34 individual countries. Placing emphasis on daily applications of science is one of the strategies that can improve students' instrumental motivation (Chong Ho, 2012).

On the other hand, some variables affecting achievement are more related to the methodologies used in schools. The results show that traditional teaching strategies, based on the central role of the teacher as someone who provides directed science instruction, are associated with higher performance in science across the overall OECD sample and in 16 individually analyzed countries, while inquiry-based science teaching and learning practices are negatively related to performance in the OECD on average and in 12 individual countries. Surprisingly, a more innovative teaching style, which aims to engage students in experimentation or to promote debates about investigations, does not seem to contribute to improving academic performance (Gil Izquierdo et al., 2018; OECD, 2016b); nevertheless, these methods can improve students' expectations regarding science, instrumental motivation and enjoyment of learning science (Hattie, 2009). These results may suggest that inquiry-based methodologies should be used more efficiently. The activities should be carefully designed, well structured, and supported by a clearly understood theoretical framework. Moreover, teachers should receive specific training on how to develop these types of activities.

Among the context factors, student characteristics, such as gender, ESCS or immigrant status, seem to determine student achievement. Although contextual variables are informative for the educational community and are mainly used as control variables for refining school effects (O'Connell & McCoach, 2008), educational authorities can implement school policies to promote equity in education and consequently reduce the influence of contextual factors, increasing school effectiveness. There are multiple strategies that can minimize inequity: interventions to support students and schools with low socioeconomic backgrounds (e.g., teaching quality, homework assistance programs, preferential funding, not grouping disadvantaged students together), strategies targeting students with an immigrant background (e.g., integration programs, curriculum adaptations, professional skills improvement, not grouping immigrant students together), the promotion of gender equity in education (reduction of stereotypes in students' perceptions of their abilities and career expectations through objective career guidance both for parents and students, promotion of an inclusive image of science, etc.) (Gomendio, 2017).

Last, the results show that some variables do not seem to have any significant impact on science performance or that their effect is moderate. These variables are teacher participation, a shortage of educational resources, a shortage of staff and professional development.

In summary, the present paper has several practical implications. On the one hand, teachers should work to increase interest in and the enjoyment of school subjects for students as well as contribute to creating an adequate working environment in which students can study in a tidy place that is free of noise. In addition, schools should favor training teachers to select methodologies that better fit the content that students should work with. In that sense, teacher-directed and inquiry-based methodologies could both be used depending on the students' learning needs. Schools should help teachers develop their abilities in inquiry-based teaching. Finally, policy makers could work on creating educational policies focused on extending equality actions to reduce effects related to gender, immigration status or ESCS.

Last, some variables exhibited opposite or very large effects in specific countries. This means that the insights from the OECD analysis should be considered carefully in specific country contexts and that country characteristics and cultural elements should be taken into account when developing country-level educational policies.

Despite the strengths of this study, some limitations need to be pointed out. First, the results of this study are restricted to science achievement. Future studies will allow us to contrast whether the effects found are similar in other subject areas. Second, interaction effects between variables were not analyzed due to the cross-sectional design of the study. Future studies using a longitudinal design will allow us to explore the interaction effects between variables, for example, to determine which variables contribute to the enjoyment of science, one of the most relevant variables for explaining science achievement in this research. Finally, a positive relationship between school size and science achievement was identified in this study. Given that this result was unexpected, future moderation analyses would allow us to understand which variables are associated with this result.

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1.4. Estudio 4

Govorova, E., Benítez, I., & Cuesta M. (2023). Strategies for Promoting Reading Competence: Teaching Practices and Enjoyment of Reading. Psicothema.

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El presente estudio tiene por objetivo identificar factores escolares relacionados con los estilos y prácticas docentes, así como las variables sobre las que se puede influir de forma directa en el aula, que están asociados con niveles más altos de adquisición de competencias básicas (en concreto, la lectura) en el contexto internacional de la OCDE. La principal aportación de este artículo a la tesis doctoral consiste en la identificación de factores de proceso asociados a la competencia lectora, analizando el efecto de dichas variables mediante la aplicación de una metodología de análisis adaptada al contexto de una evaluación internacional – Diferencias en Diferencias.

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Article

Strategies for Promoting Reading Competence: Teaching Practices and Enjoyment of Reading

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ABSTRACT

Background: Reading literacy is key for personal development and educational success. Previous studies have examined variables that influence and enhance development of reading literacy in specific contexts. However, there is no consensus about which teaching practices encourage development of reading in different settings. The aim of this study was to evaluate how educational strategies influence the development of reading literacy and to analyse their predictive capacity in various cultural, educational and social contexts. **Method:** The study used data from 294,527 students from 37 countries collected as part of the PISA 2018 study. The data were analysed using an adaptation of the Difference in Differences methodology, which allowed us to isolate the effects of the factors on the acquisition of reading literacy. **Results:** Students who enjoyed reading and explicitly used an effective reading strategy had reading scores that outperformed their mathematics results on the PISA scale by 4 to 9 points on average. **Conclusions:** Identifying key factors in the acquisition of reading literacy—such as enjoyment of reading—and the use of effective strategies—such as summarizing texts—underscores the need for suitably targeted educational policies.

Estrategias Para Fomentar la Competencia Lectora: Prácticas Docentes y Disfrute de la Lectura

Palabras clave:
PISA
Competencia lectora
Prácticas docentes
Diferencias en diferencias
Estrategias lectoras

RESUMEN

Antecedentes: La competencia lectora es clave para el crecimiento personal y el éxito educativo. Estudios previos han analizado las variables que potencian la competencia lectora en contextos específicos. Sin embargo, no existe consenso sobre las prácticas docentes que favorecen la evolución de esta competencia en distintos contextos. El objetivo de este estudio es evaluar la influencia de las estrategias educativas en el desarrollo de la competencia lectora y analizar su capacidad predictiva en distintos contextos culturales, educativos y sociales. **Método:** Se utilizaron datos de 294.527 alumnos de 37 países recogidos en el estudio PISA 2018. El análisis de datos se realizó mediante una adaptación de la metodología Diferencias en Diferencias, que permitió aislar el efecto de los factores sobre la competencia lectora. **Resultados:** Los resultados muestran que los estudiantes que disfrutan leyendo y utilizan explícitamente una estrategia de lectura eficaz superan entre 4 y 9 puntos de media los resultados en matemáticas en la escala de PISA. **Conclusiones:** La identificación de factores clave en la adquisición de la competencia lectora, como el disfrute de la lectura y la utilización de estrategias eficaces de comprensión y síntesis de textos escritos, enfatiza la necesidad de generar políticas educativas orientadas a su desarrollo.

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In a knowledge-based society like ours, reading is vitally important in the learning process because it involves skills such as communicating, sharing, and using information to solve complex problems (Binkley et al., 2012). Reading literacy is also an indispensable requirement for students' acquisition of other basic skills including mathematics and science (Akbaşlı et al., 2016), as well as active participation in adult life (Cunningham & Stanovich, 1997; Economic Co-operation and Development [OECD], 2013; Smith et al., 2000).

Previous studies have examined the influence of various factors in the process of acquiring reading literacy. On the one hand, they found that sociodemographic characteristics, such as gender, family socio-economic and socio-cultural background, and being an immigrant were the main predictors of reading achievement. In most countries, girls, students from better-off socio-economic backgrounds, and native students had systematically better results in reading (OECD, 2016, 2019a).

On the other hand, there does seem to be a certain consensus about the positive influence of family participation in early infancy on the development of reading, with starting reading early, the frequency of shared reading with parents, and the level of exposure to early reading tasks marking the difference (Anderson et al., 2010; Bus et al., 1995; Gjems, 2010; Levy, 2018; Mol et al., 2008; Perregaard, 2010). Other studies have highlighted the importance of parents' roles, showing that parents' enthusiasm for reading improved their children's reading (Clavel & Mediavilla, 2019), and that simply seeing parents reading improved children's reading habits (Clark & Hawkins, 2010; Love & Hamston, 2004; Mullan, 2010). Students' confidence in their reading abilities, as well as having been exposed to early reading tasks were also associated with a higher probability of being resilient in reading (García-Crespo et al., 2019, 2022).

Understanding the factors that promote the acquisition and development of reading may encourage the creation and implementation of educational policies aimed at boosting children's and young people's reading skills. However, many of the factors that predict reading achievement, such as socio-demographic characteristics, beginning reading early, and parental reading habits, are outside school control, limiting the possibilities of establishing transversal measures. This makes it more important to have studies which provide information about factors within the educational system, such as teaching practices. Although many studies have highlighted the key role of teachers in reducing the impact of those factors outside the education system (Le Donné et al., 2016; Hattie, 2009), there is currently no data about universally effective teaching practices (Echazarra et al., 2016; OECD, 2005).

Studies such as the OECD's Program for International Student Assessment (PISA) have attempted to address this issue by collecting detailed information about teaching practices and the strategies students use to tackle school tasks. PISA's objective is to analyze students´ levels of acquisition of basic competencies at the end of compulsory education internationally. To that end, every three years there is an assessment cycle focusing on three knowledge areas; reading, mathematics, and science. Each edition also includes an additional area of innovation. For example in the 2018 PISA study, the additional area was global competence. The PISA study is organized so that in each cycle, one of the main areas is examined in more detail and with more precision. PISA 2018 included a more extensive assessment of reading literacy, which also included the collection of international indicators about various variables associated with it. The PISA theoretical framework defines reading literacy as "understanding, using, evaluating, reflecting on, and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society" (OECD, 2019b).

Some authors have analyzed the predictor variables of reading literacy in the academic context using the data available from PISA 2018. Koyuncu and Fırat (2021) found that strategies of summarizing and evaluating credibility were common predictors in the three countries they used in their study: Turkey, Mexico, and China. Karaman (2022) looked at Turkish students, confirming previous findings and adding that students who used a greater number of metacognitive strategies demonstrated better reading performance. That author also identified enjoyment of science as a predictor of reading literacy, along with teaching practices such as directed instruction and adaptive instruction. Rojas-Torres et al. (2021) found a positive association in Costa Rican students between time spent reading, interest in reading, and reading performance.

The results seem to indicate a consistent influence from some variables. However, these studies used data from specific countries and applied statistical techniques based on regression analysis. This means that their results cannot be extrapolated to draw conclusions about the other countries in the assessment.

Various studies have called for research which would provide transcultural evidence about factors associated with educational achievement which would allow universally effective strategies to be identified to then establish a common foundation of educational policies aimed at encouraging student performance, and subsequent competitiveness in a globalized world. Other studies call for research that would offer rigorous, systematic comparisons between regions and countries with different cultural and educational traditions in order to establish policies tailored to local contexts (Boonk et al., 2018; Fernández-Alonso et al., 2022; Kim, 2020). The present study aims to contribute to this trend for transcultural research, making use of the synergy between the two approaches.

To that end, the study followed a methodological approach aimed at identifying the important variables in the development of reading literacy at both the international level and at individual country level from comparing situations where the variables were present and those where they were not. More specifically, the study used an adaptation of the Difference in Differences model (DiD) to make inferences about the relationship between the level of acquisition of reading literacy and academic context variables such as student knowledge of reading strategies, teaching practices, and reading frequency. DiD is an econometric method allowing evaluation of a program's impact through comparing observations of control and treatment groups at two timepoints—before and after the program being evaluated is implemented (Becchetti et al., 2013). In an educational setting, the DiD strategy consists of comparing the difference between people's results before and after participating in a program with results obtained at similar times from people in other schools who did not participate in the program (control group) (Schlotter et al., 2011).

Because the PISA study only has longitudinal data for some of the countries involved in the evaluation, the strategy was adapted based on the proposals from Jürges et al. (2005), who used DiD to identify the causal effect of standardized exams on student performance in German students with data from the Trends in International Mathematics and Science Study (TIMSS). More specifically, in our study, we compared observations of the same individuals' performance at a single time point in two different subjects, reading and mathematics.

