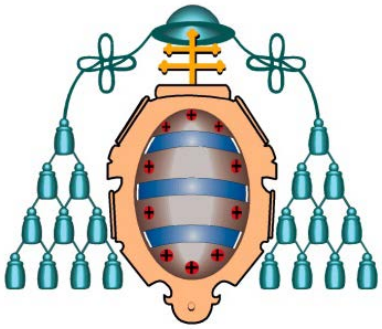

UNIVERSIDAD DE OVIEDO

Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS y PISA

Academic Resilience in the PIRLS, TIMSS and PISA International Assessments

Doctorando: Francisco Javier García Crespo

Programa de doctorado: Educación

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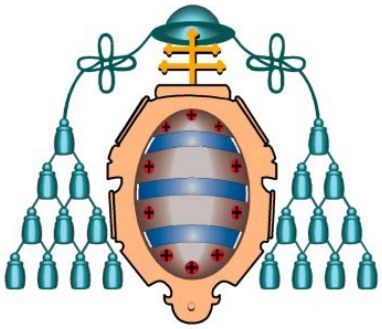

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Academic Resilience in the PIRLS, TIMSS and PISA International Assessments

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Oviedo, 2021

Universidad de Oviedo
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RESUMEN DEL CONTENIDO DE TESIS DOCTORAL

1.- Título de la Tesis	
Español: Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS y PISA	Inglés: Academic Resilience in the PIRLS, TIMSS and PISA International Assessments

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RESUMEN (en español)

Antecedentes: El contexto sociocultural de los estudiantes tiene una influencia significativa en su rendimiento académico, como lo indica la literatura especializada en este tema. Esta Tesis Doctoral se centra en estudiantes con desventajas socioculturales. Los estudiantes resilientes académicamente son aquellos que a pesar de tener condiciones socioeconómicas desfavorables, logran buenos resultados académicos, rindiendo mucho mejor de lo esperado. El principal objetivo de esta Tesis Doctoral es identificar los determinantes de la resiliencia educativa en Lectura, Matemáticas y Ciencias en Europa y Asia Oriental y Sudoriental. **Método**: Se utilizaron los resultados de los estudios PIRLS 2016 y TIMSS 2019 de los estudiantes de 4 ° grado de los países miembros de la Unión Europea que participaron en estos estudios y los estudiantes de 15 años del programa PISA 2015 de Asia oriental y sudoriental. Estos datos son los más actualizados y permiten una evaluación a gran escala de diferentes países y sus sistemas educativos. Con el fin de escalar a los estudiantes según su nivel socioeconómico, se desarrolló un Índice Social, Económico y Cultural (ISEC). El rendimiento académico se evaluó a través de pruebas de comprensión lectora, matemáticas y ciencias. Se utilizó un modelo logístico, un modelo logístico jerárquico de dos niveles y un modelo logístico jerárquico de tres niveles, con variables del alumno como sexo, antecedentes escolares o características personales y familiares para el nivel uno, variables propias de las

escuelas como clima escolar para el nivel dos, y las metas ET2020 para el nivel tres. **Resultados**: Se encontraron diferencias significativas entre países europeos en cuanto a la proporción de estudiantes resilientes y de bajo rendimiento. La confianza del estudiante, haber realizado actividades de alfabetización temprana y un clima escolar favorable aumenta en gran medida la probabilidad de que un estudiante sea académicamente resistente. Los factores relacionados con la enseñanza que mejor predecían la resiliencia eran mantener el orden en el aula, un entorno escolar seguro y ordenado y una enseñanza centrada en la comprensión y la reflexión. Los países europeos analizados compensaron en gran medida la situación de doble desventaja de los estudiantes inmigrantes. Los países con proporciones más altas de estudiantes de bajo rendimiento tenían menos estudiantes resilientes. **Conclusiones**: Las características personales de los estudiantes y las condiciones familiares son fundamentales para que los estudiantes sean considerados resilientes o de bajo rendimiento. Las políticas educativas en los estados miembros de la UE pueden compensar en gran medida las posiciones de partida desfavorables; fundamentalmente, políticas de carácter social como el apoyo a estudiantes inmigrantes, familias o escuelas. Se proponen algunas ideas para orientar la política educativa para compensar las anteriores desventajas socioeconómicas de los estudiantes, y así mejorar su resiliencia.

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RESUMEN (en Inglés)

Background: The socio-cultural context of students has a significant influence on their academic performance, as indicated by the specialist literature on this subject. This Doctoral Thesis focuses on students with socio-cultural disadvantages. Academically resilient students are those who despite having unfavourable socioeconomic conditions, achieve good academic results, performing much better than expected. The main objective of this Doctoral Thesis is to identify the determinants of educational resilience in Reading, Mathematics and Science in Europe and East and South-East Asian. **Method:** The PIRLS 2016 and TIMSS 2019 studies 4th grade student results were used from the European Union member countries that participated in this studies and the PISA 2015 program 15 years old students from East and South-East Asian. This data is the most up-to-date and allows for a large-scale evaluation of different countries and their education systems. In order to scale the students according to their socioeconomic level, a Social, Economic and Cultural Index (SECI) was developed. Academic performance was assessed through a reading comprehension, mathematics and science tests. A logistic model, two-level hierarchical logistic and three-level hierarchical logistic model were used, with student variables such as sex, school history, or personal and family characteristics for level one, variables specific to schools such as school climate for level two, and ET2020 goals for level three. **Results:** Significant differences were found between European countries in terms of the proportion of resilient and low performing students. Student confidence, having done early literacy activities and a favorable school climate greatly increases the likelihood that a student will be academically resilient. The teaching-related factors best predicting resilience were keeping order in the classroom, a safe and orderly school environment, and teaching focused on comprehension and reflection. The European countries analyzed largely

compensated for the doubly-disadvantaged situation of immigrant students. Those countries with higher proportions of low-performing students had fewer resilient students. **Conclusions:** Students' personal characteristics and family conditions are instrumental in students being considered resilient or low performers. The educational policies in the EU member states are able to largely compensate for unfavorable starting positions; fundamentally, policies of a social nature such as support for immigrant students, families, or schools. Some ideas are proposed to guide educational policy to compensate for the previous socioeconomic disadvantages of the students, and thus improve their resilience.

SR. PRESIDENTE DE LA COMISIÓN ACADÉMICA DEL PROGRAMA DE DOCTORADO EN EDUCACIÓN

Agradecimientos

Siempre he sido de pocas palabras y con pocas palabras voy a agradecer a todas aquellas personas que de uno u otro modo requieren de mi agradecimiento.

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Índice de contenidos

1. Introducción

Consultada la Real Academia Española (RAE) por el término resiliencia esta determina que proviene del inglés *resilience* y este a su vez es un derivado del latín *resiliens, -entis,* participio de presente activo de *resilire* "salto hacia atrás, rebotar". Y, lo define como "Capacidad de adaptación de un ser vivo frente a un agente perturbador o un estado o situación adversos". La resiliencia es una construcción compleja y puede definirse de una manera diferente en el contexto de individuos, familias, organizaciones, sociedades y culturas (Southwick et al. , 2014). Adicionalmente, Southwick et al. (2014) proponen que este constructo debe abordarse desde una perspectiva de múltiples niveles incluyendo variables genéticas, de desarrollo, demográficas y sociales entre otras. A pesar de que la condición de resiliencia se puede considerar en un amplio conjunto de situaciones, en esta Tesis Doctoral nos restringiremos al ámbito educativo y académico.

La literatura educativa existente considera distintos aspectos para identificar la resiliencia académica de un estudiante. El primero de ellos, se centra en la motivación como capacidad psicológica del estudiante para hacer frente a los contratiempos, la presión del estudio o al estrés en el entorno escolar que permita a este obtener logros académicos (Martin, 2002). Masten & Ciccheti (2016) destacan además de los procesos genéticos y neurobiológicos, los procesos de resiliencia que involucran a familias, escuelas, pares, cultura y otros sistemas socioecológicos. No obstante, la definición más extendida es aquella que caracteriza al estudiante académicamente resiliente como aquel que a pesar de provenir de un contexto socioeconómico y cultural desaventajado obtiene un rendimiento muy por encima del que sería esperable por su condición inicial (Agasisti et al., 2018; García-Crespo et al., 2019a; OECD, 2010; OECD, 2011a; OECD, 2011b; OECD, 2018b). Que un estudiante consiga ser resiliente, es decir, que se sobreponga a su

situación desfavorecida de partida y obtenga un buen rendimiento académico, no solo le permitirá obtener ventaja académica sino que conseguirá tener más oportunidades para desarrollar su potencial, mayores probabilidades de crecimiento social y menor riesgo de pobreza (OECD, 2016b). Agasisti et al. (2016) en su trabajo *School factors helping disadvantaged students to succeed: Empirical evidence from four Italian cities* encuentran en la potenciación de la resiliencia académica un modo para incrementar la equidad en los sistemas educativos.

Las investigaciones en torno a la resiliencia académica analizan a los estudiantes y sus contextos (Henderson & Milstein, 2003), a las familias (Henry et al., 2015), a los profesores y las escuelas (Day & Gu, 2013) y a los equipos directivos (Steward , 2014).

1.1. Caracterización de resiliencia

Atendiendo a la definición de resiliencia académica expuesta anteriormente y enunciada como la capacidad que tiene un estudiante con antecedente sociales, económicos y culturares desaventajados para obtener un alto rendimiento académico. En primer lugar, tendremos que definir el índice social económico y cultural y como se construye, y en segundo lugar determinar que se entiende por alumno desaventajado según este índice.

1.1.1. Índice Social Económico y Cultural (ISEC)

Existen varias vías para construir el Índice Social Económico y Cultural (ISEC), la más extendida consiste en utilizar un procedimiento de reducción de variables basado en el análisis por componentes principales (PCA).

Para construir el ISEC se utilizan los siguientes indicadores (OECD, 2017b):

- Indicador de educación de los progenitores. Los índices de educación de los progenitores se codifican teniendo en cuenta los niveles educativos en las siguientes categorías: (0) (No acabó la educación primaria), (1) CINE 1 (educación primaria), (2) CINE 2 (primer ciclo de secundaria), (3) Nivel CINE 3B o 3C (formación profesional/secundaria superior preprofesional), (4) CINE 3A (secundaria superior general) y / o CINE 4 (postsecundaria no terciaria), (5) CINE 5B (educación terciaria profesional) y (6) CINE 5A y / o CINE 6 (estudios terciarios y de posgrado de orientación teórica). El indicador de educación de los progenitores será el índice de nivel educativo más alto de los progenitores que corresponde al nivel CINE más alto de cualquiera de los mismos.
- Indicador de ocupación de los progenitores. Las ocupaciones se codifican en códigos ISCO de cuatro dígitos y luego se asigna al índice socioeconómico internacional de estatus ocupacional (ISEI) (Ganzeboom & Treiman, 2003). El indicador ocupacional será el índice más alto de los progenitores que corresponde al ISEI más alto de cualquiera de los mismos.
- Posesiones del hogar. Los estudiantes informan de la disponibilidad de un conjunto de posesiones en el hogar, con las respuestas se construye un índice
- Libros en el hogar. El estudiante informa sobre el número de libros en el hogar.

La razón fundamental para utilizar estas cuatro componentes fue que, por lo general, se consideraba que el estatus socioeconómico se basaba en la educación, el estatus ocupacional y los ingresos. Dado que no se dispone de una medida de ingresos directa a partir de los datos, la existencia de artículos del hogar se ha utilizado como un sustituto de la riqueza familiar (OECD, 2017b).

Con el procedimiento de análisis por componentes principales (PCA) se conserva la información aportada por los indicadores iniciales en una única componente principal que llamaremos ISEC. El objetivo del PCA es reducir la dimensionalidad del conjunto de datos e identificar nuevas variables significativas subyacentes. Así, este método es idóneo para construir el índice social, económico y cultural, pues se recoge en una única variable la información de todas las variables que la componen (Suárez-Alvarez et al., 2018; Villegas et al., 2018). El PCA forma nuevas variables, llamadas componentes principales, en orden decreciente de importancia. Estas variables no estarán correlacionadas, la primera de ellas explica lo máximo posible la variabilidad en los datos, y las subsiguientes lo máximo de la variabilidad restante. En el caso de la construcción del ISEC, las variables originales se comportan como un modelo esencialmente unidimiensional y en la forma en que se enuncia a continuación.

Si x es una observación de una población con media μ y matriz de varianzas-covarianzas ∑, se define la primera componente principal como:

$$y = a' \cdot (x - \mu)$$

donde *a* se elige para que la varianza de $a' \cdot (x - \mu)$ se maximice para todos los vectores *a* tales que $a' \cdot a = 1$. Se puede demostrar que este máximo valor de la varianza es igual al autovalor más grande de ∑, que se denotará λ_1. Este máximo ocurre cuando *a* es el autovector de ∑ correspondiente al autovalor λ_1 y que verifica que $a' \cdot a = 1$.

Utilizando el ISEC como medida del índice socioeconómico y cultural, diremos que un alumno es desfavorecido o desaventajado cuando su ISEC individual tome un valor por debajo del primer cuartil del ISEC de su país, es decir, se encuentre entre el 25% con menor puntuación en el indicador.

Una vez caracterizado el estudiante como desaventajado socioeconómica y culturalmente, el siguiente paso es definir que se entiendo por alto rendimiento académico. Para ello se ha de estudiar cómo se mide dicho rendimiento académico en las evaluaciones educativas a gran escala que se han usado en esta Tesis Doctoral.

1.1.2. Rendimiento académico según las evaluaciones a gran escala

Las evaluaciones educativas a gran escala no asignan puntuaciones directas (estimadores puntuales) a los alumnos y las alumnas participantes, estiman puntuaciones usando la teoría de respuesta al ítem (TRI) por medio de una escala en la que posiciona tanto la dificultad del ítem como la habilidad del alumnado (Martin et al., 2017; Martin et al., 2020; OECD, 2017b). Para cada estudiante se construye una distribución a posteriori de la destreza de los mismos a partir de la que se calculan valores aleatorios (habitualmente cinco), denominados valores plausibles. Con este procedimiento se consigue mejores parámetros poblacionales que los obtenidos por los procedimientos de máxima verosimilitud o por métodos Bayesianos a posteriori (von Davier et al., 2009). Adicionalmente a los valores plausibles asociados a cada estudiante se le incluye el peso que se calculó en la fase de muestreo con el fin de que los cálculos que se hagan en los análisis posteriores representen a todo el alumnado del país o región.

En cada primer ciclo de evaluación de *Progress in International Reading Literacy Study* (PIRLS), *Trends in International Mathematics and Science Study* (TIMSS) o *Programme for International Student Assessment* (PISA) se fijó la referencia central (escala continua) de conveniencia en 500 puntos y con desviación típica 100 puntos (Martin et al., 2017; Martin et al., 2020; OECD, 2017b). Este punto de referencia se ha mantenido constante a lo largo de los distintos ciclos y sirve para situar los promedios de los países y regiones participantes. El valor de 500 puntos es, por tanto, una referencia con la que es posible hacer comparaciones entre los países.

Para todos los estimadores se calcula la varianza de los mismos y, por lo tanto, los errores típicos. Para ello, PIRLS y TIMSS emplean un procedimiento de remuestreo de tipo Jackknife Repeated Replication (JRR) (Martin et al., 2017; Martin et al., 2020), mientras que PISA utiliza un remuestreo tipo Fay (Balanced Repeated Replication, BRR) (OECD, 2017b), ambos consistentes en obtener múltiples muestras a partir de la original, y calcular el parámetro de interés para cada una de las muestras replicadas, además de para la muestra completa. La variabilidad entre las replicaciones resultantes es el estimador del error típico del estadístico objeto de estudio.

Las puntuaciones obtenidas con esta metodología nos servirán como medida de rendimiento del alumnado para identificar al estudiante resiliente.

1.1.3. Identificación de alumnado resiliente

Puesto que no existe una única forma de definir la condición de resiliencia, tampoco existe un único procedimiento para determinar si un estudiante es o no resiliente. En esta Tesis Doctoral, se ha determinado que un estudiante es académicamente resiliente si tiene un ISEC que se encuentra ubicado por debajo del primer cuartil dentro de su país y con un desempeño por encima del tercer cuartil del desempeño global de los países analizados, una vez que se ha considerado el efecto del ISEC (García-Crespo et al., 2019a; OECD, 2011b; OECD, 2018b).

Analíticamente se seguirán tres pasos para caracterizar al alumnado resiliente (Clavel et al., 2021; García-Crespo et al., 2019b):

1. Identificación de los estudiantes desaventajados por su ISEC. Es decir aquellos ubicados en el primer cuarto (es decir, por debajo del Q1, percentil veinticinco) del índice ISEC dentro de sus países.
2. Cálculo del rendimiento esperado del estudiante una vez descontado su ISEC, para conocer la relación internacional ISEC-desempeño.

3. El rendimiento residual del estudiante se obtiene comparando el desempeño real de cada estudiante con el desempeño predicho por la relación internacional ISEC-desempeño.

Los estudiantes con resiliencia académica se identifican como aquellos cuyo desempeño residual se encuentra entre el cuarto superior (es decir, por encima del Q3, percentil setenta y cinco) del desempeño residual de los estudiantes de todas las economías.

Siguiendo esta estrategia de identificación. Primero, se estimó la regresión lineal por país y la regresión promedio dentro de todos esos resultados estimados. La variable dependiente son los valores plausibles (PV) en el rendimiento en cada competencia de cada estudiante. La variable independiente será el ISEC. Obteniéndose la siguiente expresión analítica:

$$PV_i = \beta_0 + \beta_1 \cdot ISEC_i + \varepsilon_i$$

donde ε_i son los errores aleatorios, que siguen una distribución con media igual a cero y varianza igual a σ^2. Los coeficientes estimados se denotan como $\hat{\beta}_0$ y $\hat{\beta}_1$. Por lo tanto, el desempeño esperado de los estudiantes dado su nivel de ISEC podría estimarse como:

$$E\left[\widehat{PV}_i\right] = \hat{\beta}_0 + \hat{\beta}_1 \cdot ISEC_i$$

En el segundo paso, se estimó la regresión trasladada al tercer cuartil, desplazando el centroide a una nueva posición en el eje horizontal: el tercer cuartil de todos los países participantes, Q3PV. El modelo se convierte en:

$$\widehat{Q3}_{PV_i} = Q3_{PV} + \hat{\beta}_1 \cdot ISEC_i + \varepsilon_i$$

Por tanto, el valor esperado es:

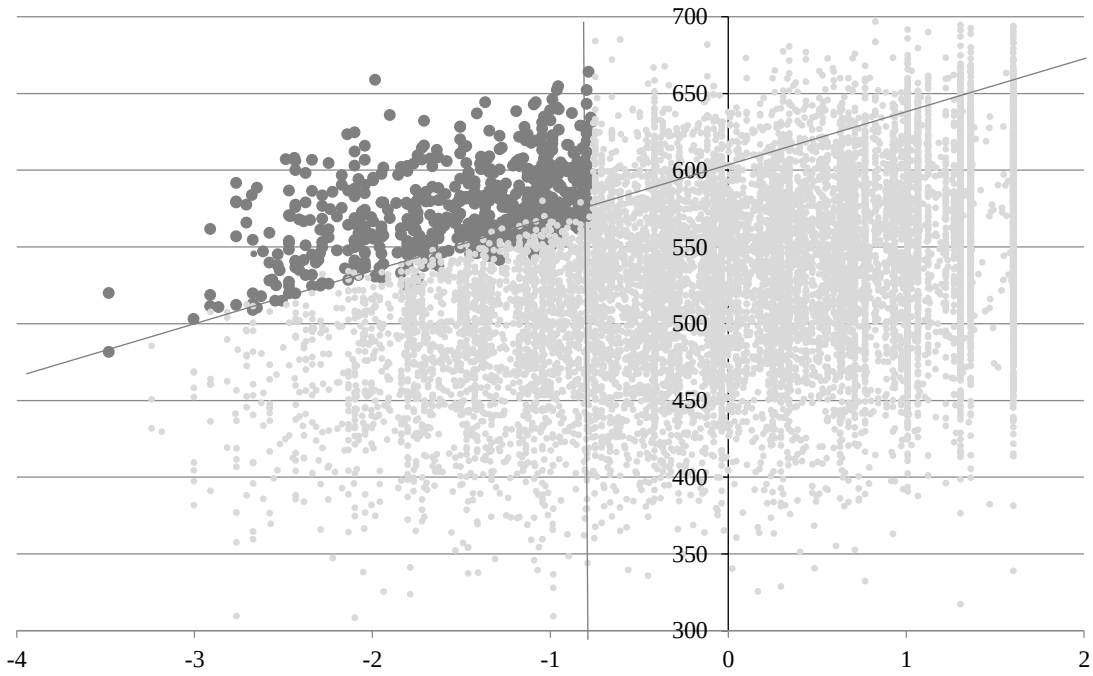
$$E\left[\widehat{Q3}_{PV_i}\right] = Q3_{PV} + \hat{\beta}_1 \cdot ISEC_i$$

A partir de ahora, usamos $E\left[\widehat{Q3}_{PV_i}\right]$ para obtener el punto de corte en función del ISEC. Se califican como resilientes, a aquellos estudiantes con ISEC en el primer cuartil de los estudiantes en su país y que tienen un número mayoritario de valores plausibles por encima del valor esperado ($E\left[\widehat{Q3}_{PV_i}\right]$) de acuerdo con sus ISEC.

Para ilustrar el procedimiento expuesto se presenta el caso de España para los datos del estudio PIRLS 2016 (Figura 1). La primera línea vertical corresponde con el primer cuartil de ISEC en España (-0,764). La línea con pendiente positiva es la recta de regresión predictora del rendimiento en PIRLS 2016 por encima del tercer cuartil en función del ISEC del estudiante.

Figura 1

Determinación del alumnado resiliente en España



El valor del intercepto de la recta es de 589,31 puntos, correspondiente con la puntuación del percentil 75 en comprensión lectora para el conjunto de la UE suponiendo ISEC 0.

De este modo la ecuación queda expresada en los siguientes términos:

$$y = 589{,}31 + 29{,}342 * ISEC$$

Los puntos en el plano cartesiano representan casos individuales, y aquellos ubicados a la izquierda de la línea vertical y, al tiempo se sitúan por encima de la recta de regresión son identificados como estudiantes académicamente resilientes en comprensión lectora, esto es, su ISEC se encuentra en el primer cuarto de España y su rendimiento es superior al tercer cuartil de rendimiento global descontando el ISEC del alumno. En el gráfico estos casos han sido presentados en gris oscuro.

1.2. Aspectos contextuales relacionados con la resiliencia

Inicialmente, Coleman et al. (1966) asociaron el rendimiento académico al contexto socioeconómico del alumnado, hecho que se ha venido confirmado independientemente de las culturas y sistemas educativos que se analicen (OECD, 2016a). Sucesivas investigaciones como los trabajos de Barragán et al. (2016) o Choi & Calero (2013) apuestan por conocer los determinantes del rendimiento académico para poder intervenir sobre el mismo y reducir la posibilidad de fracaso escolar. Por otro lado, Muñoz-Izquierdo & Guzmán (2010) y Barcaet al. (2012) determinan la influencialidad del rendimiento por variables independientes de distintos orígenes, pudiendo ser estas de tipo personal, situacional o ambiental. Viniendo el rendimiento explicado por el conjunto de ellas y no por ellas de manera independiente.

Sin embargo, también se ha demostrado que los antecedentes contextuales no son decisivos, y que las características personales y los procesos educativos presentan importantes efectos sobre los resultados escolares (Enríquez et al., 2018; Grotberg, 1995). En este contexto, el estudio de la resiliencia académica es un área pujante que suscita un interés creciente en la investigación educativa actual (Aldridge et al., 2015; Doll, 2013;

Howard & Johnson, 2000; Matin, 2002; McTigue et al., 2009; Steward et al., 2004; Yeager & Dweck, 2012).

Siguiendo la clasificación que señalan Choi & Calero (2013), indicando que la capacidad de resiliencia del alumnado proviene de la interacción entre variables personales, familiares y escolares, se analizarán en los siguientes apartados las variables que se han utilizado en el análisis de resiliencia de esta Tesis Doctoral. Complementando esta información con los objetivos que han establecido las instituciones de cooperación supra-nacional: *Sustainable Development Goals* (SDG) (UNESCO, 2021) y *Education and Training 2020 targets* (ET 2020) (European Comission, 2020).

1.2.1. Variables individuales del alumno

La resiliencia académica está fuertemente conectada con las características de personalidad de los estudiantes, tales como las variables socioafectivas, el autoconcepto, las expectativas académicas, las atribuciones causales o la confianza en la propia capacidad (Erberber et al., 2015; García-Crespo et al., 2019a; Martin & Marsh, 2003; Vaknin-Nusbaum et al., 2018; Veas et al., 2017; Waxman et al., 1997). Asimismo, existe un amplio consenso entre los investigadores en que la resiliencia académica está muy vinculada a variables motivacionales, tales como el esfuerzo, la persistencia, la fortaleza personal, la capacidad de trabajo autónomo, el afán por aprender, y el gusto por la lectura (Jacob, 2002; Kobasa et al., 1982; Martin & Marsh, 2003; Vaknin-Nusbaum et al., 2018; Veas et al., 2017).

Con datos de 28 países participantes en TIMSS 2011, la expectativa académica del estudiante y el gusto por las matemáticas fueron las variables con mayor impacto sobre la resiliencia que encontraron en el entorno individual Erberberet al. (2015). Con el mismo estudio, pero con una muestra de países asiáticos, Sandoval & Bialowolski (2016),

señalaron que la variable individual más relevantes a la hora de analizar la resiliencia era la actitud positiva del estudiante hacia las matemáticas. En uno de sus últimos estudios Cordero & Mateos-Romero (2021), con datos de 18 países europeos participantes en TIMSS 2015 y en PIRLS 2016 obtuvieron que los factores que más contribuyen a la resiliencia eran las habilidades aprendidas por los estudiantes antes de comenzar la escuela y el nivel socioeconómico de sus compañeros. Gabrielli et al. (2021) con los datos de PISA 2015 y PISA 2018 de España, Grecia e Italia estimaron que la autoeficacia y las actitudes lingüísticas en el hogar favorecen la condición de resiliencia entre los estudiantes de origen inmigrante. En cuanto al género de los estudiantes, en un trabajo con datos de ciencias de PISA 2015 y muestras del sudeste asiático, Clavel et al. (2021), encontraron que los chicos tenían más probabilidad de resiliencia académica en ciencias en Macao o Singapur.

La familia es el primer contexto de interacción, siendo evidente que ha de producir un efecto directo en el desarrollo infantil afectando en las características personales y en el rendimiento académico del niño, apareciendo asociado al incremento de probabilidad de alcanzar la resiliencia académica. Kirjavainen y Loikkanen (1998), con una muestra finlandesa, y Feinstein y Symons (1999), con datos del Reino Unido, señalaron el efecto positivo de la implicación e interés de las familias por la educación de sus hijos. Las expectativas académicas de los progenitores se han mostrado como un predictor capital de los resultados educativos (Martín-Lagos, 2018). Fernández-Alonso et al. (2017) encuentran que los estudiantes cuyos progenitores presentan un perfil de implicación familiar más distal o indirecto tienden a presentar mejores resultados que los que provienen de hogares con un estilo más controlador. Sandoval & Bialowolski (2016) encontraron que el tiempo dedicado a las matemáticas en el hogar tienen un efecto positivo entre los estudiantes de Singapur. Li (2017), utilizando una muestra de

estudiantes chinos que participaron en el examen de ingreso a la universidad, encontró que la supervisión de los padres, y la participación y reconocimiento de la escuela fomentan la resiliencia. Estudios como el de Cheung et al., (2014) y Gabrielli et al. (2021) observan que aquellos alumnos que tenían apoyo familiar, tendían a un mejor bienestar psicológico, y tenían más posibilidades de ser resilientes.

A la vista de estos antecedentes, en esta Tesis se ha decidido trabajar con un amplio conjunto de variables individuales y familiares del estudiante, tanto en Educación Primaria, como en Educación Secundaria, dichas variables se detallan a continuación.