This strategy, as proposed by Jürges et al. (2005), has been used by other studies (Clavel & Mediavilla, 2019; Cordero & Pedraja, 2018), although it has also been modified in studies using similar models based on fixed student observations in order to estimate the impact of teaching practices or characteristics on student performance (Bietenbeck, 2014; Schwerdt & Amelie, 2011) and the influence of teaching time on academic performance (Rivkin & Schiman, 2015). These studies, among others, have demonstrated the usefulness of the modified DiD strategy for establishing causal relationships in transversal studies where dependent variables are related to student performance.

The current study aims to contribute to the debate about effective teaching capable of promoting reading literacy in students at the international level. More specifically, the study's objective is to determine what factors—related to potential teaching tools in the classroom—are associated with higher levels of reading literacy in all of the OECD countries evaluated in the PISA 2018 study.

Method

Participants

The study used the data for all of the participating OECD countries in the 2018 edition of the PISA study. Table 1 shows the numbers of students in each country along with the total population they represent.

Instruments

In PISA 2018, the participating students completed a cognitive test and a context questionnaire. The cognitive performance scale assessed competencies which included students' ability to extrapolate from what they had learned and apply their knowledge and skills to real-life situations, as well as their capacity to analyze, reason, and effectively communicate their findings when they addressed, interpreted, and solved problems in various situations. The full scale includes questions related to reading, mathematics, science, and global competence, and would take 13 hours to complete. From that scale, various combinations of questions were used to make up tests which would last approximately 2 hours. Because this edition of PISA looked at reading in more detail, there were more questions for assessing this dimension than the others. The full scale has 245 items in total for evaluating reading literacy, which translates to about six hours of assessment (for more details on the design, see the PISA 2018 Assessment and Analytical Framework; OECD, 2019b). The tests were taken in an electronic format, with the reading test in this case being adaptive; the difficulty of the items in the test was tailored to the students' abilities based on their prior responses, using a multi-stage adaptive design (Yamamoto et al., 2019).

Table 1
Number and Characteristics of Participants From Each Country

Country	Sample N	% girls	Population represented
Australia	14273	50%	257779
Austria	6802	49%	75077
Belgium	8475	50%	118025
Canada	22653	50%	335197
Switzerland	5822	48%	71683
Chile	7621	50%	213832
Colombia	7522	51%	529976
Czech Republic	7019	50%	87808
Germany	5451	46%	734915
Denmark	7657	50%	59967
Spain	35943	50%	416703
Estonia	5316	50%	11415
Finland	5649	49%	56172
France	6308	49%	756477
United Kingdom	13818	51%	597240
Greece	6403	50%	95370
Hungary	5132	51%	86754
Ireland	5577	50%	59639
Iceland	3296	50%	3878
Israel	6623	54%	110645
Italy	11785	48%	521223
Japan	6109	51%	1078921
Korea	6650	48%	455544
Lithuania	6885	49%	24453
Luxemburg	5230	50%	5478
Latvia	5303	51%	15932
Mexico	7299	52%	1480904
Netherlands	4765	49%	190281
Norway	5813	50%	55566
New Zealand	6173	51%	53000
Poland	5625	51%	318724
Portugal	5932	50%	98628
Slovak Republic	5965	50%	44418
Slovenia	6401	47%	17138
Sweden	5504	50%	93129
Turkey	6890	49%	884971
United States	4838	49%	3559045
Total	294527	50%	13575905

The context questionnaire collected students' demographic data and information about non-cognitive variables. Some of those, such as gender or repeating a school year, were used as simple indexes. Others contributed to the construction of more

complex indices which sought to assess latent constructs through observable variables. One example is enjoyment of reading, a construct that is measured through five observable variables.

In addition to these two instruments, PISA 2018 included a school questionnaire to be completed by school authorities, a questionnaire for teachers, and one for students' families. The latter two were optional. Because only a few countries applied these two optional questionnaires, data collected by these instruments was not included in the study.

The explanatory variables in the study were classed as control variables and treatment variables. Control variables were determined by the student's own characteristics or their individual contexts; i.e., those which were not malleable at the school level. These variables were included in the model to control possible biases due to student characteristics. The control variables in the current study were students' gender and their economic, social, and cultural status (ESCS). ESCS is constructed from three components: parents' occupational status, parents' educational attainment (in both cases selecting the highest value from parents), and home possessions (including the number of books in the home). Since PISA began in the year 2000, there has been evidence of a strong relationship between ESCS and student performance (Raitano & Vona, 2016), which has become the focus of numerous studies.

The treatment variables were those related to the promotion of reading literacy that teachers might influence. They were spread over three blocks of constructs related to styles of teaching and learning reading, labelled: reading strategies and enjoyment of reading, teaching practices in language lessons, and reading frequency.

The PISA 2018 questionnaire covers two evaluation scenarios of students' reading strategies, both related to metacognition: a) summarizing, and b) understanding and remembering. Students were asked to score the reading strategies in relation to how useful they were for tackling a reading task, an assessment that was also done in parallel by a group of experts through multiple pairwise comparison. This assessment produced a hierarchy of all the strategies for each task, ranked from most to least useful, with the agreement of at least 80% of the experts. Based on this score, rules were created to construct a score for each student based on how often they chose a more useful strategy rather than a less useful one. The final scores assigned to each student for each task ranged from 0 to 1, and can be interpreted as the proportion of the total number of scores that agreed with the experts' hierarchical order. Higher scores indicate more choices in agreement with the experts' assessments. From those scores, the PISA study constructed two indices using Item Response Theory (IRT): UNDREM (which included the understanding and remembering strategies), and METASUM (which covered the summarizing strategies).

The reading strategies block also included enjoyment of reading, another PISA index constructed via IRT. This index assesses whether the students use reading as a pastime or to find information (rather than as an obligation), and whether they like to talk about books with other people. Higher values in this index indicate more enjoyment of reading. The PISA 2018 technical report gives a detailed description of the indices' construction (OECD, 2023).

It is worth emphasizing that PISA 2018 included an additional metacognition construct that assessed students' abilities to evaluate the credibility of information, an essential skill for the 21st century digital world (OECD, 2021). Students were asked to describe their reaction to receiving an email with potentially harmful content. Given that our study focuses on identifying effective teaching practices for encouraging transversal reading literacy, we excluded this construct from the treatment variables, which only included the traditional reading strategies. In addition, as Suárez-Álvarez et al. (2022) noted, adding specific content about digital skills without making other changes to study plans could be problematic.

To evaluate teaching practices, the students were also asked how often their teachers demonstrated their support in language classes, how often they modified their classes to students' needs, and how often they used reading stimulation strategies. Students' perceptions of their teachers' levels of enthusiasm and interest, and their directing role in the classroom were also assessed. Table 2 shows the control variables and the observable variables used to measure the strategies, reading frequencies, and perceived teaching style, along with a short description for each. All of the treatment variables followed a standardized normal distribution N(0, 1), which made it easier to compare the results of the study.

Procedure

PISA 2018 was applied following the OECD standards (OECD, 2023). Each student completed a test of cognitive items in a session lasting 120 minutes, plus a five minutes break halfway through. Following that, they completed the context questionnaire.

Data Analysis

The present study used the international PISA 2018 database, which is freely available on the OECD webpage, selecting all of the observations of students in OECD countries (OECD, 2019a).

The methodological approach was based on an adaptation of the DiD methodology, which allows transversal data—such as that collected in the PISA study—to be analyzed.

The differences between the control group and the treatment group results were assessed at the same timepoint. Because the main objective of our study was to evaluate the effectiveness of teaching styles and reading strategies, the variable of interest in the teaching group was the students' results in the PISA reading scale. The control group data was the results of the same students in another subject, in this case the results in mathematics. The first step was to calculate the dependent variable, defined as the difference between the students' scores in reading and the same students' scores in mathematics. Mathematics scores were chosen as a control (rather than scores in science) because the correlations between reading and mathematics in PISA are systematically weaker than between reading and science (Anderson et al., 2010), meaning that the effect of the treatment variables is more obvious.

Table 2
Explanatory Variables

Dimension	Variable	Description
Control variables	Gender	Whether the respondent is a boy or girl.
	Students' social, economic, and cultural index (ESCS)	Reflects the educational or occupational level of parents, possessions in the home, and the number of books in the home.
Treatment variables Reading enjoyment and reading strategies	Enjoyment of reading	Whether the student only reads because they have to, if they think reading is a waste of time, if they like to talk about books with others, and if they only read to find information they need.
	Metacognition: summarizing	Whether the student is aware of effective reading strategies for summarizing texts: checking whither the most important parts of the text are included in the summary, underlining important sentences, rewriting them later in their own words as a summary.
	Metacognition: understanding and remembering	Whether the student is aware of effective reading strategies for understanding and remembering text: discussing the content with others after reading, underlining the most important parts of the text, summarizing the text in their own words.
Teaching practices in language classes	Teacher support in language lessons	The students' opinions about whether their teachers show interest in all students' learning, offer additional help if needed, or continue explaining until all students understand the topic.
	Teacher's stimulation of reading	The students' opinions about whether the teachers often encourage them to express opinions about a text, help them to relate what they read to their own lives, or ask questions to prompt active participation from students.
	Teacher-directed instruction in language lessons	The students' opinions about whether the teachers set clear learning objectives, ask questions to check student understanding, or say what they have to learn.
	Perceived teacher's interest	The students' opinions about the teachers' levels of involvement, motivation and enjoyment of their work: whether teachers like teaching and address the topic of reading, and if the teachers' enthusiasm inspires the students.
	Adaptation of instruction in language lessons	The students' opinions about whether the teachers adapt lessons to the needs and knowledge of the class, whether they give individual support, or whether they change the structure of a lesson on a topic that most of their students struggle with.
Reading frequency	Frequency of online reading	How often the students read on digital devices (email, online news, etc.).
	Frequency of reading for school	How often the student has had to read different types of texts in class or homework in the previous month.
	Frequency of reading newspapers and news	How often the students read newspapers and magazines without having to do so.
	Frequency of reading for pleasure	How often the students read comics or fiction books when they do not have to.

In the PISA study, students' cognitive responses are analyzed using the IRT in combination with a complex imputation methodology for student scores which produces an a posteriori distribution of values for each subject with their associated probabilities, giving rise to what are called plausible values (Martínez Arias, 2006). In PISA 2018, ten plausible values are produced for each performance scale—reading, mathematics, and science. Estimating any populational parameter in PISA requires an estimation using each of the plausible values separately and then calculating the mean of the statistics obtained with each one. The estimation of the final statistic is therefore equal to the mean of the ten estimations of the statistic in question, obtained for each plausible value (OECD, 2009). In line with the PISA analytical methodology, the explained variable in our study was calculated as the difference between each of the ten plausible values in reading and the ten plausible values in mathematics. The standard errors were calculated considering the sample weightings at national level, as well as the variance of imputation. The PISA 2018 technical report includes the details of the calculation process (OECD, 2020).

Following the strategy from Clavel and Mediavilla (2019), the mathematical expression of the explanatory variable is:

$$dif_{ij}^{r-m} = pvread_{ij} - pvmath_{ij} \quad (1)$$

where $j = 1, 2, \ldots, 10$,

$pv\_read_{i,j}$ is the j-th plausible value for the reading score of subject i;

$pv\_math_{i,j}$ is the j-th plausible value for the mathematics score of subject i;

dif_{ij}^{r-m} is the difference between the j-th plausible value in reading for subject i and the j-th plausible value in mathematics for the same subject i.

The second step was to prepare the explanatory variables listed in Table 2. For the gender variable, a value of 0 corresponded to boys, a value of 1 to girls. For the second control variable, ESCS, and for the indices of reading strategies and teaching practices, the scales provided by PISA were used, derived from IRT scaling (OECD, 2020). The indices for reading frequency were calculated as the total of the scores in the variables of reading frequency standardized for the OECD sample.

The third step was to evaluate the model according to DiD methodology. The statistical expression of the model was:

$$dif_{ij}^{r-m} = (\gamma - \beta) X_i + \delta T_i + \varepsilon_i^r - \varepsilon_i^m \quad (2)$$

where X_i is a matrix containing the model's control variables (gender and ESCS);

T_i is the matrix of treatment variables (reading strategies, teaching practices for reading, and reading frequency),

δ collects the effect of treatment about the difference in performance between reading and mathematics,

ε_i^r, ε_i^m are the error terms of each model.