1.2.1.1. Variables relativas al estudiante

- Género: 0- Femenino y 1- Masculino
- El estudiante asistió a preescolar: 0- Menos de 2 años y 1- Dos años o más
- Condición de inmigrante: 0-Nativo y 1- Inmigrante

Las variables continuas se construyeron utilizando la escala de crédito parcial de la TRI y los valores del índice corresponden a estimaciones de máxima verosimilitud (WLE) (Martin et al., 2017; Martin et al., 2020; Mullis et al., 2020; Mullis et al., 2017; OECD, 2017b). Para los análisis de este trabajo se estandarizaron con media 0 y desviación estándar de 1. Las variables restantes del contexto del estudiante y la familia fueron las siguientes:

- Sentido de pertenencia a la escuela. Se preguntó a los estudiantes cuánto estaban de acuerdo con cinco afirmaciones sobre su actitud hacia la escuela, tales como el gusto por estar en su escuela o si se siente seguro en la misma.
- *Bullying* estudiantil. Se preguntó a los estudiantes sobre la frecuencia con la que experimentaron diversos comportamientos de intimidación por parte de sus compañeros de la escuela.

- Participación en las clases de lectura. Los estudiantes fueron calificados de acuerdo con su grado de acuerdo con nueve afirmaciones relacionadas con su compromiso de lectura (por ejemplo, me gusta lo que leo sobre la escuela, mi profesor me da cosas interesantes para leer, o sé lo que mi profesor espera de mí).
- Gusto por la lectura. Se construyó un índice teniendo en cuenta su grado de acuerdo con ocho afirmaciones y la frecuencia con la que realizaron actividades de lectura fuera de la escuela en las que se les preguntaba sobre si les gustaba hablar de lo que leían, si leer es aburrido o si disfrutan leyendo.
- Gusto por aprender matemáticas y ciencias. Las escalas cubren las actitudes de los estudiantes hacia las matemáticas/ciencias y el estudio de las mismas.
- Confianza en la lectura. Los estudiantes fueron calificados de acuerdo con su grado de acuerdo con seis afirmaciones sobre su autoconfianza en la lectura (por ejemplo, generalmente me va bien en lectura, leer es fácil para mí o simplemente no soy bueno para leer).
- Confianza en matemáticas y ciencias. Estas escalas miden cómo de bien los estudiantes piensan que pueden hacer matemáticas o ciencias.
- Actividades de alfabetización temprana antes de la escuela. Los estudiantes fueron calificados de acuerdo con la frecuencia con la que sus padres realizaron nueve actividades con ellos en casa: leer libros, contar historias, cantar canciones, …
- Tareas de alfabetización temprana. Los estudiantes fueron calificados de acuerdo con las respuestas de sus padres sobre cómo de bien sus hijos podían hacer seis tareas: reconocer la mayoría de las letras del alfabeto, leer algunas palabras, leer oraciones, leer una historia, escribe las letras del alfabeto y escribe algunas palabras.

- Claridad de instrucción del profesorado en lecciones de matemáticas y de ciencias. Se preguntó a los estudiantes sobre aspectos tales como si saben lo que su profesor espera que hagan, si su profesor es fácil de entender o tiene respuestas claras a sus preguntas.
- Tareas numéricas tempranas. Los estudiantes fueron puntuados de acuerdo con las respuestas de sus padres sobre cómo de bien podían hacer algunas tareas numéricas, como contar por sí mismos cuando comenzaron la escuela primaria.

1.2.1.2. Variables relativas a las familias

- Percepciones de los progenitores sobre la escuela de sus hijos. Los estudiantes fueron calificados en esta escala de acuerdo con las respuestas de sus padres a seis afirmaciones sobre la escuela, en el sentido de si la escuela de su hijo hace un buen trabajo incluyendo a la familia en la educación de su hijo, si la escuela proporciona un entorno seguro o si la escuela de su hijo se preocupa por el progreso del mismo.
- Gusto por la lectura de los progenitores. Los estudiantes fueron calificados en esta escala de acuerdo con las respuestas de sus padres a ocho afirmaciones sobre la lectura, así como la frecuencia con la que leen por placer. Algunas de ellas fueron: 1 (Leo solo si tengo que hacerlo), 2 (Me gusta hablar de lo que leo con otras personas), 3 (Me gusta pasar mi tiempo libre leyendo) ...

1.2.2. Contexto escolar

A finales de los años 70, Rutter (1979) presentó al entorno escolar como factor determinante en la resiliencia de los estudiantes. Posteriormente, Henderson & Milstein (2003) afirmaron que los centros educativos deben fomentar la resiliencia para que todos los estudiantes, mediante la creación de relaciones de afecto y apoyo, que aumenten la

Teniendo en cuenta lo expuesto, en esta Tesis Doctoral se ha utilizado un sustancial número de variables del contexto escolar y del docente con el fin de determinar el impacto que tienen sobre la condición de resiliencia en lectura, matemáticas y ciencias, y corroborar lo observado en las investigaciones previas u obtener nuevas líneas de investigación.

Solo se ha utilizado una variable dicotómica, la relativa al género del docente, el resto son variables continuas que se construyeron utilizando la escala de crédito parcial de la TRI y los valores del índice corresponden a estimaciones de máxima verosimilitud (WLE) (Martin et al., 2017; Martin et al., 2020; Mullis et al., 2020; Mullis et al., 2017; OECD, 2017b). Para los análisis de este trabajo se estandarizaron con media 0 y desviación estándar de 1. Las variables del contexto del centro escolar y los docentes fueron las siguientes:

1.2.2.1. Variables relativas al centro

- Instrucción afectada por la escasez de recursos. La escala presenta las respuestas de los directores sobre la medida en que la enseñanza escolar está limitada por la escasez de recursos.

- Disciplina escolar. Se preguntó a los directores de los centros educativos sus percepciones sobre hasta qué punto la disciplina, el desorden y los comportamientos de intimidación son problemas en su centro.

- Acceso a la escuela de los estudiantes con habilidades de lectura y numéricas básicas. El índice mide el porcentaje de alumnado que accede a la educación primaria con destrezas de lectura y numéricas.

- Énfasis escolar en el éxito académico. El índice mide aspectos como la comprensión de los maestros de las metas curriculares de la escuela, el grado de

confianza en sí mismos. También el profesor desempeña un papel crítico en la creación de entornos que fomenten la resiliencia de los alumnos (Coburn & Nelson, 1989): Proporcionando confianza, atención, empatía, disponibilidad, respeto, modelo personal …

La investigación educativa, en una primera línea de trabajo, ha acumulado bastantes evidencias que relacionan el contexto de aprendizaje de los centros con la resiliencia académica. Asociado al entorno de centro Erberber et al., (2015) y Sandoval & Bialowolski (2016), estimaron que entre los factores con mayor impacto sobre la resiliencia en matemáticas y ciencias se encuentran las expectativas docentes sobre el rendimiento de los estudiantes, el interés del centro por el éxito académico, ausencia de acoso escolar, el clima de seguridad, la disciplina del centro, y la cantidad de recursos educativos disponibles. En cuanto a una segunda línea de investigación, se han encontrado resultados muy consistentes señalando al profesorado como un factor clave en la resiliencia académica (Barber & Mourshed, 2009; Darling-Hammond et al., 2017; Hattie, 2009; OECD, 2005; OECD, 2018a). Si bien, el concepto de calidad docente es multidimensional (Fauth et al., 2014; Kane & Cantrell, 2010; Kunter & Voss, 2013; Wagner et al., 2013), las investigaciones han conseguido agrupar un conjunto de prácticas, estrategias y metodologías que permiten aumentar la motivación del alumnado, y mejorar sus resultados de aprendizaje (Baumert et al., 2010; Creemers & Kyriakides, 2008; Hattie, 2009; Isac et al., 2015; Kunter et al., 2013; Lavy, 2016; Nilsen & Gustafsson, 2016; O'Dwyer et al., 2015; Rjosk, et al., 2014). Variables propias del profesorado como la satisfacción laboral pueden ejercen igualmente un papel relevante en su docencia, y trasladarse al rendimiento académico de los estudiantes (Caprar et al., 2003; Klassen et al., 2013; Tschannen-Moran & Hoy, 2001).

éxito de los maestros en la implementación del plan de estudios de la escuela o las expectativas de los maestros para el rendimiento de los estudiantes.

- Escuela segura y ordenada. Los estudiantes fueron puntuados de acuerdo con el grado de acuerdo de sus maestros con ocho declaraciones en la escala de escuela segura y ordenada. Algunos de estos aspectos fueron: 1 (Esta escuela está ubicada en un vecindario seguro), 2 (Me siento seguro en esta escuela), 3 (Las políticas de seguridad de esta escuela y las prácticas son suficientes), 4 (Los alumnos se comportan de forma ordenada), 5 (Los alumnos son respetuosos con los profesores), …

1.2.2.2. Variables relativas al docente

- Género: 0- Femenino y 1- Masculino
- Satisfacción laboral docente. La escala se construyó de acuerdo con la frecuencia con la que los maestros respondieron positivamente a las cinco afirmaciones en la escala de satisfacción laboral del maestro: Estoy contento con mi profesión como maestro, encuentro mi trabajo lleno de significado y propósito, estoy entusiasmado con mi trabajo, mi trabajo me inspira y estoy orgulloso del trabajo que hago.
- Limitación de la enseñanza en el aula por estudiantes con limitaciones para aprender. Los estudiantes fueron puntuados de acuerdo con las respuestas de sus maestros sobre siete características de sus estudiantes que podrían limitar la forma en que enseñan su clase en la escala de instrucción en el aula limitada por las características del estudiante. Estas características no eran únicamente referentes a carencias de conocimientos o habilidades previas, sino también si los estudiantes sufren de falta de nutrición básica o no duermen lo suficiente.

- Énfasis de los profesores en la investigación científica. El índice mide la frecuencia de participación en actividades relacionadas con investigaciones y experimentos científicos.
- Formación básica del profesorado. Los estudiantes fueron puntuados en esta escala de acuerdo con las respuestas de sus maestros (En absoluto/Descripción general o introducción al tema/Fue un área de énfasis) a cuatro afirmaciones sobre su educación y/o capacitación formal, en qué medida durante sus estudios trataron las siguientes áreas: 1 (Lenguaje), 2 (Literatura), 3 (Pedagogía/enseñanza de la lectura) y 4 (Psicología educativa).
- Formación complementaria del profesor. Los estudiantes fueron calificados en esta escala de acuerdo con las respuestas de sus maestros (En absoluto/Descripción general o introducción al tema/Fue un área de énfasis) a tres afirmaciones sobre su educación y/o capacitación formal, en qué medida durante sus estudios trataron las siguientes áreas: 1 (Lectura de refuerzo), 2 (Teoría de la lectura) y 3 (Métodos de evaluación en lectura).
- Interacción del profesor. La escala se construyó de acuerdo con las respuestas de los maestros a cuatro afirmaciones sobre tipos de interacciones con otros maestros y con qué frecuencia las hacen.
- Estrategias de rutina para la lectura. Los estudiantes fueron calificados en esta escala de acuerdo con las respuestas de sus maestros a afirmaciones sobre actividades de lectura consideradas rutinarias como leer en voz alta con los estudiantes, pedir a los estudiantes que lean en voz alta y pedir a los estudiantes que lean en silencio para sí mismos y con qué frecuencia las realizan.
- Estrategias sistemáticas para la lectura. Los estudiantes fueron puntuados en este índice de acuerdo con las respuestas de sus maestros a afirmaciones sobre

actividades de lectura consideradas sistemáticas como enseñar a los estudiantes estrategias para decodificar sonidos y palabras, enseñar a los estudiantes nuevo vocabulario sistemáticamente, enseñar a los estudiantes cómo resumir las ideas principales y enseñar estrategias de exploración.

- Uso de técnicas de lectura integral. Los estudiantes fueron puntuados en esta escala de acuerdo con las respuestas de sus maestros a las siguientes afirmaciones sobre la frecuencia con la que hacen cosas para ayudar a desarrollar las habilidades de comprensión lectora: 1 (Localizar información dentro del texto), 2 (Identificar las ideas principales de lo que han leído) y 3 (Explicar o apoyar la comprensión de lo que han leído).
- Uso de técnicas de lectura reflexiva. El índice se construyó de acuerdo con las respuestas de los maestros a seis afirmaciones sobre la frecuencia con la que hacen cosas para ayudar a desarrollar estrategias de lectura: (por ejemplo, comparar lo que han leído con las experiencias que han tenido, comparar lo que han leído con otras cosas que han leído, hacer predicciones sobre lo que sucederá a continuación en el texto que están leyendo, …).
- Seguimiento de tareas. Los estudiantes fueron puntuados en esta escala de acuerdo con las respuestas de sus maestros a tres afirmaciones sobre la frecuencia con la que hacen lo siguiente con las tareas de lectura para su clase: 1 (Corregir las tareas y dar retroalimentación a los estudiantes), 2 (Discutir las tareas en clase) y 3 (Controlar si se completó o no la tarea).
- Selección de lecturas adaptadas. Los estudiantes fueron calificados en esta escala de acuerdo con las respuestas de sus maestros sobre con qué frecuencia hacen lo siguiente al enseñar a leer a su clase: 1 (Proporcionar materiales de lectura que coincidan con los intereses de los estudiantes), 2 (Proporcionar materiales que

sean apropiados para los niveles de lectura de estudiantes individuales) y 3 (Dar tiempo a los estudiantes para leer libros de su propia elección).

1.2.3. Otras variables de país (Objetivos de Desarrollo Sostenible)

Los Objetivos de Desarrollo Sostenible 2030 (*Sustainable Development Goals* 2030, SDG 2030) y la UNESCO determinan como objetivo 4 (UNESCO, 2021):

- Garantizar una educación inclusiva, equitativa y de calidad y promover oportunidades de aprendizaje durante toda la vida para todos.

La Unión Europea dentro del marco estratégico para la cooperación europea en el ámbito de la educación y la formación trabaja en un foro que permite a los Estados miembros intercambiar las mejores prácticas y aprender unos de otros. Producto de este foro, la Comisión Europea (2020) presenta siete indicadores clave (*The Education and Training* 2020 *targets*, ET2020) que aproximan el grado de consecución de los SDG 2030. Los indicadores clave y sus objetivos son:

1. Abandono temprano de la educación y la formación. Reducción por debajo del 10% del porcentaje de abandono de los estudios o la formación entre 18 y 24 años.
2. Titulados en Educación Terciaria (30-34 años). Como mínimo un 40% de la población de entre 30 y 34 años debe haber terminado alguna forma de educación superior.
3. Participación en Educación Infantil (> 4 años). Integración de al menos el 95% de los niños en la educación preescolar.
4. Bajo rendimiento en las competencias básicas en la era digital. Reducción a menos del 15% del porcentaje de jóvenes de 15 años con aptitudes insuficientes en lectura, matemáticas y ciencias.