The model was specified using the traditional Ordinary Least Squares (OLS) procedure. This involved calculating the parameters associated with the explanatory variables that reflect the mean effect of each variable on the dependent variable.

The model was specified separately for each sample from each of the 37 OECD countries. The mean of the OECD was also calculated, along with the total standard error. The OECD mean and its sample variance were calculated as follows:

$$\mu = \frac{\sum_{i=1}^{c} w_i \mu_i}{\sum_{i=1}^{c} w_i} \text{ and } \sigma_\mu^2 = \frac{\sum_{i=1}^{c} w_i^2 \sigma_{\mu i}^2}{\left[\sum_{i=1}^{c} w_i\right]^2} \quad (2)$$

Where w_i is the total of the final weights of the students for a given country.

Because of the complexity of the data structure and the PISA methodology, the statistics and final standard errors were calculated using the R package intsvy in a configuration designed for the PISA evaluation (Caro & Przemyslaw, 2017).

Results

Table 3 shows the estimations of the DiD model at the level of the OECD. It also indicates the probability associated with the effect of the explanatory variables on the dependent variable (difference between reading and mathematics).

The results in Table 3 indicate the strong impact on reading literacy of both mastery of strategies for summarizing texts and the enjoyment of reading. Students who read not only because they have to, who do not feel that reading is a waste of time, and who indicate reading as one of their preferred pastimes and a topic of conversation with others had scores in reading which, on average, were nine points higher than mathematics in the PISA scale. The aspect with the next-strongest impact on reading literacy was knowledge of effective summarizing strategies. Students with high scores in this scale had scores in reading that were five points higher than in mathematics. Another strategy associated with higher scores in reading, albeit to a lesser extent, was understanding and remembering. Reading frequency—particularly online reading which included reading news on the internet, searching for information online, and participating in online discussions and forums, as well as frequent reading of fiction, diagrams and maps, or digital texts with links, in class or as homework—was positively associated with reading performance.

The prevalent teaching practices in reading classes or classes aimed at stimulating students' reading did not seem to have a significant relationship with performance. Only the perception of teacher support in language lessons had a positive impact on reading results. Students who indicated that their teachers showed an interest in each student's learning, who provided extra help when students needed it, and who continued explaining things until the students understood exhibited higher scores in reading than in mathematics.

Table 3

Mean OECD Estimation of the Impact of Teaching Strategies and Reading Strategies on the Differences Between Results in Reading and Mathematics

		B	*Sig.*
Dimension	Explanatory variables		
Reading strategy	Enjoyment of reading	8.810	***
Reading strategy	Metacognition: summarizing	4.921	***
Reading frequency	Frequency of reading online	3.046	***
Reading strategy	Metacognition: understanding and remembering	1.763	***
Teaching practices	Teacher support in language lessons	1.594	***
Reading frequency	Frequency of reading for school	1.353	***
Teaching practices	Teacher-directed instruction	0.264	***
Reading frequency	Frequency of reading newspapers and news	0.098	***
Teaching practices	Perceived teacher interest	-0.115	***
Teaching practices	Teacher's stimulation of reading	-0.119	***
Teaching practices	Adaptation of instruction	-0.185	***
Reading frequency	Frequency of reading for pleasure	-0.688	***
	Control variables		
	Gender (girl)	26.783	***
	Social, economic, and cultural index (ESCS)	-3.007	***

Note. Significance: *** $p <$ .001 (The probability values were lower than .000 in all cases)

Among the control variables, gender was associated with a significant increase in reading performance compared to mathematics, of up to 27 points in girls. Students with higher ESCS levels tended to score, on average, three points higher in mathematics than in reading. Table 4 shows the estimations of the DiD model in each of the OECD countries.

As Table 4 shows, enjoying reading, knowing effective reading strategies of summarizing, understanding and memorization, and frequent reading of digital texts had a positive impact on the treatment variable in practically all of the OECD countries. In general, the effects of the different teaching practices were relatively heterogeneous, and varied considerably between countries. Teachers' stimulation of reading—where teachers encourage the students to express their opinions about a text, help students to relate what they read to their lives, or ask questions that encourage students to actively participate—were highly effective strategies in Greece, Denmark, and Lithuania, whereas in Japan, they were associated with lower scores in reading than in mathematics. Moreover, teacher support in language lessons was confirmed as a positive strategy in 27 countries, while adapting teaching to student needs was a positive strategy in eleven. An active teacher-led style also had an impact on performance, although it was positive in seventeen of the OECD countries and negative in fifteen.

Table 4

Estimation of the Impact of Teaching Practices and Learning Strategies on the Differences Between Reading and Mathematics Results in Each OECD Country

Countries	Joy/Like reading	Meta-cognition: summarising	Meta-cognition: understanding and remembering	Teacher support in test language lessons	Adaptation of instruction	Teacher-directed instruction
Australia	11,32 ***	6,14 ***	2,13 ***	2,49 ***	NS	-2,65 ***
Austria	7,83 ***	4,95 ***	0,84 ***	-0,50 ***	-0,48 ***	0,89 ***
Belgium	8,50 ***	5,16 ***	1,73 ***	2,99 ***	0,29 *	-2,38 ***
Canada	11,23	4,08	-0,49	ND	-0,01	ND
Chile	7,67 ***	7,42 ***	1,48 ***	0,86 ***	-0,58 ***	0,91 ***
Colombia	9,10 ***	4,39 ***	3,28 ***	5,62 ***	-3,68 ***	-0,18 **
Czech Republic	8,43 ***	4,50 ***	1,15 ***	-1,34 ***	1,62 ***	3,76 ***
Denmark	7,02 ***	4,43 ***	2,48 ***	NS	1,52 ***	-0,54 **
Estonia	8,82 ***	4,89 ***	2,66 ***	3,77 ***	NS	-2,66 ***
Finland	8,63 ***	6,15 ***	2,12 ***	3,45 ***	NS	-2,26 ***
France	10,21 ***	4,69 ***	3,13 ***	2,03 ***	-1,26 ***	1,70 ***
Germany	7,98 ***	6,60 ***	2,27 ***	3,20 ***	-2,21 ***	0,89 ***
Greece	7,88 ***	3,33 ***	5,06 ***	0,58 ***	-1,05 ***	NS
Hungary	9,05 ***	5,49 ***	1,52 ***	0,99 ***	-1,14 ***	1,23 ***
Iceland	8,73 ***	4,74 ***	3,01 ***	2,42 *	2,59 **	NS
Ireland	12,02 ***	4,22 ***	1,41 ***	-0,42 *	NS	NS
Israel	9,40 ***	7,99 ***	0,68 ***	1,41 ***	3,35 ***	-1,84 ***
Italy	10,37 ***	3,84 ***	1,60 ***	1,23 ***	-0,35 ***	1,66 ***
Japan	10,89 ***	6,13 ***	0,35 ***	1,60 ***	-0,59 ***	2,29 ***
Korea	7,18 ***	2,53 ***	NS	0,37 ***	NS	3,26 ***
Latvia	8,92 ***	6,73 ***	3,01 ***	NS	-0,86 *	1,82 ***
Lithuania	2,48 ***	4,34 ***	2,53 ***	-0,81 **	-3,69 ***	0,92 ***
Luxembourg	9,75 ***	4,93 ***	NS	NS	NS	NS
Mexico	7,62 ***	2,80 ***	2,24 ***	3,59 ***	-0,80 ***	-0,44 ***
Netherlands	9,03 ***	5,53 ***	2,95 ***	1,80 ***	1,28 ***	1,32 ***
New Zealand	12,06 ***	5,16 ***	1,25 ***	0,58 *	-0,93 ***	-2,34 ***
Norway	7,77 ***	6,63 ***	1,82 ***	0,82 ***	0,81 ***	-1,06 ***
Poland	10,63 ***	3,97 ***	1,52 ***	2,68 ***	0,64 ***	1,66 ***
Portugal	10,28 ***	4,48 ***	-0,37 **	2,33 ***	-0,74 ***	2,11 ***
Slovak Republic	7,49 ***	4,16 ***	1,32 ***	-1,27 ***	-2,60 ***	3,47 ***
Slovenia	8,78 ***	4,46 ***	0,72 *	2,01 ***	NS	2,07 ***
Spain	9,19 ***	4,28 ***	2,02 ***	3,92 ***	0,59 ***	-0,34 ***
Sweden	6,41 ***	5,50 ***	1,87 ***	3,05 ***	0,92 ***	-0,63 ***
Switzerland	10,39 ***	4,27 ***	1,66 ***	2,15 ***	NS	-1,13 ***
Turkey	7,75 ***	-0,21 ***	1,83 ***	1,34 ***	-1,43 ***	2,11 ***
United Kingdom	8,80 ***	6,46 ***	-1,09 ***	2,36 ***	2,29 ***	-0,75 ***
United States	8,82 ***	6,08 ***	2,93 ***	-0,24 ***	-0,99 ***	-2,56 ***

Table 4

Estimation of the Impact of Teaching Practices and Learning Strategies on the Differences Between Reading and Mathematics Results in Each OECD Country (Continuation)

Countries	Teacher's stimulation of reading engagement	Perceived teacher's interest	Frequency of reading for school	Frecuencia de lectura para el entretenimiento	Frequency of reading newspapers and news	Frequency of reading for pleasure
Australia	-2,14 ***	1,73 ***	0,67 ***	-0,94 ***	-2,93 ***	1,07 ***
Austria	0,92 ***	0,54 ***	2,53 ***	0,81 ***	0,99 ***	2,81 ***
Belgium	0,86 ***	-2,16 ***	0,60 ***	-1,22 ***	0,54 ***	2,63 ***
Canada	1,61	ND	3,00	-7,89 ***	-2,72 ***	4,13 ***
Chile	-0,59 ***	NS	4,18 ***	0,76 ***	-4,11 ***	1,77 ***
Colombia	-1,03 ***	1,55 ***	3,41 ***	-4,43 ***	1,70 ***	3,25 ***
Czech Republic	-0,75 ***	-2,74 ***	2,46 ***	-0,38 *	1,56 ***	4,46 ***
Denmark	2,28 ***	-1,20 ***	-0,72 ***	-3,41 ***	-2,48 ***	4,61 ***
Estonia	-1,10 **	NS	1,56 ***	-1,06 **	2,89 ***	5,17 ***
Finland	NS	-0,79 ***	0,93 ***	2,05 ***	1,34 ***	3,92 ***
France	-0,73 ***	-2,27 ***	0,30 ***	NS	-0,19 ***	3,53 ***
Germany	-1,17 ***	-0,90 ***	-0,69 ***	1,66 ***	1,03 ***	3,02 ***
Greece	5,60 ***	1,58 ***	2,67 ***	-4,13 ***	-1,19 ***	NS
Hungary	1,19 ***	0,52 ***	3,07 ***	-2,32 ***	1,10 ***	2,97 ***
Iceland	NS	-1,81 *	NS	2,33 **	NS	NS
Ireland	NS	1,80 ***	0,95 ***	-0,95 ***	-1,12 ***	2,13 ***
Israel	1,43 ***	-2,16 ***	-0,63 ***	-6,59 ***	3,18 ***	4,30 ***
Italy	1,48 ***	0,21 **	2,44 ***	-0,45 ***	NS	5,23 ***
Japan	-5,20 ***	1,81 ***	0,09 **	2,70 ***	1,43 ***	4,82 ***
Korea	-1,67 ***	-0,30 ***	2,20 ***	0,85 ***	-1,08 ***	3,10 ***
Latvia	1,87 ***	-2,11 ***	2,60 ***	NS	NS	2,89 ***
Lithuania	2,50 ***	1,01 ***	0,68 **	-0,98 ***	0,43 *	2,29 ***
Luxembourg	NS	NS	NS	NS	NS	1,50 **
Mexico	-0,92 ***	1,23 ***	1,97 ***	-1,98 ***	0,96 ***	1,69 ***
Netherlands	-2,51 ***	-2,02 ***	-2,78 ***	0,66 ***	1,06 ***	4,97 ***
New Zealand	NS	2,41 ***	1,23 ***	-2,63 ***	-0,79 ***	2,32 ***
Norway	NS	2,69 ***	1,74 ***	NS	NS	2,93 ***
Poland	1,56 ***	-1,20 ***	2,10 ***	0,38 ***	1,84 ***	7,36 ***
Portugal	1,49 ***	-3,38 ***	2,98 ***	0,91 ***	0,98 ***	4,74 ***
Slovak Republic	0,71 **	-1,26 ***	NS	NS	2,27 ***	5,02 ***
Slovenia	-2,66 ***	NS	1,98 ***	-5,86 ***	NS	2,43 ***
Spain	-2,36 ***	0,28 ***	-0,90 ***	-0,29 ***	-1,38 ***	3,88 ***
Sweden	-1,01 ***	-0,85 ***	2,50 ***	NS	0,54 ***	2,56 ***
Switzerland	-3,03 ***	3,77 ***	3,72 ***	3,44 ***	-0,55 ***	2,29 ***
Turkey	NS	-1,81 ***	0,94 ***	NS	-0,31 ***	3,18 ***
United Kingdom	0,93 ***	-0,30 ***	2,49 ***	-0,20 **	-0,49 ***	0,83 ***
United States	-0,63 ***	2,62 ***	-0,12 ***	-2,32 ***	-3,54 ***	NS

Note. The grey bars are the estimates of positive impact, the white bars are estimates of negative impact.
Significance: *** $p < .01$, ** $p < .05$, * $p < 0.1$; NS Not significant; ND Not available.