5. Tasa de empleo de los graduados recientes. Al menos el 82% de los titulados (personas de entre 20 y 34 años que han terminado al menos el segundo ciclo de enseñanza secundaria) debe tener un empleo en un plazo de no más de tres años después de terminar los estudios.
6. Aprendizaje de adultos. Como mínimo un 15% de la población adulta debe participar en actividades de formación.
7. Movilidad. Al menos el 20% de los titulados superiores y el 6% de los jóvenes de entre 18 y 34 años con un título de formación profesional inicial debe haber cursado algún periodo de estudios o formación en el extranjero.

Para los análisis se han desestimado los indicadores Participación en Educación Infantil and Movilidad por su escasa variabilidad.

En todo caso, apenas existen evidencias sobre si los indicadores de política educativa aumentan la probabilidad de resiliencia académica.

1.3. Datos analizados

Las evaluaciones de los sistemas educativos constituyen una herramienta fundamental para describir el desarrollo competencial del alumnado y el modo en que los centros educativos ayudan en la mejora de los aprendizajes (García Sanz, 2003). Debido a su utilidad, cada vez mayor número de países participan en los estudios de comparación de sistemas de educativos promovidos por instituciones internacionales como la *Organisation for Economic Co-operation and Development* (OECD), la *International Association for the Evaluation of Educational Achievement* (IEA), o la *European Comission* (EC), entre otras (Cordero & Manchón, 2014).

La participación en las evaluaciones educativas a gran escala requiere una explicación de los resultados, una comparación con los de otros países evaluados y, como

finalidad, facilitar la toma de decisiones en políticas públicas educativas con el objetivo de mejorar el rendimiento de los estudiantes (Hambleton, 2002).

1.3.1. Evaluaciones internacionales

1.3.1.1. PIRLS 2016

PIRLS evalúa en alumnado de 4º grado (4º de Educación Primaria en España), esto es, niños y niñas que llevan escolarizados 4 años de enseñanza obligaoria, propósitos de lectura y procesos de comprensión lectora (Mullis & Martin, 2015). Siguiendo el marco teórico diseñado para la evaluación por el TIMSS & PIRLS *International Study Center, Lynch School of Education*, Boston College, y la IEA se elaboraron 16 cuadernillos empleando un diseño matricial incompleto parcialmente balanceado (Fernández-Alonso & Muñiz, 2011). A partir de una selección de lecturas (cinco literarias y cinco informativas) que toman el papel de estímulos, se elaboran los ítems, pudiendo ser estos de:

- respuesta de opción múltiple (4 opciones de las cuales sólo una es correcta),
- respuesta construida (el estudiante responde con una frase), o
- respuesta semiconstruida (se debe completar con una palabra o una frase muy corta).

La recogida de datos, tanto de los cuadernillos cognitivos como de los cuestionarios de contexto de PIRLS 2016 se realizó según los estándares previstos por la IEA (Martin, Mullis, & Hooper, 2017) la siguiente estructura:

- Sesión 1: 40 minutos.
- Descanso: un máximo de 30 minutos.
- Sesión 2: 40 minutos.

- Cuestionario de contexto de alumnado: 30 minutos.

Durante las sesiones 1 y 2 el estudiante respondió una serie de cuestiones sobre una lectura literaria y otra informativa.

Al finalizar las sesiones de lectura, el estudiante respondió un cuestionario de antecedentes. Además, la recogida de datos de complementa con un cuestionario del hogar (*Learning to Read Survey*), un cuestionario de profesorado y un cuestionario de centro.

1.3.1.2. TIMSS 2019

TIMSS evalúa en alumnado de 4º grado las competencias matemática y científica. Los cuadernillos para evaluar Matemáticas y Ciencias se elaboraron siguiendo el marco teórico establecido por el TIMSS & PIRLS *International Study Center, Lynch School of Education*, Boston College, y la IEA (Mullis & Martin, 2017). El total de ítems está compuesto por 32 bloques (16 de cada competencia) con aproximadamente 10 ítems cada bloque. Los ítems, de la misma tipología de respuesta que en PIRLS, se distribuyeron en 14 modelos de cuadernillos.

La recogida de datos de TIMSS 2019 siguió los estándares de la IEA (Martin et al., 2020), con una estructura similar a la de PIRLS:

- Sesión 1: 36 minutos.
- Descanso: un máximo de 30 minutos.
- Sesión 2: 36 minutos.
- Cuestionario de contexto de alumnado: 30 minutos.

Durante las sesiones 1 y 2 (parte cognitiva) el estudiante se enfrentó a un cuadernillo dividido en dos partes, una por competencia y sesión, respondiendo un total de 40 ítems aproximadamente que contenía dos bloques de cada competencia.

Al finalizar las sesiones cognitivas (matemáticas y ciencias), el estudiante respondió un cuestionario de antecedentes. Además, la recogida de datos de complementa con un cuestionario del hogar, un cuestionario de profesorado y un cuestionario de centro (Martin et al., 2020).

1.3.1.3. PISA

El programa PISA en 2015 evaluó a los jóvenes de 15 años de 72 países con el fin de confirmar qué saben y qué son capaces de hacer. PISA evalúa tres competencias consideradas troncales: ciencias, lectura y matemáticas (MECD, 2016; OECD, 2017b). En el ciclo de PISA 2015 la competencia principal fue ciencias, evaluando las siguientes formas de conocimiento: biología, geología, física, química y tecnología. Evalúa la competencia científica no solo desde el punto de vista formal (lo que aprende en la escuela) si no también lo que ha adquirido de manera no formal e informal (lo que aprende fuera del contexto escolar) (OECD, 2017a).

Al igual que las evaluaciones anteriores, las pruebas cognitivas de PISA se organizan en unidades de evaluación, y estas, en estímulos, asociados a ellos se encuentran los ítems (relacionados con los estímulos o con informaciones previas) que serán de respuesta múltiple, construida o semiconstruida. La prueba completa de ciencias contenía 184 preguntas o ítems, organizadas dentro de unidades de evaluación, que aproximadamente supondrían seis horas de examen.

La recogida de datos de PISA 2015 siguió los estándares de la OECD (OECD, 2017b), con la siguiente estructura:

- Sesión 1: 60 minutos.
- Descanso: un máximo de 30 minutos.
- Sesión 2: 60 minutos.
- Cuestionario de contexto de alumnado: 45 minutos.

Durante las sesiones 1 y 2 cada estudiante contestó preguntas de ciencias, lectura y matemáticas. Todos los estudiantes dedicaron al menos sesenta minutos a las ciencias en su prueba, lo que equivalía a 30 preguntas aproximadamente.

Al finalizar las sesiones cognitivas, el estudiante respondió un cuestionario de antecedentes de treinta y cinco minutos y otro de diez minutos de familiaridad con las tecnologías de la información y la comunicación o de carrera educativa. Además, se recogió un cuestionario del profesor de ciencias y un cuestionario de centro (OECD, 2017b).

1.3.2. Estructura de las bases de datos

Para seleccionar los estudiantes que realizaron la prueba en cada país se llevó a cabo un muestreo clásico de dos etapas (centros-alumnos) por conglomerados. Más concretamente el modelo usado fue el bietápico estratificado secuencial por conglomerados (Martin et al., 2017; Martin et al., 2020; OECD, 2017b). Como paso previo, cada país determina qué estratos representan mejor la población objetivo de cada estudio.

Para cada estrato el procedimiento secuencial de selección de muestra fue el siguiente:

1- Primera etapa de muestreo. Se seleccionan los centros secuencialmente y de manera proporcional a su tamaño (el tamaño del centro viene determinado por

el número de estudiantes objetivo matriculados en el mismo). La probabilidad de que un centro sea seleccionado es proporcional a su tamaño (centros grandes tienen más probabilidad de ser seleccionados que centros pequeños).

2- Segunda etapa de muestreo. En el caso de PIRLS y TIMSS, se seleccionaron las clases (conglomerados) que debían participar dentro del centro. En el caso de PISA, se seleccionaron 42 alumnos que cumplían 16 años durante el curso de aplicación de la prueba independientemente de la clase o el curso en el que estuvieran matriculados.

Una vez seleccionados los estudiantes que participaron en la prueba se asignó un peso de estudiante y un peso de centro o clase, de esta manera cada alumno o centro se representa a sí mismo y a los de su entorno. La suma de los pesos de todos los estudiantes de la prueba es igual al total de alumnado objetivo del estudio correspondiente. Estos pesos, que reflejan las probabilidades de selección de estudiantes y centros en el estudio, permiten reproducir adecuadamente el tamaño poblacional y optimizan la representatividad de los resultados (Rutkowski et al., 2010).

Para recuperar los datos perdidos se empleó el procedimiento de tendencia lineal en el punto que implementa el módulo *Missing Value Analysis* de SPSS, tomando como segmentación la clase a la que el alumno pertenece (Fernández-Alonso et al., 2012).

1.4. Modelos matemáticos utilizados

Los procedimientos de análisis derivados de los modelos generales clásicos asumen que los casos son seleccionados mediante un muestreo aleatorio simple. Como se indicó en el apartado anterior, las evaluaciones educativas a gran escala (PIRLS, TIMSS y PISA) emplean un diseño muestral complejo (estratificado bietápico secuencial por conglomerados) donde los elementos muestrales no son independientes ya que los

estudiantes (etapa 2/nivel 1 de análisis) dentro de una misma clase o centro (etapa 1/nivel 2 de análisis) son más parecidos entre sí que respecto de los estudiantes de otros centros (De la Cruz, 2008; Garner & Raudenbush, 1991). La consecuencia es que los datos recogidos de las evaluaciones educativas no cumplen el supuesto de independencia que se requieren en las muestras aleatorias simples (Iñiguez-Berrozpe & Marcaletti, 2018). En los diseños anidados cada nivel de jerarquía tiene una variabilidad distinta y los errores no son independientes, pero los procedimientos del modelo general lineal clásico no tienen en cuenta esta interdependencia estadística de los casos por lo que sus resultados muy probablemente presentarán sesgo (Bryk & Raudenbush, 1992).

1.4.1. Regresión logística

El primer modelo estadístico usado en esta Tesis Doctoral es la regresión logística binaria (Bernoulli 0-1), donde la variable de interés, variable dependiente, será una variable dicotómica ({0, No cumple la condición}, {1, Cumple la condición}) y las variables predictoras, variables independientes, pueden ser continuas o discretas (descritas en el apartado 1.2) (Kleinbaum & Klein, 2010).

El proceso de análisis está dirigido a comprobar las relaciones causales entre las variables predictoras y la variable de interés, más concretamente, a predecir en forma de probabilidad que ocurra una categoría u otra en función de los valores que tomen las variables independientes.

Analíticamente el modelo se presenta como sigue:

$$P[Y = 1 \,/\, x_1, x_2, \dots, x_k] = \frac{1}{1 + e^{(-\beta_0 - \beta_1 x_1 - \beta_1 x_1 - \cdots - \beta_k x_k)}}$$

Se observa que se expresa como la probabilidad de que ocurra la condición de interés (Y=1) supuesto que el estudiante toma los valores:

$$(X_1 = x_1, X_2 = x_2, \ldots, X_k = x_k).$$

Por tanto, el objetivo es calcular los coeficientes:

$$(\beta_0, \beta_1, \beta_2, \ldots, \beta_k),$$

que mejor ajusten el modelo.

Para analizar el modelo estadístico usado, así como la bondad de ajuste del mismo, se tendrán en cuenta los siguientes elementos:

1. R^2 de Cox y Snell (CSR) y R^2 de Nagelkerke (NKR). Siendo L_s el valor de la verosimilitud (probabilidad que tiene un modelo de haber generado unos datos) del modelo saturado (con todas las variables) y L_0 la verosimilitud del modelo base (solo con la constante) la formulación de los R^2 serán:

$$R^2_{Cox} = 1 - \left(\frac{L_s}{L_0}\right)^{\frac{2}{n}}$$

$$y$$

$$R^2_{Nagelkerke} = \frac{1 - \left(\frac{L_s}{L_0}\right)^{\frac{2}{n}}}{1 - (L_0)^{\frac{2}{n}}}$$

   Estiman la parte de la varianza de la variable dependiente explicada por las variables predictoras. Cuanto más altos sean los valores de los R^2 más explicativos serán los modelos.

2. β y su signo. Valores positivos para β indicarán impacto directo positivo de la variable predictora sobre la variable dependiente, los valores negativos indicarán impacto inverso.

3. Odds (posibilidades). Indican la probabilidad de que ocurra la condición de la variable dependiente frente a que no lo haga:

$$\text{odds} = \frac{p}{1-p}$$

4. Odds ratio, dado por $e^{\beta} \in (0, \infty)$. Permite comparar las odds de diferentes valores de una variable independiente. Cuantifica el impacto existente, siendo 1 el valor que indicaría que β tiene impacto nulo. Cuanto más separado de 1 mayor será dicho efecto, bien en sentido directo (valores mayores que 1 y que pueden llegar a ∞) o inverso (valores menores que 1 y que pueden llegar a 0) (García-Crespo et al., 2019b).

5. Significatividad de β. Se usarán niveles de significación al 1%, al 5% y al 10%.

Para calcular los estimadores y sus errores es necesario utilizar las técnicas de remuestreo mostradas en el apartado 1.1.2. Para PIRLS y TIMSS se emplea el método JRR (Martin et al.; Martin et al., 2020), mientras que para PISA se utilizará un remuestreo tipo Fay (BRR) (OECD, 2017b). Para la estimación de los modelos construidos para esta Tesis se ha utilizado el software IDBAnalyzer© que permite llevar a cabo análisis utilizando réplicas.

1.4.2. Regresión logística multinivel

Sin embargo el modelo que mejor se ajusta a la estructura de muestreo y datos de esta Tesis Doctoral es el modelo de regresión logística multinivel (Cohen et al., 2013; Gelman & Hill, 2006; Merino Noé, 2017; Snijders & Bosker, 2012), que modelizan adecuadamente la variabilidad de los datos en los diseños muestrales de las evaluaciones educativas internacionales a gran escala (De la Cruz, 2008; Iñiguez-Berrozpe &

Marcaletti, 2018), al tiempo que evitan el uso de las ponderaciones replicadas presentes en las bases de datos (Fishbein et al., 2021).

Por todo ello, para analizar el impacto de las variables predictoras sobre la condición de resiliencia de los estudiantes se han utilizado modelos logísticos multinivel de efectos fijos que recogen la estructura anidada de la muestra. Para la estimación de los modelos construidos para este trabajo se ha utilizado el software HLM6© utilizando la aproximación de Laplace para la estimación del modelo de Bernouilli (Raudenbush & Bryk, 2002) que permite llevar a cabo análisis utilizando variables dependientes binarias y niveles jerárquicos.

Las ecuaciones del modelo usado son:

Nivel 1 del modelo:

$$P[Y = 1 \,/\, \beta] = P$$

$$\log\left[\frac{P}{1-P}\right] = \alpha_0 + \alpha_1 \cdot x_1 + \alpha_2 \cdot x_2 + \alpha_3 \cdot x_3 + \alpha_4 \cdot x_4 + \ldots + \alpha_m \cdot x_m$$

Nivel 2 del modelo:

$$\alpha_0 = \beta_{00} + \beta_{01} \cdot y_1 + \beta_{02} \cdot y_2 + \beta_{03} \cdot y_3 + \beta_{04} \cdot y_4 + \ldots + \beta_{0n} \cdot y_n + R_0$$

Nivel 3 del modelo:

$$\beta_{00} = \gamma_{000} + \gamma_{001} \cdot z_1 + \gamma_{002} \cdot z_2 + \gamma_{003} \cdot z_3 + \gamma_{004} \cdot z_4 + \ldots + \gamma_{00p} \cdot z_p + U_{00}$$

$R_0 \sim N\ (0, \sigma^2_{R_0})$

$U_{00} \sim N\ (0, \sigma^2_{U_{00}})$

Donde:

- Y, representa la condición o no de resiliencia.

- $(X_1 = x_1, X_2 = x_2, \ldots, X_k = x_k)$, $(Y_1 = y_1, Y_2 = y_2, \ldots, Y_k = y_k)$ y $(Z_1 = z_1, Z_2 = z_2, \ldots, Z_k = z_k)$ corresponden con las variables del primer, segundo y tercer nivel de análisis respectivamente.
- α_i, son los coeficientes fijos para cada variable predictora del nivel 1.
- β_{0i}, son los coeficientes fijos para cada variable predictora del nivel 2.
- γ_{00i}, son los coeficientes fijos para cada variable predictora del nivel 3.
- γ_{000}, es el intercepto de la regresión.

Para analizar el modelo estadístico usado se tendrán en cuenta los siguientes elementos:

1. β y su signo.
2. Significatividad de β. Se usarán niveles de significación al 1%, al 5% y al 10%.
3. Odds ratio, dado por $e^{\beta} \in (0, \infty)$.

2. Objetivos

Esta Tesis Doctoral tiene por objetivo general analizar qué variables del contexto del estudiante potencian la condición de resiliencia académica del mismo y cuantificar el impacto de dichas variables. Para lograr este objetivo se construyó un modelo para caracterizar la resiliencia y de este modo poder clasificar a los estudiantes como resilientes o no resilientes. Una vez conseguido este hito, se hizo una revisión exhaustiva de las referencias bibliográficas que tratan la resiliencia académica y los antecedentes que incrementan su probabilidad. Con posterioridad se profundizó en las evaluaciones educativas internacionales a gran escala, pues sería la fuente de información que se usaría en los análisis. De dichas evaluaciones se obtuvieron las variables de rendimiento y de nivel socioeconómico y cultural que determinarían la resiliencia o no del estudiante. Como paso final se seleccionó un amplio conjunto de variables del contexto del alumno; individuales, familiares, del entorno educativo y docente que fueron objeto de análisis para identificar cuáles de ellas eran significativas y en qué medida sobre la condición de resiliencia. Para alcanzar el objetivo general se plantean cuatro objetivos específicos:

- Objetivo 1: Construir un procedimiento que sea capaz de identificar la resiliencia o no de un estudiante.
- Objetivo 2: Estimar el porcentaje de alumnado resiliente de los países analizados.
- Objetivo 3: Identificar qué variables del contexto del estudiante son significativas tanto positiva como negativamente sobre la condición de resiliencia.
- Objetivo 4: Estimar en qué medida las variables significativas tienen impacto sobre la condición de resiliencia.

Trabajaremos sobre la hipótesis general de que si se identifica al alumnado resiliente y qué variables hacen que lo sea se podrán dictar políticas públicas de educación que reduzcan el fracaso escolar aumento la proporción de alumnado resiliente. Se plantean cuatro hipótesis específicas una para cada uno de los objetivos específicos establecidos:

- Hipótesis 1: Si se consigue un procedimiento para identificar al alumnado resiliente podremos clasificarlos de manera inmediata y evaluar su contexto de un modo integral.
- Hipótesis 2: Si se estima el porcentaje de alumnado resiliente de cada país, será posible analizar sus políticas de educativas y evaluar cuales de ellas incrementar la probabilidad de resiliencia.
- Hipótesis 3: Si se identifican las variables que tienen impacto sobre la condición de resiliencia se podrá incidir en ellas mediante políticas públicas y mejorar los porcentajes de alumnado resiliente.
- Hipótesis 4: Si se cuantifica el impacto de las variables significativas, se podrá también cuantificar en qué medida será necesario incidir para conseguir más eficiencia en las políticas.

3. Publicaciones

Los objetivos e hipótesis planteados se desarrollan con detalle en los cinco artículos que se presentan, todos ellos publicados en revistas de Factor de Impacto JCR (*Journal Citation Reports*). En el primer artículo *Educational Resilience in Reading Comprehension: Determinant factors in PIRLS-Europe* (García-Crespo et al., 2019b) se propone un procedimiento para clasificar al alumnado resiliente y analizar variables individuales y de centro que tengan impacto en la condición de resiliencia en lectura en la UE en 4º grado. El segundo artículo *Resilient and low performer students: Personal and family determinants in European countries* (García-Crespo et al., 2019a) pretende contrastar como intervienen las variables individuales del estudiante para que este sea resiliente o *low performer* (muy bajo rendimiento) en lectura en la UE en 4º grado. En el tercer artículo *Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts?* (Clavel et al., 2021) se analiza el impacto de variables individuales (habilidades cognitivas y no-cognitivas), familiares y del entorno escolar sobre la condición de resiliencia en alumnado de 15 de años del Este y Sudeste asiático. El cuarto artículo *Academic resilience in European countries: The role of teachers, families, and student profiles* (García-Crespo et al., 2021) analiza un gran número de variables del maestro, tanto individuales como de práctica docente para conocer el impacto de la actividad docente sobre la condición de resiliencia. El quinto artículo *Academic Resilience in Mathematics and Science: Europe TIMSS-2019 data* (García-Crespo et al., 2022) analiza variables individuales y centro que tengan impacto en la condición de resiliencia en matemáticas y ciencias en la UE en 4º grado.

3.1. Primer artítuclo

García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019b). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. *Revista de Educación*, *384*, 65-89. doi:10.4438/1988-592X-RE-2019-384-413

El objetivo de este artículo es proponer un procedimiento analítico para clasificar al alumnado resiliente y analizar mediante una primera aproximación qué variables individuales y de centro tienen impacto en la condición de resiliencia en lectura en la UE en 4º grado. La principal aportación de este artículo a la Tesis Doctoral es encontrar el procedimiento que permita clasificar al alumnado resiliente y una visión preliminar de las variables que mayor relevancia tienen con respecto a la condición de resiliencia y contrastar los resultados con la literatura previa.

Factor de Impacto JCR 2020 = 1.057; Q4

Factor de Impacto 5 años = 1.335

Educational Resilience in Reading Comprehension: Determinant factors in PIRLS-Europe[1]

Resiliencia Educativa en Comprensión Lectora: Factores determinantes en PIRLS-Europa

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Abstract

The socio-cultural context of students has a significant influence on their academic performance, as indicated by the specialist literature on this subject. This study focuses on students with socio-cultural disadvantages. Academically resilient students are those who despite having unfavourable socioeconomic conditions, achieve good academic results, performing much better than expected. The main objective of this study is to identify the determinants of educational resilience in Europe. The PIRLS 2016 study 4th grade student results were used from the European Union member countries that participated in this study. This data is the most up-to-date and allows for a large-scale evaluation of different countries and their education systems. In order to scale the students according to their socioeconomic level, a Social, Economic and Cultural Index (SECI) was developed. Academic performance was assessed through a reading

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comprehension test assuming that a good reading level will allow students to achieve better results in other skills. A two-level hierarchical logistic model was used, with student variables such as sex, school history, or personal and family characteristics for level one, and variables specific to schools such as school climate for level two. Differences were found between the different countries of the European Union. Student confidence in reading and a favorable school climate greatly increases the likelihood that a student will be academically resilient. Some ideas are proposed to guide educational policy to compensate for the previous socioeconomic disadvantages of the students, and thus improve their resilience.

Key words: resilience, reading comprehension, PIRLS, hierarchical models, academic performance, educational assessment

Resumen

El contexto socio cultural del alumnado influye notablemente en su rendimiento académico, como indica una abundante literatura al respecto. Este trabajo se centrará en el alumnado con desventaja socio cultural. El alumnado académicamente resiliente es aquel que a pesar de tener unas condiciones socioeconómicas desfavorables obtiene buen resultado académico, es decir, un rendimiento muy por encima de lo esperado. El objetivo central del presente trabajo es identificar los factores determinantes de la resiliencia educativa en Europa. Se han utilizado los resultados del alumnado de 4º grado del estudio PIRLS 2016 para los países miembros de la Unión Europea que participaron en dicho estudio por ser estos datos los más actuales que permiten comparar mediante una evaluación a gran escala a distintos países y sus sistemas educativos. Para escalar al alumnado según su nivel socioeconómico se elaboró un Índice social, económico y cultural (ISEC). El rendimiento académico se evaluó mediante una prueba de comprensión lectora asumiendo que un buen nivel competencial en lectura permitirá al alumnado conseguir mejores resultados en el resto de las competencias. Se utilizó un modelo jerárquico logístico de dos niveles, usando variables asociadas al alumnado tales como el sexo, historia escolar o características personales y familiares, para el nivel 1, mientras que para el segundo nivel se seleccionaron variables propias de los centros educativos como el clima escolar. Se obtuvieron diferencias entre los distintos países de la Unión Europea. La confianza del alumnado en la lectura y un clima escolar favorable incrementan considerablemente la probabilidad de ser académicamente resiliente. Se proponen algunas ideas para orientar sobre las medidas en política educativa para compensar las desventajas socioeconómicas previas del alumnado y mejorar así su resiliencia.

Palabras clave: resiliencia, comprensión lectora, PIRLS, modelos jerárquicos, rendimiento académico, evaluación educativa

Introduction

Modern educational systems periodically participate in evaluation programs in order to check the quality of the education they offer (García Sanz, 2003). One of these programs is the *Progress in International Reading Literacy Study* (PIRLS), a study backed by the International Association for the Evaluation of Educational Achievement, which has evaluated the reading comprehension of 4th year primary students every five years since 2001. Its objective is to gather information to facilitate decision-making in educational policy that would improve reading comprehension considering educational contexts (Ministerio de Educación, Cultura & Deporte, 2017). The product of these evaluations which is probably most recognised are the student scores and competence levels, which are interpreted with an expression that is comparable or approximate to the participating countries' and regions' academic performance (Cordero & Manchón, 2014). However, the term academic performance is controversial, as it is the final product of a process which involves teachers, families, students and in fact the whole social, political and cultural system surrounding the student (Lamas, 2015; Montes & Lerner, 2011). Understanding the determinants of academic performance is a necessary step towards being able to intervene and prevent school failure (Barragán et al., 2016; Choi & Calero, 2013). Muñoz-Izquierdo and Guzmán (2010) talk about the "elasticity" of performance because they see it as being heavily influenced by various types of independent variables which have been studied over time, reaching the conclusion that it is "a complex, multidimensional factor which involves personal, situational and environmental factors. No single variable alone can explain it" (Barca, Mascarenhas, Brenlla & Morán, 2012, p. 373). Initially, Coleman et al. (1966) associated academic performance with students' socioeconomic contexts, and today this is being confirmed in all cultures and educational systems (OCDE, 2016). However, it has also been found that contextual background factors are not decisive, and that personal and educational process characteristics have significant effects on school results (Enríquez, Insuasty & Sarasty, 2018; Grotberg, 1995). This background has led to the increased interest in recent years in the study of academic resilience, the analysis of individual and school factors that allow students from difficult cultural or economic backgrounds to achieve good academic performances.

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The aim of this study is to determine which factors are most important for academic resilience in reading comprehension. Resilience is "The ability of a living being to adapt to a disruptive agent or an adverse situation or state", although the term is interpreted differently depending on the context of its use (Carle & Chassin, 2004; Luthar, 2006). In education, an academically resilient student is one who despite coming from a disadvantaged social or family environment, achieves good academic results (Servicio de Evaluación Educativa, 2017). Resilience can be taught and can be improved by the resources available to students from their surroundings (Bernard, 1991), and is the product of the interaction between attitudes, abilities and the family and contextual situation (Manciaux, 2003; Rutter, 1993). Choi and Calero (2013) presented a classic model in which the determinants of academic success operated on three levels (individual, family and school) which may be of interest when reviewing the available evidence about academic resilience. Jacob (2002) associated resilience with certain individual characteristics such as the capacity for attention, persistence, desire to learn, and ability to work independently. In general, most research has indicated that resilient students have robust personalities or personal fortitude (Kobasa, Maddi & Kahn, 1982) and they stand out as being strong in their beliefs, being positive about the future, having confidence in their abilities, and having self-control, humour and autonomy (González-Arratia & Valdez, 2007). According to Waxman, Huang and Padron (1997) the characteristics that differentiate the academically resilient student are: engagement with reading and homework, high academic aspirations, good academic self-concept, not having to repeat any school years, participation and satisfaction. Student gender has been shown to be another individual variable with differential effects on achievement (Moffitt, Caspi, Rutter & Silva, 2001). Jacob (2002) found that girls exhibited higher mean scores in variables associated with resilience: attention, persistence, interest in learning, and ability to work alone. Kotliarenco, Cáceres and Fontecilla (1997) found that boys were usually less resilient than girls, who are better able to adapt to adverse situations, something that seems to be confirmed by the OECD (2018). However, the conclusions are not unanimous, as Agasisti, Avvisati and Longobardi (2018) indicated that disadvantaged girls were 9% less likely than boys from the same school to be resilient.