Discussion

The objective of our study was to evaluate the impact of various factors, such as teaching practices and knowledge of effective reading strategies, on the reading literacy assessed in the OECD countries in the 2018 PISA study.

The results show that the most effective factor in reading literacy in all of the OECD countries was enjoyment of reading. Students who often read voluntarily and for interest scored a mean of nine more points in reading than in mathematics, even after controlling for the effect of student gender and socio-economic background. These results are in line with the findings from Cheema (2018) and Clark and Rumbold (2006), who showed that reading for pleasure also improved reading comprehension and grammar, encouraged positive attitudes towards reading and pleasure in reading as adults, and improved general knowledge.

Another aspect that had one of the strongest relationships with reading literacy was students' knowledge of effective summarizing strategies for texts. The strong impact of reading strategies on reading competence had been demonstrated in PISA 2009, the previous edition of the study where reading was examined in greater detail (OECD, 2010a; OECD, 2010b). Students who were effective readers prioritized the following summarizing strategies: reading the whole text, underlining the most important sentences, writing

them out later in their own words, or checking carefully whether the most important parts of the text are covered by the summary, at the same time as ruling out copying all the possible sentences. Metacognition with regard to deploying effective strategies for understanding and remembering were also positively related to reading performance, albeit to a lesser extent. These strategies prioritize debate about the content of texts with other people and are less about strategies such as reading the text twice very quickly or aloud, or focusing on the parts of the text that are easy to understand. There is a solid base of scientific evidence showing that direct teaching of effective reading strategies contributes to increased student reading abilities (Pressley, 2000; Rosenshine & Meister, 1996; Waters & Schneider, 2009), which is why teachers must work on reading strategies throughout students' schooling.

In most educational systems, and despite its importance in developing other competencies, reading is not taught as an independent subject to 15-year-old students in the same way as mathematics or science (OECD, 2019b), which is why the limited role of the teacher in promoting adolescents' reading literacy is clear. In most cases, reading habits hare already shaped by the family context or previous schooling (García-Crespo et al., 2019; García-Crespo et al., 2019; García-Crespo et al., 2022; Levy, 2018). Nonetheless, guidelines for effective reading may be given explicitly or incidentally in language lessons or in other subjects (OECD, 2019a).

The frequency of online reading—such as emails, online news, or internet searches—is another factor that was related to better reading performance than mathematics in PISA 2018. This result confirms previous findings that practices related to searching for information online explained a significant, albeit small, part of the variance in digital reading skills (Naumann, 2015; OECD, 2010a). The frequency of reading in class or as part of homework was also related to better reading results, although to a lesser extent.

In terms of the teaching practices we evaluated, students whose teachers showed an interest in each student´s learning, who provided extra help when students needed it, and who continued with explanations until students understood the topic scored a mean of 1.6 points more in reading than in mathematics. Previous research has also shown that support activities and strategies that the teacher provides for the student to construct knowledge and acquire autonomy and self-concept improve students' performance in reading, increase awareness of reading strategies, and encourage student participation in reading activities (Guthrie et al., 2012; Guthrie et al., 2013). Other strategies we analyzed in this study, such as teacher-led instruction, teachers' enthusiasm, teachers stimulating reading, and adapted teaching did not demonstrate a significant impact on promoting reading at the OECD level. However, these practices were effective in some countries. These included Greece, Denmark, and Lithuania, where students whose teachers encouraged their students to express opinions about texts, helped students to relate the stories they read to their own lives, or asked questions that encouraged students to actively participate, performed significantly better in reading than in mathematics.

The OECD identifies various aspects related to common teaching policies for high-performing countries. These include a varied, tailored offering of opportunities for continuing professional development and teacher assessment mechanisms with a strong focus on the design of individualized educational trajectories (OECD, 2018). Teaching effective reading strategies, as well as techniques and practices that encourage reading enjoyment should be included in teachers' continuing training because of their importance and high impact.

In addition, programs promoting early starts with reading in the first few years of schooling, along with activities that promote family involvement in reading together are the foundation for creating sound reading habits and enhancing enjoyment of reading (Levy, 2018), allowing the education of a generation of active, competent readers.

The limitations of the present study are mainly related to the characteristics of the data collection in the PISA study. The fact that the results of the study indicate that the teaching practices we evaluated do not exhibit consistent effects between countries may be due to the type of evaluation. The PISA data is collected via self-report questionnaires, where the student response is according to a specific school and the teachers responses are according to a specific subject, without their being a subsequent link between the responses and, for example, teaching characteristics or styles, and without considering past learning experiences which would have no doubt had an impact on student reading performance. These limitations highlight the need to improve the design of studies aimed at identifying factors associated with performance.

Despite these limitations, and largely due to the data collection process, the international nature of the PISA study gives researchers a singular opportunity to identify universal mechanisms capable of improving educational quality, creating a sound base of scientific evidence that is indispensable for producing educational policies that are based on the principles of efficacy, efficiency, and equity.

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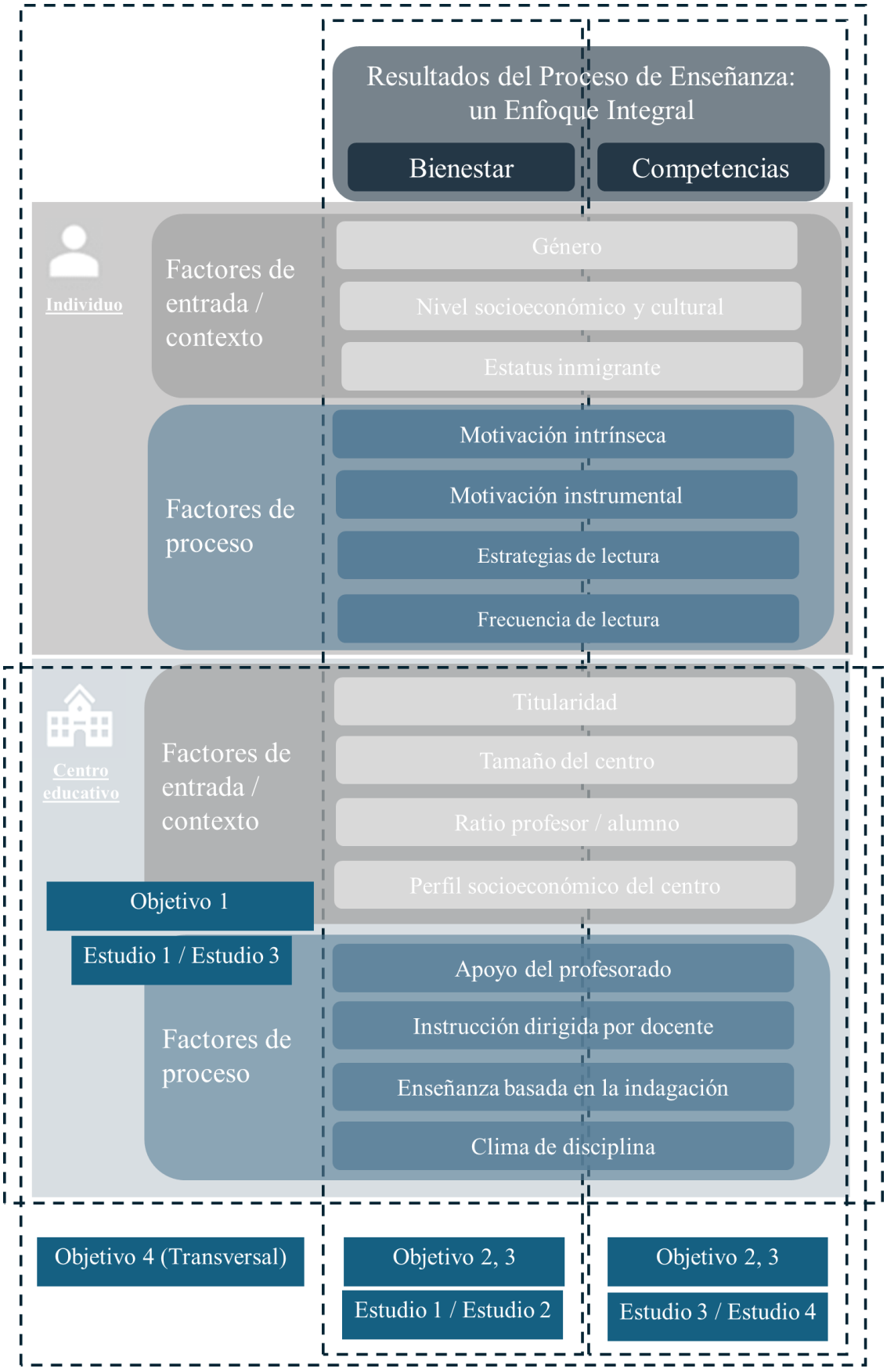
5. Discusión

El objetivo principal de esta tesis doctoral era identificar aquellos factores que influyen en los resultados educativos de los estudiantes de una institución educativa, específicamente aquellos sobre los que el centro puede actuar para mejorar su eficacia. Con este propósito, se ha diseñado un modelo que identifica la influencia de un conjunto de factores sobre los resultados educativos, considerados desde una perspectiva holística que integra tanto el rendimiento académico como el bienestar del alumnado. Los resultados del análisis basado en el modelo propuesto pretenden proporcionar a las instituciones educativas herramientas prácticas, ofreciendo recomendaciones sobre métodos de enseñanza y aprendizaje que optimizan los resultados educativos de los estudiantes.

A modo de resumen, en la Figura 3 se presenta el modelo de análisis de factores asociados a los resultados del proceso de enseñanza y su vinculación a los objetivos y los estudios de la tesis doctoral. Se identifican los factores que mayor relación han demostrado tener con los resultados del proceso de enseñanza. Estos factores se agrupan siguiendo la categorización basada en la taxonomía del enfoque sistémico, entrada/contexto-proceso (Jornet et al., 2012; Murillo et al., 2007), combinada con la clasificación según el nivel al que pertenece, alumnado/centro educativo (Gamazo et al., 2017).

A continuación, se discuten los resultados de la investigación llevada a cabo siguiendo una estructura que permite abordar de manera exhaustiva los objetivos planteados en la investigación. En primer lugar, se discutirá el efecto del centro educativo en el aumento de los resultados educativos, considerando tanto el rendimiento académico como el bienestar del alumnado (Objetivo 1). Después, se discutirá la influencia de diversos factores asociados a estos resultados educativos, identificando y evaluando aquellos que tienen un mayor impacto (Objetivo 2). Seguidamente, se presentarán recomendaciones específicas dirigidas a los centros educativos generadas en base a los resultados anteriores y orientadas a incidir en la mejora escolar y en la optimización de los procesos de enseñanza y aprendizaje (Objetivo 3). Finalmente, se discutirán propuestas metodológicas innovadoras que faciliten tanto la definición como la estimación del modelo de factores asociados a los resultados educativos de una institución, proporcionando una base sólida para futuras investigaciones y prácticas educativas (Objetivo 4).