The family is the primary context of interaction, and it is evident that it must have a direct effect on infant development, affecting

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personal characteristics and academic achievement. The positive effect of interest and family involvement on education and learning has been demonstrated by Kirjavainen and Loikkanen (1998), in a Finnish sample, Feinstein and Symons (1999), with a UK sample, and by Fernández-Alonso, Álvarez-Díaz, Woitschach, Suárez-Álvarez and Cuesta (2017), with Spanish data. Martín-Lagos (2018) showed that the likelihood of getting better results was associated with high family educational expectations. Kang (2007), with a South Korean population, highlighted the role of the amount and quality of educational and cultural resources available in the home. Grotberg (1995) asserted the effect of the home on academic resilience as the family is the main protective factor for the student being able to positively deal with adversity. Jadue, Galindo, and Navarro (2005) indicated that this happens when families are concerned about their children at the personal level, talking to their tutors, checking homework and above all providing a stable environment of listening and understanding. In contrast, these same researchers noted that families with a low socioeconomic or cultural level were a risk because of the lack of support for school tasks, little interest in their children's academic progress, family arguments, as well as poor understanding of performance. In the light of these results, Muñoz and De Pedro (2005) concluded that improving family participation in schools would improve the chances of achieving academic resilience.

Sitting somewhere between family and school factors we find attendance at pre-school education. The OECD (2018) noted that schooling before the obligatory stage of education increases the chances of being resilient. School is where students spend a large part of their daily lives, therefore, as Jadue et al. (2005) indicated, it is in this context that they can develop their capacity for resilience, being able to interact with their peers. Agasisti et al. (2018) agreed that the school can make efforts to encourage disadvantaged students to be resilient. For example, schools with higher socioeconomic levels tend to have students who are more likely to be resilient. This study also detailed the positive relationship between school discipline and student resilience. Something similar happens with teachers, whose role in the creation of surroundings that encourage resilience is critical. If teachers are motivating, they can positively influence the development of academic resilience, and on the contrary, teachers with low expectations of their students, who are demotivating and lack diverse methodologies can directly and negatively

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affect students (Jadue et al., 2005). Barragán et al. (2016) identified leadership as one of the aspects that student achievement of objectives most depends on, and Bettinger and Long (2005) indicated that the teacher's gender can influence achievement of educational goals and mitigate disparities that may exist between students.

This study has two main objectives: a) identify resilient students in terms of their Social, Economic and Cultural Index (SECI) and their results in reading comprehension in the PIRLS 2016; and b) analyse which factors predict resilience in reading comprehension in the educational systems in the European Union.

Method

Participants

Fifty-nine countries and regions participated in PIRLS 2016 selecting students by stratified two-stage sampling. Each country decided the number and character of strata to best represent their population. The two-stage model consisted of selecting schools with a probability proportional to the size in the first stage and in the second stage selecting the classes within the schools to participate. This study includes the 23 countries making up the European Union, although in practice there are 24 sample groups as Belgium separated the Flemish and French-speaking populations. The final sample was 117,539 students from 4,324 schools representing the school population in each country or region (Table 1)

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TABLE I. Sample of students and schools

	Students	Schools
Germany	3959	208
Austria	4360	150
Belgium (Fl)	5198	148
Belgium (Fr)	4623	158
Bulgaria	4281	153
Czechia	5537	157
Denmark	3508	185
Slovenia	4499	160
Spain	14595	629
Finland	4896	151
France	4767	163
Hungry	4623	149
England	5095	170
Ireland	4607	148
Northern Ireland	3693	134
Italy	3940	149
Latvia	4157	150
Lithuania	4317	195
Malta	3647	95
The Netherlands	4206	132
Poland	4413	148
Portugal	4642	218
Slovakia	5451	220
Sweden	4525	154
Total	117539	4324

Procedure

The PIRLS 2016 test was applied by expert personnel not belonging to the school. The test was given on one school day in two 40 minute sessions with a break. Following the reading comprehension test, the students were asked to complete a context questionnaire which took about 30

minutes. The same day, questionnaires were given to the schools, the teachers and the families (Martin, Mullis & Hooper, 2017).

Measuring Instruments

Reading comprehension test

The cognitive tests were created from within a theoretical framework organised along two axes of specification: reading purposes and reading comprehension processes (Mullis & Martin, 2015). The evaluation stimuli are organised as a series of readings paired with multiple-choice response items. The complete set of readings and items represent 8 hours of evaluation in total. In order to keep the evaluation time to 80 minutes the readings are spread over 16 different booklets following a partially balanced incomplete block design (Fernández-Alonso & Muñiz, 2011). The students scores in reading comprehension, which are used as one of the criteria to determine academic resilience, are expressed in a scale with a mean of 500 points and standard deviation of 100 points through five plausible values (Martin et al,, 2017), a method which improves population parameters later obtained by maximum likelihood procedures or Bayesian methods (von Davier, González & Mislevy, 2009).

Social, economic and cultural index (SECI)

The socioeconomic level of students was evaluated using the SECI. This indicator was created using an analysis of components which produced a single score from the information from four groups of variables from the context questionnaire: possessions in the home, books in the home, highest academic qualifications of parents, and highest level of employment of parents. The index is expressed in a normalised scale with a mean of 0 and a standard deviation of 1 for the whole sample (European Union) such that students with more socioeconomic and cultural advantages would score more highly in the SECI and conversely, more disadvantaged students would score lower. Evidence of validity for the SECI and the other instruments used may be found in Martin et al. (2017).

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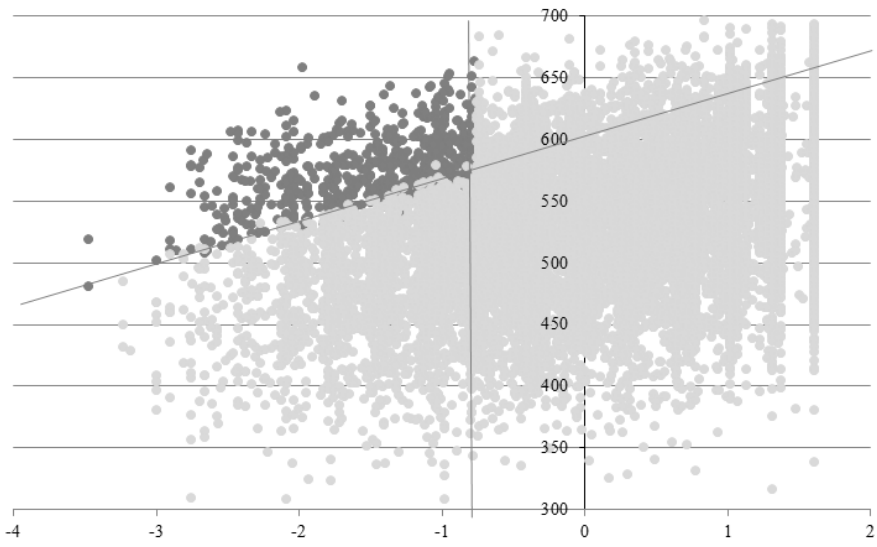
Students would be considered to be academically resilient if their score in the SECI is in the lowest quartile for their country or region, while at the same time, their result in the PIRLS 2016 is in the top quartile of students evaluated in the European Union.

Figure 1 shows how the condition of academically resilient students was determined in the case of Spain. The vertical line on the left marks the first quartile of SECI in Spain (-0.764), while the positively sloped line is the linear regression line predicting performance in PIRLS above the third quartile based on student SECI scores. The intercept value of the linear regression line is 589.31 points, which is the equivalent to the 75th percentile scores in reading comprehension for the whole EU supposing an SECI score of 0. The equation may be expressed as follows $y = 589.31 + 29.342 * SECI$. The points on the Cartesian plane represent individual cases; those on the left of the vertical line, and above the regression line, are identified as resilient students, their SECI is in the first quartile in Spain, and their performance is better than the third quartile in achievement overall, once the SECI is discounted. In figure I, these cases are in dark grey.

FIGURE I. Determination of resilient students in Spain.



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Variables associated with resilience

Starting with the information in the context questionnaires, we selected a broad mix of variables potentially associated with the condition of resilience. These variables were organised in two levels of analysis. Level 1 collected the student variables such as sex, school history (attendance at pre-school and early reading skill activities), individual characteristics (enjoyment of reading, commitment to reading, reading confidence and feeling of belonging at school), and family variables (enjoyment of reading, family perception of school, and stimulation and encouragement to read at home). Level 2 looked at three school variables: available reading resources, school discipline and academic emphasis of the school. The procedure for evaluation and construction of these variables may be found in Mullis, Martin, Foy and Hooper (2017).

Data Analysis

As previously stated, PIRLS uses the method of plausible values. This allows the fusion of Item Response Theory with latent regression techniques in order to arrive at estimations of student performance which ensure the accuracy of the distribution estimations for the population as a whole or for sub-populations. Plausible values are not used to infer individual performance but they do conserve the uncertainty relative to each student. It is precisely this which means that additional analytical procedures are needed to estimate student abilities. To produce consistent estimations of the population statistics it is necessary to consider the context questionnaires (Martin et al., 2017).

In order to avoid bias and to be consistent with the above, PIRLS uses student and class background questionnaires to conserve the variability of the data. This variability is essential to be able to apply the hierarchical models in this study. The analysis procedures derived from the classical general linear model (e.g. ANOVA and multiple regression) assume that the cases are in a similar hierarchical order and are selected through simple random sampling. However, it is rare for large scale educational evaluations to comply with the supposed independence of data (Iñiguez-Berrozpe & Marcaletti, 2018). PIRLS 2016 uses a complex sample design where the observations are not independent, as the students (level 1)

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from a similar class or school (level 2) are more similar to each other than students from other classes or schools (De la Cruz, 2008). In nested designs, each level of hierarchy has a different variability and the errors are not independent, but the classical general linear model procedures do not consider this interdependence of cases so their results may very well be biased. Multilevel hierarchical models are specifically aimed at the analysis of data that have this hierarchical structure and allow this "design effect" problem to be corrected in those cases where there is no independence.

The main statistical model in the family of multi-level hierarchical models is the linear hierarchical model. This model is suitable for continuous variables and for data with normally distributed random effects in each level. In this study the dependent variable is binary ({0, Not resilient}, {1, Resilient}), therefore it would not be realistic to assume that the data complies with supposed normality. For that reason, we used the binary multilevel logistic model (Bernouilli), where the variable of interest only takes two values and which allows us to use various types of predictor variables (continuous, discreet, binary, etc.) in all analysis levels. The effects of the independent variables are presented as probabilities, odds (possibilities) and odds ratios.

- *Odds* (possibilities) are a way of expressing the likelihood that an event happens. It is a ratio of probabilities, the probability the something happens over the probability that it does not: odds = $\pi/(1-\pi)$. It takes values in the interval $(0,\infty)$.
- *Odds Ratios* (OR) allow the comparison of the odds of different values of an independent variable. Suppose that the odds of someone having attended a pre-primary school being resilient are 0.8, and the odds of someone who has not attended one are 0.4. The OR will be: 0.8/0.4=2, and indicates that a student who attended pre-primary is twice as likely to be resilient as a non-attendee. The OR quantifies and indicates the direction of the relationship between the independent and dependent variables in binary logistic regression. The following basic criteria should be considered when interpreting OR values:
  - An OR equal to 1 indicates that the likelihood of an event happening is the same regardless of the value of the independent variable.

– If the OR is greater than 1, it indicates that the likelihood of the event happening increases as the independent variable increases.
– If the OR is less than 1, it indicates that the likelihood of the event decreases as the independent variable increases.

Assuming that the countries in the EU are a heterogeneous group and have dissimilar education systems, one would expect that in each country the independent variables would exhibit different effects on resilience. As a consequence of that, we produced an independent model for each country and obtained richer information from the available data. All of the models are random intercepts produced with the HLM6 software using Laplace's approximation for the estimation of the Bernoulli model (Raudenbush & Bryk, 2002). The HLM6 model was chosen because it allowed us to work with the plausible values in this model. As the PIRLS 2016 sample is probabilistic, the schools and students are weighted according to their probabilities of selection such that these weightings appropriately reconstruct the population sizes and proportions. We took the variables SCHWGT and STUDWGT from the PIRLS 2016 database which are the school weightings and student weighting in the school respectively, and used them in all analyses to weight the results.

Missing data is common in this type of study, but this is particularly concerning in additive designs as the lack of data in level 2 would mean in practice missing the school and all students at that school in level 1. While there are various methods for recovering missing data (Fernández-Alonso, Suárez-Álvarez & Muñiz, 2012), on this occasion we used the regression procedure which involves the SPSS *Missing Value Analysis* module, noting whether the missing data was in level 1 or 2. If the missing data was in the lower level, the school was used as the group to perform the regression. If the missing data was a level 2 variable, the regression was performed at country level. This gives an imputation which is as close as possible to the record.

Results

Table II gives the SECI by country and the percentage of academically resilient students in each country or region, together with the standard errors of the estimated parameters. Overall in the EU the estimate is

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that 20.53% of students are resilient. Poland and Italy have the highest proportion of resilient students, while Belgium (Fr) and Malta have the lowest. The proportion of resilient students in Spain is statistically equal to the EU proportion overall.

TABLE II. SECI and percentage of resilient students by country and region

	SECI	S.E. of SECI	Percentage of resilient students	S.E. of percentage
Germany	0.01	0.04	20	1.86
Austria	0.09	0.03	16.43	1.8
Belgium (Fl)	0.25	0.03	12.8	1.25
Belgium (Fr)	0.11	0.03	5.96	0.77
Bulgaria	-0.24	0.06	27.48	3.4
Czechia	0.09	0.03	22.88	1.81
Denmark	0.65	0.03	17.45	1.56
Slovenia	0.16	0.03	22.09	1.9
Spain	-0.02	0.03	20.93	1.1
Finland	0.49	0.02	32.76	1.95
France	0.01	0.03	11.88	1.21
Hungry	0	0.06	25.33	2.15
Ireland	0.23	0.03	36.23	1.9
Northern Ireland	0.34	0.03	36.9	2.03
Italy	-0.45	0.04	40.57	1.88
Latvia	0.3	0.03	27.18	1.77
Lithuania	0.11	0.03	23.14	1.76
Malta	-0.1	0.01	6.45	0.77
The Netherlands	0.45	0.03	19.23	1.85
Poland	-0.04	0.03	42.22	2.2
Portugal	-0.2	0.03	24.95	1.8
Slovakia	-0.16	0.04	18.92	1.71
Sweden	0.66	0.03	18.8	1.61
Total EU	0	0.01	20.53	0.29

Source: compiled by the researchers.

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Table III gives the results of the binary hierarchical logistic model by country and region. In each case we show the most important estimations associated with the variables of study, both level 1 (students) and level 2 (schools): coefficient, standard error of estimation of the coefficient, p-value and odds ratio. The level of significance was set at 95% and variables were significant for the model with a p-value below 0.05. The statistically significant variables for the model in each country are marked in grey and the odds ratios for those variables are in bold.

TABLE III. Summary of results of multilevel binary hierarchical logistic analysis

		IG00	GRRS	GEAS	GDAS	SEX	HAPS	GSSB	GERL	GSLR	GSCR	HELA	HELT	HPCS	HPLR
Germany	Coefficient	-0.776	0.044	0.439	0.447	0.042	0.275	0.167	-0.268	0.080	0.593	0.184	-0.060	0.016	0.179
	S.E.	0.254	0.135	0.157	0.160	0.312	0.218	0.126	0.134	0.167	0.117	0.156	0.161	0.098	0.133
	P-value	0.003	0.746	0.006	0.006	0.894	0.208	0.185	0.045	0.631	0.000	0.239	0.709	0.869	0.179
	Odds ratio	**0.460**	1.045	**1.551**	**1.564**	1.043	1.317	1.182	**0.765**	1.083	**1.809**	1.202	0.942	1.016	1.196
Austria	Coefficient	-1.240	0.023	0.604	0.007	-0.213	-0.173	-0.101	-0.210	-0.024	0.799	0.187	0.031	-0.032	0.044
	S.E.	0.407	0.178	0.273	0.296	0.261	0.349	0.127	0.186	0.196	0.107	0.157	0.132	0.120	0.154
	P-value	0.003	0.896	0.029	0.981	0.414	0.620	0.427	0.259	0.902	0.000	0.233	0.816	0.790	0.775
	Odds ratio	**0.289**	1.024	**1.829**	1.007	0.808	0.841	0.904	0.811	0.976	**2.224**	1.206	1.031	0.968	1.045
Belgium (Fl.)	Coefficient	-2.270	0.186	0.231	-0.036	-0.546	0.730	0.201	0.014	0.065	0.493	-0.072	-0.028	0.130	-0.011
	S.E.	0.332	0.164	0.189	0.121	0.245	0.353	0.150	0.150	0.099	0.109	0.090	0.129	0.124	0.104
	P-value	0.000	0.259	0.224	0.767	0.026	0.039	0.182	0.924	0.512	0.000	0.424	0.827	0.295	0.918
	Odds ratio	**0.103**	1.204	1.259	0.965	**0.579**	**2.074**	1.222	1.014	1.067	**1.638**	0.931	0.972	1.138	0.989
Belgium (Fr)	Coefficient	-2.343	-0.281	0.533	0.181	-0.399		-0.056	-0.001	0.485	0.668	0.050	0.035	-0.067	0.218
	S.E.	0.227	0.260	0.157	0.174	0.301		0.158	0.159	0.160	0.143	0.179	0.200	0.131	0.152
	P-value	0.000	0.283	0.001	0.299	0.185		0.721	0.996	0.003	0.000	0.778	0.861	0.611	0.151
	Odds ratio	**0.096**	0.755	**1.704**	1.198	0.671		0.945	0.999	**1.625**	**1.951**	1.052	1.036	0.936	1.244

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Bulgaria	**Coefficient**	-0.400	-0.061	0.366	0.005	-0.209	-0.076	-0.257	0.368	-0.240	0.461	-0.099	0.225	-0.092	-0.102
	S.E.	0.363	0.161	0.221	0.158	0.253	0.214	0.143	0.113	0.109	0.122	0.087	0.114	0.170	0.148
	P-value	0.273	0.705	0.101	0.977	0.409	0.722	0.073	0.002	0.028	0.000	0.255	0.048	0.588	0.491
	Odds ratio	0.670	0.941	1.442	1.005	0.811	0.927	0.774	**1.445**	**0.786**	**1.586**	0.906	**1.253**	0.912	0.903
Czechia	**Coefficient**	-1.840	-0.077	0.024	-0.059	0.170	0.948	0.285	-0.346	0.040	0.627	-0.089	0.134	-0.118	0.280
	S.E.	0.272	0.136	0.132	0.166	0.190	0.271	0.124	0.116	0.125	0.097	0.123	0.103	0.109	0.098
	P-value	0.000	0.570	0.854	0.724	0.371	0.001	0.022	0.003	0.751	0.000	0.472	0.196	0.279	0.005
	Odds ratio	**0.159**	0.926	1.025	0.943	1.185	**2.580**	**1.330**	**0.708**	1.040	**1.873**	0.915	1.143	0.889	**1.323**
Denmark	**Coefficient**	-3.164	0.099	0.183	-0.335	-0.052	1.387	0.224	-0.121	0.167	0.776	-0.066	0.276	0.079	-0.066
	S.E.	0.651	0.122	0.172	0.176	0.353	0.642	0.136	0.193	0.204	0.133	0.165	0.131	0.108	0.153
	P-value	0.000	0.419	0.289	0.058	0.884	0.031	0.101	0.531	0.413	0.000	0.690	0.036	0.463	0.667
	Odds ratio	**0.042**	1.104	1.201	0.715	0.950	**4.003**	1.251	0.886	1.182	**2.173**	0.937	**1.317**	1.083	0.936
Slovenia	**Coefficient**	-0.813	-0.190	0.242	-0.088	-0.567	0.156	0.245	-0.599	0.258	0.693	0.178	0.101	-0.193	0.073
	S.E.	0.325	0.169	0.188	0.114	0.237	0.294	0.138	0.154	0.159	0.107	0.117	0.099	0.126	0.170
	P-value	0.014	0.265	0.200	0.442	0.017	0.596	0.076	0.000	0.104	0.000	0.126	0.307	0.127	0.667
	Odds ratio	**0.444**	0.827	1.273	0.916	**0.567**	1.168	1.278	**0.549**	1.295	**1.999**	1.195	1.106	0.825	1.076
Spain	**Coefficient**	-1.291	0.060	-0.076	0.098	-0.028	0.058	0.210	-0.089	-0.160	0.598	0.146	0.334	-0.074	-0.080
	S.E.	0.187	0.080	0.069	0.076	0.129	0.183	0.074	0.087	0.070	0.088	0.084	0.101	0.070	0.081
	P-value	0.000	0.458	0.276	0.197	0.831	0.751	0.005	0.309	0.023	0.000	0.081	0.001	0.292	0.318
	Odds ratio	**0.275**	1.061	0.927	1.103	0.973	1.060	**1.234**	0.915	**0.852**	**1.819**	1.157	**1.396**	0.929	0.923
Finland	**Coefficient**	-0.816	-0.147	0.057	0.283	0.015	-0.040	0.061	-0.133	0.268	0.634	-0.135	0.527	-0.019	0.033
	S.E.	0.215	0.129	0.121	0.122	0.170	0.213	0.095	0.120	0.113	0.114	0.116	0.088	0.112	0.102
	P-value	0.000	0.257	0.635	0.021	0.929	0.853	0.522	0.266	0.018	0.000	0.248	0.000	0.865	0.745
	Odds ratio	**0.442**	0.863	1.059	**1.327**	1.015	0.961	1.063	0.875	**1.308**	**1.885**	0.874	**1.693**	0.981	1.034

France	Coefficient	-1.468	0.037	-0.095	0.440	-0.549	-0.118	0.026	0.090	-0.201	0.671	-0.068	0.596	0.039	-0.025
	S.E.	0.334	0.183	0.222	0.181	0.298	0.350	0.162	0.138	0.129	0.101	0.149	0.153	0.130	0.170
	P-value	0.000	0.841	0.670	0.016	0.065	0.736	0.874	0.513	0.120	0.000	0.650	0.000	0.767	0.885
	Odds ratio	**0.230**	1.038	0.910	**1.553**	0.578	0.889	1.026	1.094	0.818	**1.956**	0.935	**1.814**	1.039	0.976
Hungary	Coefficient	-0.755	-0.028	-0.030	0.394	-0.373	0.256	0.255	0.005	-0.099	0.774	-0.112	0.143	-0.136	-0.092
	S.E.	0.418	0.158	0.179	0.138	0.199	0.338	0.099	0.108	0.123	0.100	0.112	0.111	0.112	0.139
	P-value	0.073	0.860	0.866	0.006	0.060	0.450	0.010	0.964	0.423	0.000	0.320	0.197	0.223	0.508
	Odds ratio	0.470	0.972	0.970	**1.483**	0.689	1.291	**1.290**	1.005	0.906	**2.169**	0.894	1.154	0.873	0.912
Ireland	Coefficient	-0.963	0.276	-0.011	-0.003	-0.269	0.280	0.332	-0.327	0.075	0.580	0.169	0.665	-0.049	-0.064
	S.E.	0.221	0.082	0.075	0.111	0.171	0.199	0.112	0.110	0.129	0.101	0.116	0.120	0.114	0.092
	P-value	0.000	0.001	0.879	0.977	0.117	0.159	0.004	0.004	0.559	0.000	0.148	0.000	0.666	0.488
	Odds ratio	**0.382**	**1.317**	0.989	0.997	0.764	1.323	**1.393**	**0.721**	1.078	**1.787**	1.184	**1.945**	0.952	0.938
Northern Ireland	Coefficient	-0.521	-0.074	0.137	0.130	-0.245		0.141	-0.379	0.212	0.803	-0.050		0.192	-0.053
	S.E.	0.193	0.157	0.140	0.217	0.185		0.144	0.112	0.121	0.102	0.103		0.131	0.092
	P-value	0.008	0.638	0.328	0.552	0.186		0.326	0.001	0.082	0.000	0.627		0.142	0.562
	Odds ratio	**0.594**	0.929	1.147	1.138	0.783		1.152	**0.684**	1.236	**2.233**	0.951		1.212	0.948
Italiy	Coefficient	-0.482	-0.094	0.128	0.181	0.150	0.411	0.200	-0.061	-0.204	0.665	-0.031	0.147	0.112	0.033
	S.E.	0.315	0.173	0.175	0.089	0.151	0.311	0.123	0.127	0.105	0.092	0.099	0.103	0.088	0.094
	P-value	0.128	0.588	0.465	0.044	0.321	0.187	0.104	0.633	0.052	0.000	0.754	0.153	0.203	0.722
	Odds ratio	0.617	0.911	1.137	**1.199**	1.162	1.509	1.222	0.941	0.816	**1.944**	0.970	1.158	1.119	1.034
Latvia	Coefficient	-0.277	0.016	0.241	0.195	-0.568	-0.236	0.213	-0.315	-0.139	0.721	-0.044	0.388	-0.113	-0.111
	S.E.	0.487	0.100	0.165	0.137	0.235	0.418	0.156	0.203	0.138	0.144	0.106	0.149	0.110	0.151
	P-value	0.569	0.870	0.146	0.158	0.016	0.573	0.172	0.121	0.314	0.000	0.675	0.010	0.306	0.464
	Odds ratio	0.758	1.016	1.273	1.215	**0.566**	0.790	1.238	0.730	0.870	**2.058**	0.957	**1.474**	0.893	0.895

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Lithuania	Coefficient	-1.406	0.010	0.101	0.345	-0.383	0.258	-0.019	0.031	-0.343	0.654	-0.093	0.644	0.092	0.021
	S.E.	0.221	0.150	0.160	0.140	0.269	0.206	0.133	0.173	0.143	0.122	0.144	0.151	0.151	0.118
	P-value	0.000	0.947	0.530	0.015	0.155	0.211	0.890	0.857	0.017	0.000	0.520	0.000	0.542	0.858
	Odds ratio	**0.245**	1.010	1.106	**1.412**	0.682	1.294	0.982	1.032	**0.710**	**1.923**	0.912	**1.904**	1.096	1.021
Malta	Coefficient	-2.605	-0.140	0.110	-0.222	-0.395	-0.117	0.021	0.262	-0.063	0.875	0.130	0.249	-0.007	-0.101
	S.E.	0.513	0.162	0.187	0.212	0.300	0.421	0.132	0.181	0.140	0.118	0.147	0.168	0.270	0.148
	P-value	0.000	0.389	0.560	0.299	0.188	0.782	0.871	0.149	0.651	0.000	0.377	0.139	0.980	0.496
	Odds ratio	**0.074**	0.869	1.116	0.801	0.674	0.890	1.022	1.299	0.939	**2.398**	1.139	1.283	0.993	0.904
The Netherlands	Coefficient	-1.628	0.281	-0.049	0.032	-0.375	0.379	0.240	-0.450	0.486	0.503	0.144	0.296	-0.061	0.259
	S.E.	0.416	0.174	0.171	0.176	0.262	0.447	0.120	0.161	0.140	0.098	0.140	0.157	0.130	0.139
	P-value	0.000	0.110	0.774	0.855	0.153	0.397	0.044	0.006	0.001	0.000	0.305	0.058	0.638	0.063
	Odds ratio	**0.196**	1.324	0.952	1.033	0.687	1.461	**1.272**	0.638	**1.625**	**1.653**	1.154	1.345	0.941	1.295
Poland	Coefficient	-0.153	-0.267	0.064	0.383	-0.430	0.091	0.030	-0.051	-0.360	0.612	-0.240	0.519	0.108	0.257
	S.E.	0.225	0.084	0.127	0.137	0.195	0.237	0.125	0.147	0.132	0.105	0.116	0.158	0.117	0.128
	P-value	0.498	0.002	0.618	0.006	0.027	0.701	0.813	0.725	0.007	0.000	0.038	0.001	0.356	0.044
	Odds ratio	0.858	**0.765**	1.066	**1.466**	**0.650**	1.095	1.030	0.950	**0.698**	**1.844**	**0.786**	**1.680**	1.114	**1.293**
Portugal	Coefficient	-0.645	-0.177	0.007	0.243	-0.193	-0.053	0.131	0.008	-0.254	0.804	-0.048	0.163	-0.142	0.065
	S.E.	0.273	0.135	0.120	0.116	0.160	0.220	0.096	0.095	0.094	0.085	0.080	0.077	0.088	0.093
	P-value	0.019	0.190	0.952	0.037	0.229	0.808	0.173	0.937	0.007	0.000	0.549	0.035	0.107	0.484
	Odds ratio	**0.525**	0.837	1.007	**1.275**	0.824	0.948	1.139	1.008	**0.775**	**2.234**	0.953	**1.177**	0.868	1.067
Slovakia	Coefficient	-1.385	-0.221	0.401	0.039	0.120	0.719	0.068	-0.068	0.106	0.566	-0.009	-0.035	-0.075	0.179
	S.E.	0.251	0.183	0.162	0.145	0.187	0.260	0.114	0.115	0.117	0.086	0.116	0.107	0.090	0.103
	P-value	0.000	0.229	0.015	0.789	0.522	0.006	0.548	0.555	0.365	0.000	0.937	0.741	0.408	0.082
	Odds ratio	**0.250**	0.802	**1.493**	1.040	1.128	**2.053**	1.071	0.934	1.112	**1.761**	0.991	0.965	0.928	1.196