Figura 3. Relación Entre los Objetivos y los Estudios de la Tesis Doctoral



En los siglos XX-XXI, la educación se ha consolidado como un pilar fundamental en el desarrollo de la sociedad (UNESCO, 2005; World Bank, 2017). El centro educativo ha evolucionado de ser un mero transmisor del conocimiento basado en contenidos teóricos a convertirse en un espacio donde se fomenta el desarrollo de una variedad de estrategias de aprendizaje para el futuro, por ejemplo, la creatividad, el pensamiento crítico, la comunicación o la resolución de problemas (OECD, 2008b). A la vez, el propósito de un centro educativo en la sociedad moderna también consiste en ayudar a los niños a construir confianza en sí mismos en un ambiente de calidad, de seguridad y de bienestar, no solo cultivando la preparación académica, sino también la cognitiva y emocional, para que puedan enfrentar con éxito los desafíos de un futuro lleno de retos, y también de oportunidades. En definitiva, más allá de la necesaria adquisición de conocimientos, se busca desarrollar habilidades que preparen a los estudiantes para enfrentar los desafíos del mundo moderno, forjando su carácter e identidad en la sociedad (Darling-Hammond et al., 2020). En este sentido, el rol del educador ya no se limita únicamente a impartir lecciones o clases magistrales, sino que también implica guiar a los estudiantes en el descubrimiento de sus propias habilidades y fortalezas, incentivando así su autoestima y bienestar (Hattie, 2008).

Los datos recopilados a través de evaluaciones internacionales como, por ejemplo, la evaluación a gran escala más importante a nivel internacional, PISA, pueden proporcionar a los centros educativos una comprensión más profunda de las habilidades y competencias que los estudiantes necesitan para tener éxito en el siglo XXI, traspasando fronteras y horizontes temporales. Por un lado, las evaluaciones internacionales desarrollan marcos teóricos innovadores que permiten definir el objetivo final del proceso educativo: el desarrollo integral del estudiante. Dichos marcos se adaptan a la cambiante demanda de la sociedad moderna, actualizando los conceptos históricamente reconocidos, por ejemplo, introduciendo el pensamiento computacional como parte de la competencia matemática o la lectura digital como parte de la competencia lectora en PISA 2022 y desarrollando conceptos novedosos como la resolución de problemas en colaboración en PISA 2015, la competencia global en PISA 2018 o el aprendizaje en el mundo digital en PISA 2025 (OECD, 2016a, 2019a, 2023b). Por otro lado, las evaluaciones internacionales desarrollan instrumentos de evaluación basados en altos estándares técnicos y psicométricos que garantizan la replicabilidad y la comparabilidad de los resultados a nivel mundial (Okubo, 2024), elaborando escalas y constructos innovadores que pretender medir no solo el grado de adquisición de competencias básicas, sino también un amplio espectro de áreas y constructos no cognitivos (por ejemplo, el bienestar y las competencias socioemocionales; Borgonovi y Pál, 2016). Por último, los datos recopilados en las evaluaciones internacionales son una valiosa fuente de información que puede proporcionar múltiples evidencias empíricas no solo a los gobiernos o a las administraciones educativas, sino también a los educadores de los centros educativos (OECD, 2015). Al tener acceso a esta

información objetiva y comparativa sobre el rendimiento y el bienestar de los estudiantes, los educadores pueden identificar áreas de fortaleza y áreas de mejora en su práctica pedagógica. Esto les permite tomar decisiones informadas sobre cómo adaptar sus métodos de enseñanza para satisfacer las necesidades individuales de los estudiantes y mejorar continuamente la calidad de la educación que ofrecen.

A continuación, se presenta la discusión de los resultados siguiendo el orden de los objetivos planteados:

5.1. Efecto de la Escuela en los Resultados de Procesos de Enseñanza

Antes de analizar qué factores determinan los resultados de procesos de enseñanza, se ha pretendido investigar en qué medida un centro educativo tiene el poder de influir en el desarrollo integral de sus estudiantes, no solo en términos de conocimiento académico, sino también en la construcción de habilidades socioemocionales y en la formación de una identidad personal sólida. El primer objetivo del presente trabajo consistía, por tanto, en explorar y comparar el efecto del centro educativo en el aumento del rendimiento educativo y del bienestar del alumnado. Para cada una de las variables definidas como producto del proceso educativo se han estimado los efectos brutos y netos de la escuela. El efecto bruto se extrajo a partir del modelo multinivel bruto, sin variables predictoras. En la distribución de la cantidad total de varianza de los resultados de los procesos educativos entre los estudiantes y las escuelas, el tamaño del efecto de centro educativo sobre la variable dependiente correspondía al porcentaje de la varianza atribuible a la escuela. El efecto ajustado, por su parte, se extrajo a partir del modelo multinivel ajustado, un modelo enriquecido con variables de contexto/entrada a nivel de estudiante y de escuela: variables que están fuera del control de las escuelas y no pueden modificarse fácilmente. Por último, el efecto neto se calculó a partir del modelo multinivel completo, en el que se incluyó todo el conjunto de variables de proceso, tanto a nivel de estudiantes como de escuelas: variables que se encuentran al alcance del centro educativo, como el clima escolar o la metodología docente. Este modelo permitió estimar los efectos fijos de las variables de proceso sobre la variable dependiente. Los modelos descritos fueron confeccionados para ambos constructos definidos en este trabajo como resultados del proceso educativo (producto): el bienestar estudiantil y el rendimiento medido a través del grado de adquisición de competencias clave.

A nivel de la OCDE, en el modelo nulo se observa que el 61% de la varianza en el grado de adquisición de competencias clave se encuentra a nivel de los estudiantes. Cuando el modelo se ajusta con factores contextuales, la varianza a nivel de los estudiantes aumenta hasta el 77%. En el modelo completo, donde se introdujeron las variables del proceso, los efectos de la

escuela adquirieron mayor importancia, alcanzando el 27% de varianza en los resultados cognitivos. Los países con los mayores efectos escolares en los tres modelos fueron Países Bajos y Hungría. Los países donde la variación en el rendimiento se concentraba principalmente a nivel de los estudiantes fueron Islandia, Noruega y Finlandia. Estos datos son consistentes con las conclusiones de la OCDE, que dicen que el 28% de la varianza es atribuible a las diferencias en el rendimiento de los centros educativos (OECD, 2016b). Estos resultados refuerzan la idea de que la identificación de los factores escolares asociados con el rendimiento de los estudiantes es un aspecto clave en la investigación educativa en busca de la efectividad escolar (Creemers & Kyriakides, 2015; Rutter & Maughan, 2002), ya que la detección de estos factores haría posible aumentar el rendimiento de los estudiantes al menos en un 30% en promedio, mejorando los mecanismos de intervención de un centro educativo, o bien aumentar el papel de la escuela a través de la introducción de prácticas y métodos de enseñanza más eficaces.

Considerando la influencia de la escuela en el fomento del bienestar estudiantil, la magnitud de efecto de la escuela se reduce considerablemente. Mientras que en el modelo nulo la variación total de resultados cognitivos atribuible a la escuela en los países de la OCDE fue del 39%, el impacto de la escuela apenas alcanzó el 9% para los componentes del bienestar, lo que indica que el papel del centro educativo resulta ser mucho menos importante en la promoción del bienestar de los estudiantes (Govorova et al., 2020a). En el modelo ajustado, que incorpora las variables de proceso/entrada, no se observaron diferencias significativas en cuanto a los efectos de la escuela, permaneciendo el porcentaje de varianza de los componentes del bienestar en los mismos niveles que en el modelo bruto. En el modelo completo enriquecido con las variables de proceso, los efectos de la escuela explican apenas un 5% de la variación en la percepción del bienestar dentro de las escuelas. Estos resultados son consistentes con estudios previos (Lazarides & Buchholz, 2019; Murillo & Hernández, 2011) proporcionando evidencia adicional tanto para todos los países de la OCDE en su conjunto, como a nivel individual. Los resultados de esta tesis doctoral apuntan a que la influencia de la escuela en el bienestar estudiantil no es homogénea entre los países miembros de la OCDE (Govorova et al., 2020a). Así, Italia y Suiza parecen tener más éxito en el fomento del bienestar con las intervenciones a nivel escolar, mientras que otros, como Polonia e Islandia, tienen una influencia a nivel escolar muy limitada. Pueden existir múltiples razones que expliquen este bajo impacto en el bienestar a nivel escolar, por ejemplo, la falta de educación socioemocional en el centro educativo, la baja disponibilidad de herramientas y políticas para la mejora del bienestar o el poco tiempo que se dedica al logro de resultados no cognitivos (Murillo & Hernández, 2011).

La principal contribución de los resultados de este análisis es que ponen de manifiesto la necesidad de que las escuelas reconozcan y valoren la importancia del bienestar emocional y social de los estudiantes en el proceso educativo y que tomen acciones para tener un papel más activo en su fomento, ya que la atención exclusiva a los aspectos académicos del aprendizaje ha

dejado de ser suficiente para preparar a los estudiantes para enfrentar los desafíos del mundo moderno. Es probable que este enfoque también les permita aumentar su potencial en el fomento de las competencias tradicionales, donde tienen una influencia mayor que en el fomento del bienestar, aunque esta influencia tampoco es decisiva.

Para lograr este objetivo, sería necesario implementar estrategias y programas específicos que integren el desarrollo socioemocional en el currículo escolar. Esto puede incluir la enseñanza de habilidades como la inteligencia emocional, la empatía, la resolución de conflictos y la autoestima, tanto de manera explícita como integrada en otras materias. Además, es crucial crear un ambiente escolar seguro y de apoyo donde los estudiantes se sientan valorados y escuchados, lo que fomentará su bienestar emocional y su motivación intrínseca (Govorova et al., 2020b, 2020a). De hecho, cada vez es más común introducir prácticas escolares dirigidas a la promoción del bienestar cognitivo, social y emocional, así como a la reducción del estrés (Jennings et al., 2013; Schonert-Reichl et al., 2015). Los hallazgos proporcionan evidencia que respalda la idea de que la implementación de tales métodos mejora los déficits de atención, reduce el estrés y promueve la autorregulación entre los jóvenes (Albrecht et al., 2012; Carboni et al., 2013).

5.2. Factores Asociados a los Resultados Educativos

El segundo objetivo de este trabajo fue investigar los factores relacionados con los estudiantes o los centros educativos que afectan a los resultados educativos de los estudiantes, con el fin de identificar aquellos factores más influyentes sobre los que un centro educativo puede actuar, bien para aumentar el rendimiento de sus estudiantes o bien para contrarrestar el efecto de variables contextuales, promoviendo de esta forma la equidad educativa. En esta tesis doctoral, los resultados de todos los países de la OCDE mostraron que hay factores que influyen sistemáticamente en el desempeño estudiantil y en su bienestar tanto a nivel de la OCDE como a nivel de cada país individual. Las variables de investigación fueron clasificadas en factores de contexto/entrada y en factores de proceso, con un foco especial en los factores de proceso por ser los que están bajo el control directo de los centros educativos (Jornet et al., 2012; Murillo et al., 2007).

La motivación intrínseca, la motivación para realizar una actividad debido al placer obtenido de esa actividad, ha demostrado ser la variable de proceso que mayor impacto tiene en los resultados cognitivos del estudiante. En este trabajo se ha medido la motivación intrínseca a través de las variables *disfrute de las ciencias* en el Estudio 3 y *gusto por la lectura* en el Estudio 4. Los estudiantes que se divierten y están contentos aprendiendo temas científicos, se interesan por aprender materias relacionadas con las ciencias y disfrutan leyendo sobre las ciencias, alcanzaron de media hasta 30 puntos más en la escala de ciencias en PISA 2015.

Adicionalmente, los estudiantes que leen frecuentemente de forma voluntaria y por interés, considerando la lectura su pasatiempo preferido, y que disfrutan hablando sobre libros con otras personas, obtuvieron un promedio de nueve puntos más en lectura que en matemáticas en PISA 2018, incluso después de controlar el efecto del género del estudiante y el estatus socioeconómico (Govorova et al., 2023). Estos resultados están en línea con los hallazgos de numerosas investigaciones (Cheema, 2018; Clark & Rumbold, 2006; García Crespo, 2022; Harackiewicz et al., 2000; Vaknin-Nusbaum et al., 2018; Wigfield & Cambria, 2010), que confirman el fuerte impacto del interés y el placer por aprender en los resultados cognitivos.

El clima disciplinario es la segunda variable de proceso que influye en el rendimiento en ciencias. Su efecto positivo se observó en el 79% de los países analizados con un aumento en las puntuaciones en ocho puntos de media en la escala de PISA. El papel del profesor es un factor determinante en la creación de un entorno de aula adecuado, libre de ruido y desorden, donde los estudiantes pueden concentrarse en un aprendizaje productivo (Donné et al., 2016). Según los datos de la OCDE, la enseñanza efectiva, los altos niveles de bienestar docente y las percepciones de autoeficacia solo son posibles cuando el clima disciplinario en el aula es positivo (Gomendio, 2017). Los directores de centros educativos también pueden desempeñar un rol activo en la promoción de políticas disciplinarias constructivas, mientras que la administración educativa puede contribuir a la mejora del clima escolar incluyendo la formación en métodos de gestión del ambiente del aula en la formación continua del profesorado (Brown & Zhang, 2017; Mitchell et al., 2017).

En el estudio basado en el análisis de redes de los elementos de bienestar y de factores asociados a los mismos, se pudo observar de forma gráfica que el estilo de enseñanza no parecía impactar directamente en el bienestar de los estudiantes. No obstante, se observó una conexión entre el estilo docente y el clima de disciplina (Govorova et al., 2020b). El clima de disciplina positivo demostró a su vez tener un papel moderador en la percepción de una menor competitividad y una mayor cooperación entre pares, reportadas por los estudiantes, resultando en una disminución de la probabilidad de acoso escolar. Estos resultados son consistentes con las conclusiones de otros estudios empíricos que apuntan a la importancia del clima escolar para reducir el riesgo de acoso escolar (Bradshaw et al., 2015; Cornell & Cole, 2012; Hawley & Williford, 2015).

Otra de las evidencias de la investigación de esta tesis doctoral, en línea con hallazgos previos de la OCDE sobre prácticas educativas (OECD, 2019b), es que las prácticas de lectura de los individuos, así como el conocimiento sobre la eficacia de las estrategias de lectura, desempeñan un papel prominente en ella. Los estudiantes que saben bien qué estrategias utilizar, por ejemplo, para resumir un texto o comprender su significado, tienden a ser más competentes en lectura (OECD, 2019a). En el Estudio 4 de esta tesis doctoral se muestra que, en PISA 2018,

los estudiantes ubicados en lo alto de la escala de la variable *Metacognición: resumir* obtienen de media cinco puntos más en lectura que matemáticas (Govorova et al., 2023). Otra estrategia asociada a los resultados más altos en lectura, aunque en menor magnitud, es la comprensión y la memorización. La frecuencia de lectura, especialmente la lectura en línea que incluye la lectura de noticias en internet, la búsqueda de información en internet y la participación en discusiones y foros *online*, así como la lectura frecuente de ficción, diagramas y mapas o de textos digitales con enlaces, tanto en clase o como en casa, también se asocia positivamente con el rendimiento en lectura. Estas variables merecen una atención especial en el estudio de factores asociados no solo porque son predictores potenciales de la competencia en lectura, sino también porque son factores controlables, susceptibles de cambio. Por ejemplo, existe una fuerte evidencia de que el compromiso en la lectura y el conocimiento de las estrategias eficaces pueden ser mejorados a través de la enseñanza y prácticas de apoyo en el aula (Brozo, 2017; Guthrie et al., 2013; Reeve, 2012).

El análisis conjunto de los datos de los países de la OCDE participantes en PISA 2015 pone de manifiesto que las estrategias de enseñanza tradicionales, donde el profesor desempeña un papel central en el aula proporcionando una instrucción directa, correlaciona positivamente con un rendimiento en ciencias tanto en la muestra total de la OCDE como en 16 países analizados de manera individual. El estudio de los factores asociados al bienestar del alumnado en PISA 2015 también proporciona evidencias de que los profesores que emplean la metodología tradicional de instrucción centrada en la enseñanza dirigida por el docente consiguen mejorar los indicadores de bienestar (Govorova et al., 2020a). Un enfoque de enseñanza tradicional, donde el profesor lidera las discusiones en clase y explica las ideas, se asocia con mayores niveles de motivación intrínseca (en concreto, *disfrute de las ciencias*) y una mejor predisposición hacia el trabajo cooperativo.

Por otro lado, las prácticas de enseñanza y aprendizaje de ciencias basadas en la investigación mostraron una asociación negativa con el rendimiento en ciencias en toda la OCDE y en 12 países miembros. Resulta sorprendente que un enfoque más innovador en la enseñanza, que busca involucrar a los estudiantes en la experimentación y promover debates sobre investigaciones, no parezca tener un impacto positivo en el rendimiento académico (Gil Izquierdo et al., 2018). Estos resultados sugieren la necesidad de una implementación más eficiente de las metodologías basadas en la investigación (Hmelo-Silver, 2004). Las actividades deben ser cuidadosamente diseñadas, estructuradas y fundamentadas en un sólido marco teórico. Además, los profesores deberían recibir una formación específica para desarrollar estas actividades de manera efectiva y maximizar su impacto en el aprendizaje de los estudiantes (Bell et al., 2005; Kidman & Casinader, 2017; Windschitl et al., 2008).

En contraste con los resultados anteriores, las prácticas docentes más innovadoras, basadas en la indagación y el trabajo en equipo, parecen ser herramientas poderosas para mejorar el bienestar del alumnado (Govorova et al., 2020a), ya que la promoción de la discusión entre pares aumenta la motivación intrínseca de los estudiantes para aprender ciencias (Hattie, 2008; Jocz et al., 2014; Logan & Skamp, 2013). Otras investigaciones también demostraron que el disfrute del aprendizaje de las ciencias está asociado con una mayor frecuencia de prácticas de enseñanza que implican interacciones (por ejemplo, se les da a los estudiantes oportunidades para explicar sus ideas), actividades prácticas (por ejemplo, se requiere que los estudiantes diseñen un experimento para investigar una pregunta científica en el laboratorio) y aplicaciones de las ciencias (por ejemplo, el profesor utiliza la ciencia para ayudar a los estudiantes a entender el mundo fuera de la escuela) (Bennett et al., 2013). Adicionalmente, los resultados de esta tesis apuntan que las prácticas de enseñanza y aprendizaje que incluyen experimentación y fomento del pensamiento crítico aumentan la autoeficacia de los estudiantes en ciencias y reducen la ansiedad ante los exámenes. Estas evidencias son especialmente importantes dado que los métodos de enseñanza orientados al estudiante parecen estar negativamente relacionados con el rendimiento académico, tal y como se describía con anterioridad (Gil Izquierdo et al., 2018). Estos resultados respaldan la idea de la importancia de una pedagogía adaptativa que combine la innovación y la instrucción dirigida por el profesor, en lugar de que los profesores opten exclusivamente por uno de estos enfoques (Donné et al., 2016; OECD, 2008a; Rowe, 2007).

El apoyo del profesor demostró estar negativamente relacionado con el rendimiento de los estudiantes a nivel de la OCDE; sin embargo, a nivel de país, esta tendencia se mantuvo solo en cuatro países. En dos de ellos, el efecto del apoyo del profesor fue positivo y en 18 países no se observó ninguna relación. Aunque el apoyo del profesor a los alumnos se relaciona de manera débil, e incluso negativa, con el rendimiento académico, este factor resultó ser el predictor más fuerte del bienestar estudiantil. Cuando el docente trabaja para asegurar la comprensión completa de los problemas por parte de los estudiantes, ayuda a los alumnos en su aprendizaje, proporcionando ayuda adicional cuando es necesario, y muestra interés por el aprendizaje de cada alumno, los estudiantes informan de un mayor bienestar subjetivo (Govorova et al., 2020a). Investigaciones previas también han demostrado que el apoyo percibido por los estudiantes por parte de los docentes está negativamente relacionado con la ansiedad y el aburrimiento de los estudiantes a nivel individual (Ahmed et al., 2014). Otros autores destacan una relación positiva entre el apoyo del profesor y la motivación intrínseca, así como una relación negativa con la ansiedad a nivel de la clase (Lazarides & Buchholz, 2019).

El resto de las variables a nivel escolar tuvieron un escaso efecto en el rendimiento o sus efectos fueron principalmente bajos. Es notable que las características escolares, como el tamaño de la escuela o de la clase, la escasez de recursos o la autonomía escolar, no parecen

definir el rendimiento de los estudiantes cuando se tienen en cuenta el resto de las variables del proceso.

Entre los factores de contexto/entrada, las características sociodemográficas de los estudiantes como el género, el nivel social, económico y cultural o el estatus de inmigrante desempeñan un papel determinante en el rendimiento de los estudiantes. Los resultados del efecto escolar, descritos anteriormente, ya respaldaban esta afirmación con un alto porcentaje de varianza en el rendimiento concentrado a nivel de estudiante. En ciencias, a nivel del conjunto de los países de la OCDE los chicos obtienen nueve puntos más y los estudiantes aventajados 17 puntos más, mientras que los estudiantes de origen inmigrante obtienen 22 puntos menos en la escala de PISA 2015. En lectura, el género se asocia con un aumento significativo en el rendimiento en lectura en comparación con matemáticas, con una diferencia de hasta 27 puntos a favor de las chicas en PISA 2018. Los estudiantes con niveles más altos de ESCS tienden a obtener, en promedio, tres puntos más en matemáticas que en lectura. Aunque las variables contextuales se utilizan principalmente como variables de control para refinar los efectos escolares en los modelos de factos asociados al rendimiento (O'Connell & McCoach, 2008), las autoridades educativas pueden implementar políticas educativas para promover la equidad en la educación y, en consecuencia, reducir la influencia de los factores contextuales aumentando la efectividad escolar.

Se han identificado múltiples estrategias que pueden minimizar la desigualdad: intervenciones para apoyar a estudiantes y escuelas de bajos recursos socioeconómicos (por ejemplo, programas de apoyo escolar, financiación preferencial, evitar la agrupación de estudiantes desfavorecidos, etc.); estrategias dirigidas a estudiantes de origen inmigrante (por ejemplo, programas de integración, adaptación del currículo, mejora de habilidades profesionales, evitar la agrupación de estudiantes inmigrantes, etc.); promoción de la equidad de género en la educación (reducción de estereotipos en la percepción de los estudiantes sobre sus habilidades y expectativas profesionales a través de orientación profesional objetiva tanto para padres como para estudiantes, promoción de una imagen inclusiva de la ciencia, etc.) (Darling-Hammond & Post, 2000; Gomendio, 2017; Moll et al., 1992; Oakes, 2018; UNESCO, 2016a).

5.3. Recomendaciones Dirigidas a los Centros Educativos Sobre cómo Incidir en la Mejora Escolar

Como resultado del análisis de los factores que afectan al rendimiento y al bienestar de los estudiantes, en esta tesis doctoral se han identificado determinados aspectos sobre los que los centros educativos podrían actuar para incrementar su eficacia en el fomento de los resultados escolares. A partir del análisis contrastado de las evidencias, se han elaborado una serie de recomendaciones dirigidas a los docentes.

A continuación, se explican las recomendaciones extraídas de la investigación de esta tesis doctoral:

Recomendación 1: Incrementar la Motivación Intrínseca

La motivación intrínseca, como el interés por las ciencias y la lectura, ha demostrado estar fuertemente relacionada con el grado de adquisición de competencias del alumnado en todos los países de la OCDE. Además, se ha observado que el efecto del centro educativo en esta variable es relativamente alto en comparación con otras variables de la dimensión del bienestar cognitivo, lo que indica que los centros educativos tienen un margen significativo de acción para potenciar esta motivación (Govorova et al., 2020a).

Para aumentar la motivación intrínseca de los estudiantes, es fundamental que los centros educativos fomenten un entorno de aprendizaje que promueva la autonomía, la competencia y la relación social (Ryan & Deci, 2000). Las actividades que permiten a los alumnos tomar decisiones sobre su aprendizaje y establecer metas personales son especialmente efectivas. Es recomendable que los profesores ofrezcan opciones y oportunidades para que los estudiantes elijan proyectos y tareas que se alineen con sus intereses personales (Reeve, 2009).

Otra estrategia clave es proporcionar retroalimentación constructiva que se centre en el proceso de aprendizaje en lugar de focalizarse únicamente en los resultados finales (Hattie & Timperley, 2007; Wisniewski et al., 2020). La retroalimentación debe destacar los esfuerzos y estrategias empleadas por los estudiantes, ayudándoles a desarrollar una mentalidad de crecimiento que valore la mejora continua y el esfuerzo (Dweck, 2006).

Recomendación 2: Mejorar el Clima de Disciplina

El establecimiento de un clima de disciplina positivo es esencial para crear un ambiente propicio para el aprendizaje. Este factor ha demostrado estar positivamente relacionado tanto con el rendimiento, como con el bienestar (Govorova et al., 2020b). Los estudiantes parecen demandar espacios de aprendizaje libres de ruido y desorden, donde todos prestan atención al docente y pueden trabajar a gusto. El alumnado espera que el docente tenga control sobre lo que ocurre en el aula y en el centro educativo, lo cual podría explicar por qué un mejor clima de disciplina está relacionado con una menor frecuencia de prácticas de acoso.

Los profesores deben establecer expectativas claras y coherentes, así como consecuencias predecibles para el comportamiento, lo cual ayuda a los estudiantes a comprender y cumplir con las normas. Se recomienda que los centros educativos implementen prácticas de gestión del aula basadas en el respeto mutuo y la coherencia (Marzano et al., 2003).

La disciplina restaurativa es otra práctica recomendada, ya que se centra en reparar el daño y restaurar las relaciones en lugar de simplemente castigar (Anyon et al., 2016; Payne & Welch, 2015). Este enfoque promueve una cultura de responsabilidad y respeto, y puede ser particularmente efectivo para reducir los conflictos y mejorar la cohesión del grupo.

Recomendación 3: Combinar la Enseñanza Basada en Metodología Tradicional con la Enseñanza Basada en Indagación y Trabajo en Equipo

Los resultados de esta tesis doctoral destacan la importancia de combinar técnicas de enseñanza y aprendizaje tradicionales con metodologías innovadoras, en lugar de optar exclusivamente por un estilo de enseñanza. Por un lado, la enseñanza tradicional, en la que el profesor ocupa un rol central, está asociada con un mayor rendimiento competencial. Por otro lado, la enseñanza basada en la indagación y el trabajo en equipo se relaciona positivamente con el bienestar de los estudiantes, especialmente en lo que respecta a su motivación intrínseca (Govorova et al., 2023).

Se recomienda, por tanto, que los profesores estructuren las lecciones de manera que incluyan explicaciones claras, ejemplos concretos y oportunidades para la práctica guiada y la práctica de trabajo autónomo (Rosenshine, 2012). Para mejorar la enseñanza basada en la indagación y el trabajo en equipo, es importante que los centros educativos capaciten a los profesores en el uso de estas metodologías activas (Hmelo-Silver et al., 2007). Los docentes deben aprender a diseñar y facilitar actividades que promuevan la exploración y el descubrimiento, así como a guiar a los estudiantes en la formulación de preguntas y la búsqueda de respuestas. El trabajo en equipo puede ser potenciado mediante la creación de grupos de aprendizaje cooperativo, donde cada miembro tiene una responsabilidad específica y todos trabajan juntos para alcanzar un objetivo común (Johnson et al., 1998). Esta estrategia no solo mejora el aprendizaje académico, sino que también desarrolla habilidades sociales y de colaboración entre los estudiantes.

Recomendación 4: Enseñar Técnicas de Estudio y Técnicas para la Comprensión y la Memorización

Otra de las evidencias destacadas en esta investigación, en línea con hallazgos previos de la OCDE, es la conciencia sobre las estrategias de lectura efectivas. Los estudiantes que conocen bien qué estrategias utilizar para resumir un texto, comprender su significado o memorizarlo tienden a ser más competentes en lectura (Govorova et al., 2023). El conocimiento de estrategias eficaces puede ser significativamente mejorado a través de intervenciones pedagógicas. Es fundamental que los educadores enseñen a los estudiantes no solo a identificar las estrategias adecuadas, sino también a aplicarlas de manera práctica en diversas situaciones en todas las áreas de enseñanza y aprendizaje. Programas de instrucción metacognitiva que

incluyen el modelado de estrategias de comprensión y técnicas de memorización pueden ayudar a los estudiantes a desarrollar una mayor conciencia de sus procesos de pensamiento y a mejorar el nivel competencial del alumnado de manera sostenible (Brozo, 2017; Guthrie et al., 2000; Reeve, 2009).

Más concretamente, se recomienda que el profesorado enseñe a los estudiantes estrategias específicas para mejorar su comprensión lectora, como la identificación de ideas principales, la inferencia de significado a partir del contexto y la realización de conexiones entre ideas (Duke & Pearson, 2009). Los docentes pueden modelar el uso de estas estrategias mientras leen en voz alta, destacando cómo aplican las técnicas de comprensión para procesar y entender el texto (Pressley, 2000). Después de modelar las estrategias, los estudiantes pueden practicar su aplicación con el apoyo y la retroalimentación del docente, tanto individualmente como en grupos pequeños (Duke & Pearson, 2009). Los organizadores gráficos, como mapas conceptuales o diagramas de Venn, pueden ayudar a los estudiantes a visualizar la estructura y las relaciones de la información, lo que facilita la comprensión y la retención (Marzano et al., 2001). Los docentes pueden enseñar a los estudiantes técnicas efectivas de memorización, como la creación de mnemotecnias, la elaboración de tarjetas de memoria o la práctica de la recuperación activa, para ayudarles a recordar información de manera más eficiente (Dunlosky et al., 2013). La retroalimentación, ya mencionada con anterioridad, en esta ocasión centrada en el uso de las estrategias de estudio también puede ayudar a mejorar su efectividad y autoeficacia (Hattie & Timperley, 2007). Por último, el fomento de la metacognición, centrada en la reflexión sobre la eficacia de las técnicas de estudio utilizadas puede ayudar los estudiantes a desarrollar una mayor conciencia de sus fortalezas y áreas de mejora (Schraw & Dennison, 1994).

Recomendación 5: Potenciar la Enseñanza Individualizada

La potenciación de la enseñanza individualizada es una estrategia crucial en el contexto educativo, especialmente considerando las complejidades de la relación entre el apoyo del profesor y el rendimiento académico de los estudiantes. Aunque la relación entre el apoyo del profesor y el rendimiento académico puede ser débil o incluso negativa a nivel general, es fundamental reconocer que este factor es un predictor sólido del bienestar estudiantil. Cuando los docentes se comprometen activamente en asegurar la comprensión completa de los problemas por parte de los estudiantes, proporcionando ayuda adicional cuando es necesario y mostrando un genuino interés por el aprendizaje individual de cada alumno, los estudiantes reportan un mayor bienestar subjetivo (Govorova et al., 2020a). Además, el apoyo del profesor tiene un impacto positivo en la motivación intrínseca, que es el factor de proceso más estrechamente relacionado con el rendimiento académico.

Estos hallazgos parecen indicar que es importante esforzarse por comprender las necesidades individuales de cada estudiante, lo cual implica conocer sus estilos de aprendizaje, intereses y niveles de habilidad. Según Tomlinson (2000), la efectividad de la enseñanza radica en comprender y abordar las diferencias individuales de los estudiantes. Esto implica reconocer que los alumnos tienen diversos estilos de aprendizaje, ritmos de progreso y fortalezas y debilidades. Al tener en cuenta estas diferencias, los educadores pueden diseñar estrategias de enseñanza que se ajusten a las necesidades específicas de cada estudiante, promoviendo así un aprendizaje más significativo y efectivo. De nuevo, la retroalimentación personalizada es fundamental para el aprendizaje individualizado. Según Hattie y Timperley (2007), la retroalimentación efectiva proporciona a los estudiantes información sobre el estado de su aprendizaje y les ayuda a cerrar la brecha entre su comprensión actual y el desempeño deseado.

5.4. Propuestas Metodológicas Innovadoras

Las metodologías habitualmente utilizadas para el análisis de factores asociados al rendimiento académico enfrentan diversas limitaciones que pueden dificultar una comprensión completa de los procesos educativos. En esta tesis doctoral, se han explorado varios enfoques metodológicos menos comunes en las investigaciones de factores asociados al rendimiento. Con el uso de estas técnicas se pretende aportar métodos y evidencias adicionales en búsqueda de modelos metodológicos que contrarresten las limitaciones de las metodologías clásicas. Explorar propuestas metodológicas innovadoras para la definición y la estimación de un modelo de factores asociados a los resultados educativos de una institución es el último objetivo específico de esta investigación.

Como se ha comentado, existen varias limitaciones en los enfoques más comunes utilizados en las investigaciones de factores asociados al rendimiento. En primer lugar, las variables de producto de la mayoría de las metodologías utilizadas en investigaciones similares se limitan a los conceptos de rendimiento escolar tradicional, en la mayoría de los casos basado en las puntuaciones en exámenes estandarizados, sin considerar otras vertientes importantes que deben fomentar los centros educativos, como la motivación intrínseca y las relaciones interpersonales o el bienestar (Wang & Eccles, 2012). Con la introducción de las variables de bienestar psicológico y cognitivo como producto en los modelos jerárquico-lineales tradicionales, se ha pretendido arrojar luz sobre el papel del centro educativo en su fomento en un contexto internacional.

Cabe destacar que el bienestar estudiantil es un concepto multidimensional para cuya medición aún no existe consenso. Desde una perspectiva metodológica, la estructura del bienestar y otras variables psicológicas puede ser estudiadas siguiendo diversos enfoques. Por ejemplo, los análisis factoriales, exploratorio y confirmatorio, u otros métodos de agrupamiento

permiten proporcionar información sobre grupos de ítems que miden el mismo constructo subyacente (Wood, 2008). La fuerza de las relaciones entre variables puede ser estimada a través de índices de correlación o regresión. Sin embargo, estos procedimientos no permiten ilustrar la conectividad entre las variables de tal manera que los cambios en la estructura indiquen diferencias significativas. Teniendo en cuenta la complejidad y el carácter multidimensional del fenómeno de bienestar, en esta tesis doctoral se ha propuesto el uso de la metodología de análisis de redes para su definición (Govorova et al., 2020b). Para ello, primero se analizaron los elementos que componen el concepto de bienestar en sí mismo y la naturaleza de las interacciones entre estos elementos. Y a continuación, a través del mismo enfoque metodológico, se evaluaron las relaciones entre las dimensiones del bienestar y los factores de proceso, como el clima escolar y las prácticas de enseñanza. Tras definir un modelo que ilustra las relaciones entre el bienestar y los factores escolares, se compararon los modelos entre grupos, caracterizando los grupos poblaciones por género, por nivel de rendimiento y también por país de procedencia, en línea con el enfoque internacional adaptado en otros estudios de la tesis doctoral. El enfoque de redes permitió visualizar el modelo de bienestar como un sistema integrado y representar las complejas interacciones entre los conceptos de bienestar, resaltando los elementos más importantes. Los datos del estudio mostraron la importancia de promover la autoestima, la resiliencia y la autoeficacia de los estudiantes, junto con el uso de estrategias que reduzcan la ansiedad y el miedo al fracaso, dado que estos elementos fueron identificados como los nodos con los mayores niveles de medidas de centralidad y de conectividad (Govorova et al., 2020b).

Otra limitación clave de las metodologías clásicas radica en la dificultad para establecer relaciones causales claras y directas entre los factores identificados y el rendimiento estudiantil. A menudo, los análisis correlacionales o las regresiones simples identifican asociaciones entre variables sin poder determinar si una variable realmente causa efecto sobre la otra. Esto puede llevar a conclusiones erróneas o simplificaciones excesivas sobre la compleja y multifacética naturaleza del rendimiento académico (Marsh & Yeung, 1997). Con un diseño adecuado, la metodología de Diferencias en Diferencias (DiD) puede contribuir a la detección de relaciones causales entre variables. En un diseño longitudinal típico de DiD, se comparan los cambios en la variable dependiente entre un grupo de tratamiento que experimenta una intervención y un grupo de control que no la experimenta. Al comparar las diferencias en los cambios de las variables entre estos dos grupos antes y después del tratamiento, se pueden atribuir los cambios observados a la intervención, bajo la suposición de que los dos grupos seguirían un patrón de cambio similar en ausencia de la intervención (Angrist & Pischke, 2008; Bertrand et al., 2004). Al no disponer de datos longitudinales en el contexto de esta investigación, se ha utilizado una estrategia DiD adaptada en la que la diferencia entre el grupo experimental y el grupo control se modela a través de las diferencias entre las puntuaciones del mismo individuo en dos áreas de

evaluación, en concreto entre la lectura y las matemáticas. Considerando estas diferencias como variable dependiente en un modelo de regresión, se han identificado variables con un elevado impacto en la competencia lectora, pero no en las matemáticas, como el gusto por la lectura o el conocimiento de estrategias eficaces a la hora de resumir, comprender y memorizar (Govorova et al., 2023).

Otra de las limitaciones de las metodologías actuales utilizadas en modelos de factores asociados al rendimiento es que pueden tener dificultades para capturar la interacción entre diferentes factores y su efecto sinérgico en el rendimiento estudiantil. Los procesos educativos son inherentemente complejos y están influenciados por una amplia gama de factores que interactúan entre sí de maneras no lineales. Sin embargo, las metodologías tradicionales a menudo tratan estos factores de manera aislada, lo que puede limitar la capacidad de comprender la dinámica completa del rendimiento académico (Raudenbush & Bryk, 2002). El último instrumento metodológico utilizado para contrarrestar los efectos de esta limitación ha sido el modelo de ecuaciones estructurales multinivel en el que los factores asociados de rendimiento a nivel de estudiante fueron modelados a través de constructos latentes construidos a partir de variables directamente observables. Todos los modelos construidos, tanto en el conjunto de todos los países de la OCDE, como a nivel de cada uno de los países miembros analizados, han mostrado índices de ajuste adecuados según los criterios de Hu y Bentler (1995).

En resumen, los avances metodológicos y tecnológicos ofrecen nuevas oportunidades para descubrir patrones ocultos y relaciones en los datos educativos. Estos avances no solo mejoran la calidad y la fiabilidad de los hallazgos, sino que también facilitan la toma de decisiones basadas en evidencia, contribuyendo así a la mejora continua de los sistemas educativos. No obstante, aún quedan por superar varios retos importantes, por ejemplo, aislar efectos causales de algunas variables de contexto o de proceso, o adaptar algunos métodos de análisis, como análisis de redes, a la estructura anidada de los datos en el contexto educativo. Por último, es necesario realizar investigaciones adicionales para definir con mayor precisión el constructo de bienestar en el ámbito de educación y seguir explorando los factores que lo determinan.

Los principales hallazgos de este trabajo indican que, aunque los antecedentes individuales y los factores socioeconómicos influyen significativamente en los resultados del proceso de enseñanza, los centros educativos disponen de un margen de maniobra para mejorar el rendimiento y el bienestar estudiantil. Esto se puede lograr combinando los métodos de enseñanza tradicionales e innovadores para potenciar la motivación intrínseca, fomentando un clima de disciplina positivo, enseñando técnicas de estudio eficaces y proporcionando apoyo y retroalimentación constante a los estudiantes a lo largo de todo el proceso de aprendizaje.

6. Conclusiones

A continuación, se enumeran las principales conclusiones obtenidas a partir del conjunto de estudios desarrollados en esta tesis doctoral:

1. Se ha logrado estimar y analizar el impacto del centro educativo en el rendimiento educativo y el bienestar del alumnado. Los resultados obtenidos resaltan la importancia del entorno escolar en la formación integral de los estudiantes, mostrando que el centro educativo puede influir en hasta un 30% en el desempeño académico, mientras que su papel en el fomento del bienestar estudiantil es más limitado, situándose en aproximadamente un 5%.

2. Se ha llevado a cabo un análisis exhaustivo de los factores que influyen en los resultados educativos. Este análisis ha permitido identificar factores clave que pueden afectar el rendimiento y el bienestar de los estudiantes, proporcionando una comprensión más profunda de los determinantes del éxito escolar.

3. Se han formulado recomendaciones específicas dirigidas a los centros educativos con el fin de incidir en la mejora escolar. Estas recomendaciones, basadas en la evidencia recopilada, buscan proporcionar orientación práctica para la implementación de intervenciones efectivas que promuevan un ambiente escolar más favorable para el aprendizaje y el desarrollo integral de los estudiantes.

4. Se ha evaluado la utilidad de propuestas metodológicas innovadoras para definir y estimar el modelo de factores asociados a los resultados educativos de una institución. Esta evaluación ha permitido identificar enfoques y herramientas que pueden ser de gran utilidad para futuras investigaciones y para el diseño de estrategias de mejora educativa más efectivas.

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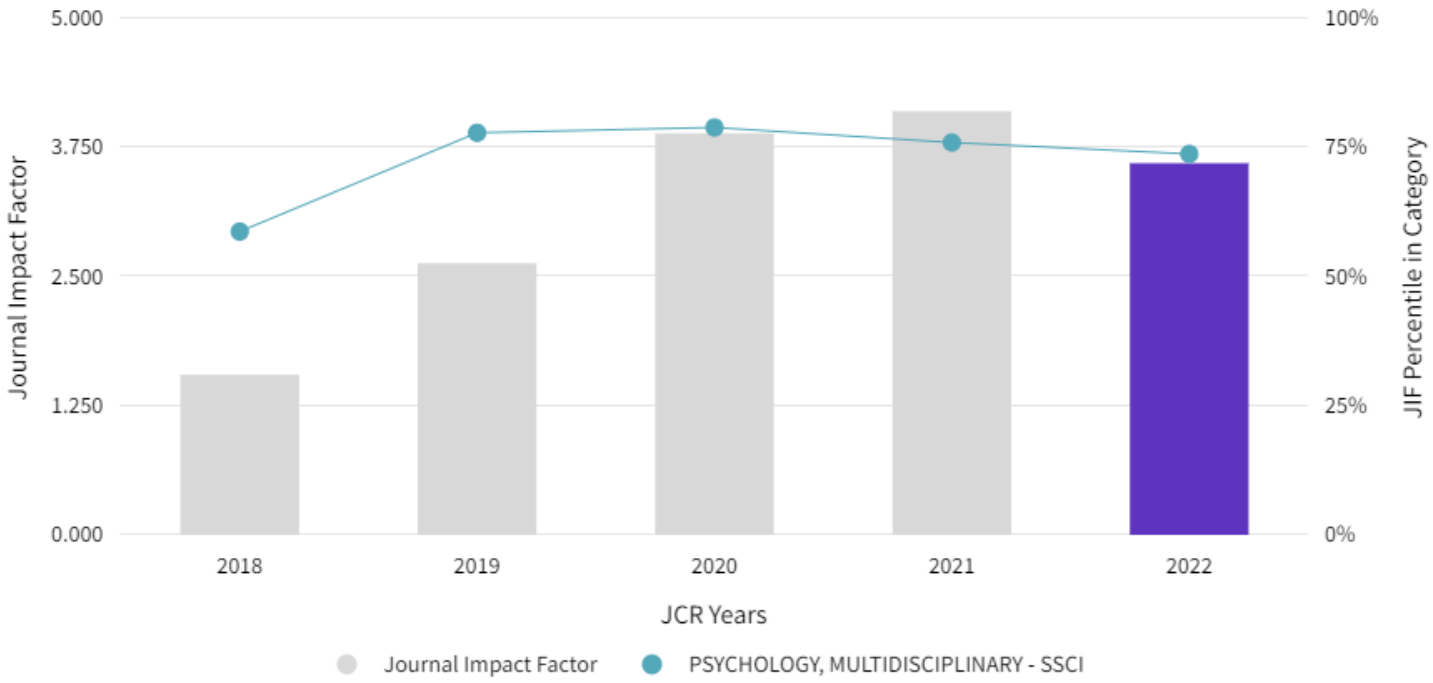

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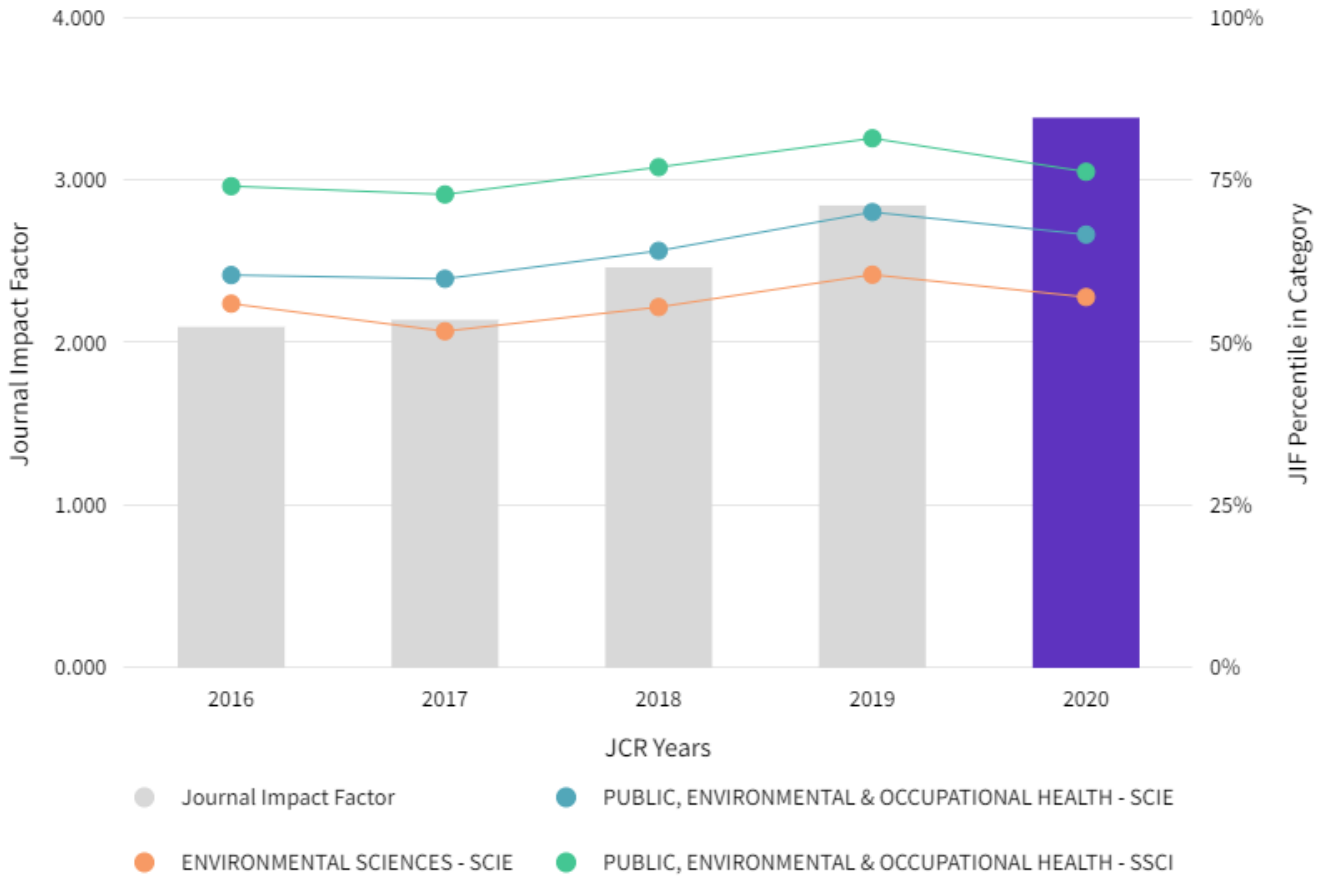

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