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Sweden	Coefficient	-2.301	0.249	-0.097	0.178	0.074	0.764	0.005	-0.400	0.210	0.546	-0.144	0.522	-0.038	-0.039
	S.E.	0.411	0.154	0.159	0.190	0.229	0.346	0.132	0.146	0.112	0.133	0.105	0.136	0.098	0.111
	P-value	0.000	0.108	0.544	0.350	0.746	0.027	0.972	0.007	0.061	0.000	0.173	0.000	0.696	0.724
	Odds ratio	**0.100**	1.283	0.908	1.195	1.077	**2.147**	1.005	**0.670**	1.233	**1.727**	0.866	**1.685**	0.962	0.962

IG00: Intercept, GRRS: limited teaching due to lack of reading resources , GEAS: academic emphasis in the school, GDAS: school discipline, SEX: sex of student, HAPS: attendance at pre-primary school, GSSB: feeling of belonging at school, GERL: student commitment to reading classes, GSLR: student enjoyment of reading, GSCR: reading confidence, HELA: early reading skill activities before attending school, HELT: early reading comprehension activities, HPCS: family perception of school HPLR: family enjoyment of reading

Source: compiled by the researchers..

Conclusions

This study had two objectives: establish a procedure to identify academically resilient students in reading comprehension, and analyse the associated individual, family, and school factors. With respect to the first objective, we estimate that in the EU, one in five students is academically resilient in reading. However, there were significant variations in the proportion of resilient students in each country. In some cases just over 5% of the student population were resilient, while in others this figure was over 35%.

In terms of the second objective, the results confirm that the impact on resilience of each analysed variable varied by country, probably due to cultural differences or perhaps as a consequence of the distinct education systems in each country (Mullis, Martin, Goh & Prendergast, 2017; OCDE, 2016). Nonetheless, there were some common general patterns, with one variable in each level standing out from the rest. At the student level (Level 1) the variable related to reading confidence (GSCR) was statistically significant in all countries, showing that students who exhibited more self-confidence in their reading were twice as likely to be resilient as those with less confidence. This is in line with Jacob (2002) and Waxman, Huang and Padron (1997), who stated that resilient students have more confidence in their reading potential and are more industrious and persistent in their tasks. At the school level (Level 2), the variable with the greatest effect is school discipline (GDAS), a high value in the index of school discipline may mean more than a 50% chance of

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a student at that school being resilient, confirming findings from Agasisti et al. (2018).

Apart from student reading confidence, it is worth noting other student factors, either because they are high, or scarce. Having had early reading comprehension activities (HELT) was significant in 11 of the countries examined, where students who did these activities before attending primary school were more likely to be resilient than those who did not. The increase in probability of being resilient in this variable ranged between 17.7% in Portugal and 94.5% in Ireland, which supports the findings of the OECD (2018) in terms of the benefits of students starting primary school with prior knowledge of reading. Student commitment in reading classes (GERL) and reading enjoyment (GSLR) were also significant in a number of countries, although the important thing to note in this case is that the effect could be positive or negative depending on the country. Students who did not enjoy reading and had little commitment in reading classes may become resilient, probably because the effect of other factors compensates for these variables, although to confirm this it would be necessary to do more analysis in future research. Attending pre-primary school (HAPS) was statistically significant in five countries, where it at least doubled the likelihood of being resilient, especially in Denmark, where those attending two or more years of pre-primary school were four times as likely to be resilient as those attending one year or less, which coincides with results from the OECD (2018). A sense of belonging at school (GSSB) also influenced resilience, although in those cases the increased probability of being resilient was no more than 40%. Family perception of school (HPCS) and family enjoyment of reading (HPLR) were not significant in this study, in contrast to other research such as Martín-Lagos (2018), which did indicate the importance of family motivation.

For school variables other than school discipline, academic emphasis at the school, when it is significant, may increase the probability of being resilient by 82.9%, as in the case of Austria. However, a lack of reading resources at school was not significant in the analysis of resilience, probably because, as indicated by Gaviria, Martínez Arias, and Castro (2004), the resources variable would tend to have a greater effect in developing than developed countries.

This data has significant implications which could guide education policies, and seems to indicate that efforts to improve student resilience

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should be aimed at developing programs to improve reading confidence, along with encouraging reading skill activities before primary school as that would better compensate for situations of social, economic or cultural disadvantage in terms of academic results. Pre-primary development programs and early beginning of reading before attending primary school will be key to improving the performance of students in unfavourable situations, and it would also be useful to get the active participation of families to improve the sense of belonging at school along with their expectations for their children and the schools themselves. One should not forget that a favourable school climate also brings with it an increased likelihood that students will produce results above what might be expected for their SECI.

The results of this study should be evaluated in light of some limitations, which should be considered in future research. Firstly, and given the nature of PIRLS studies, some student variables that may influence resilience were not available, such as cognitive skills, personality profiles, or learning styles and family involvement (Santos, Ferraces, Godas & Lorenzo, 2018). Another limitation is that this study used a transversal design which does not allow us to examine progression over time, which would be extremely interesting. We do not know whether our results for Reading Comprehension would be generalisable to other areas of academic performance such as science or mathematics. Looking to the future, it would be advisable to include recent methodological advances in the construction and analysis of indicators (Byrne & van de Vijver, 2017; Suárez et al., 2018).

References

Agasisti, T., Avvisati, F. B. & Longobardi, S. (2018). Academic resilience: What schools and countries do to help disadvantaged students succeed in PISA. *OECD Education Working Papers*, 167, 1-40. doi: http://dx.doi.org/10.1787/e22490ac-en

Barca, A., Mascarenhas, S.A., Brenlla, J.C., & Morán, H. (2012). Contextos de aprendizaje, determinantes familiares y rendimiento escolar en el alumnado de Educación Secundaria de Galicia [Learning contexts, family determiners and

school performance in students of secondary education in Galicia]. *Revista AMAzónica*, *9*(2), 370-412.

Barragán, A. B., Pérez-Fuentes, M. C., Martos, Á., Simón, M. M., Molero M. M., Martínez-Sánchez, A., Sánchez-Beato, E. J. & Gázquez, J. J. (2016). Intervención y variables del personal docente y el centro escolar que modulan el rendimiento académico del alumno [Intervention and variables in the teaching staff and the school which modulate student academic performance]. *European Journal of Child Development, Education and Psychopathology, 4*(2), 89-97. doi: https://doi.org/10.1989/ejpad.v4i2.37

Bettinger, E.P., & Long, B.T. (2005). Do Faculty Serve as Role Models? The Impact of Instructor Gender on Female Students. *American Economic Review, 95*(2), 152-157. doi: 10.1257/000282805774670149

Bernard, B. (1991). *Fostering Resiliency in Kids: Protective Fac-tors in the Family, School, and Community.* Wes Ed. Regional Educational Laboratory. Recuperado de https://www.wested.org/wp-content/files_mf/1373568312resource93.pdf

Bryk, A. & Raudenbush, S. (2002). *Hierarchical linear models: Aplications and data analysis methods*. London: SAGE.

Byrne, B. M., & van de Vijve, F. J. (2017). The maximum likelihood alignment approach to testing for approximate measurement invariance: A paradigmatic cross-cultural application. *Psicothema, 29*(4), 539-551. doi: 10.7334/psicothema2017.178

Carle, A. & Chassin, L. (2004). Resilience in a community sample of children of alcoholics: Its prevalence and relation to internalizing symptomatology and positive affect. *Journal of Applied Developmental Psychology, 25*(5), 577-595. doi: https://doi.org/10.1016/j.appdev.2004.08.005

Choi, A. & Calero, J. (2013). Determinantes del riesgo de fracaso escolar en España en PISA-2009 y propuestas de reforma [Determinants of the risk of school failure in Spain in PISA-2009 and proposals for reform] *Revista de Educación, 362*, 562-593. doi: 10.4438/1988-592X-RE-2013-362-242

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, A. M., Weinfeld, F. D., & York, R. L. (1966). *Equality of Educational Opportunity*, Washington, DC: Government Printing Office.

Cordero, J. M. & Manchón, C. (2014). Factores explicativos del rendimiento en educación primaria: un análisis a partir de TIMSS 2011. [Explanatory Factors for Achievement in Primary Education: An Analysis Using TIMSS 2011]. *Estudios Sobre Educación*, *27*, 9-35. doi. https://doi.org/10.15581/004.27.9-35

De la Cruz, F. (2008). Modelos multinivel [Multi-level models]. *Revista Peruana de Epidemiolología*, *12*(3), 1-8. Recuperado de http://sisbib.unmsm.edu.pe/bvrevistas/epidemiologia/v12_n3/pdf/a02v12n3.pdf

Enríquez, M., Insuasty, M., & Sarasty, M. (2018). Escuela para familias: Un escenario de socialización entre la familia y la escuela [School for Families: A scenario of socialization between the family and the school]. *Revista Katharsis, 25,* 94-107. Recuperado de http://revistas.iue.edu.co/index.php/katharsis/article/view/978

Feinstein, L. & Symons, J. (1999). Attainment in secondary education. *Oxford Economic Papers*, *51*(2), 300-321. doi: https://doi.org/10.1093/oep/51.2.300

Fernández-Alonso, R., Álvarez-Díaz, M., Woitschach, P., Suárez-Álvarez, J., & Cuesta, M. (2017). Parental involvement and academic performance: Less control and more communication. *Psicothema, 29*(4), 453-461. doi: 10.7334/psicothema2017.181

Fernández-Alonso, R., & Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de las competencias básicas [Booklet designs for the evaluation of basic skills]. *Aula Abierta*, *39*(2), 3-34.

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2012). Imputación de datos perdidos en las evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. *Psicothema, 24*(1), 167-175. Recuparado de: http://www.psicothema.com/psicothema.asp?id=3995

García Sanz, M. P. (2003). *La evaluación de programas en la intervención socioeducativa.* Murcia: DM.

Gaviria, J, L., Martínez Arias, R. & Castro, M. (2004). Un estudio multinivel sobre los factores de eficacia escolar en países en desarrollo. El caso de los recursos en Brasil. *Education Policy Análisis Archives, 12*(20). Recuperado de http://epaa http://www.quadernsdigitals.net/datos/hemeroteca/r_69/nr_720/a_9700/9700.html .asu.edu/epaa/v12n20/

González-Arratia, N., & Valdez, J. (2007). Resiliencia en Niños [Children´s Resiliency]. *Psicología Iberoamericana, 15*(2), 38-50. Recuperado de http://www.redalyc.org/articulo.oa?id=133915933006

Grotberg, E. (1995). *A guide to promoting resilience in children: streng -hening the human spirit.* The International Resilience Project. BernardVan Leer Foundation: La Haya, Holanda.

Iñiguez-Berrozpe, T., & Marcaletti, F. (2018). Modelos lineales multinivel en SPSS y su aplicación en investigación educativa [Models lineals multinivell en SPSS i la seva aplicació en investigació educativa]. *REIRE Revista d'Innovació i Recerca en Educació, 11*(1), 26-40. doi: http://doi.org/10.1344/reire2018.11.118984

Received: 16-05-2018 Accepted: 11-02-2019

Jacob, B. A. (2002). Where the Boys Aren't: Noncognitive Skills, Returns to School and the Gender Gap in Higher Education. *Economics of Education Review, 21*(6), 589-598. Recuperado de http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.603.1097&rep=rep1&type=pdf

Jadue, G., Galindo, A. & Navarro, L. (2005). Factores de riesgo para el desarrollo de la resiliencia encontrados en una comunidad educativa en riesgo social [Protective and risk factors for the development of resilience in a social risk school]. *Estudios Pedagógicos, XXXI*(2), 43-55. Recuperado de http://www.redalyc.org/pdf/1735/173519073003.pdf

Kang, C. (2007). Classroom peer effects and academic achievement: Quasi-randomization evidence from South Korea. *Journal of Urban Economics, 61*, 458-495.

Kirjavainen, T. & Loikkanen H. A. (1998). Efficiency differences of Finnish senior secondary schools: an application of DEA and Tobit analysis. *Economics of Education Review*, *17*(4), 377-394. doi. https://doi.org/10.1016/S0272-7757(97)00048-4

Kobasa, S. C., Maddi, S. R., & Kahn, S. (1982). Hardiness and health: A prospective study. *Journal of Personality and Social Psychology, 42*(1), 168-177. doi. http://dx.doi.org/10.1037/0022-3514.42.1.168

Kotliarenco, M. A., Cáceres, I. & Fontecilla, M. (1997). *Estado del arte en resiliencia [State of the art in resilience]*. Organización Panamericana de la Salud. Recuperado de http://www1.paho.org/hq/dmdocuments/2009/Resil6x9.pdf

Lamas, H. (2015). Sobre el rendimiento escolar. *Propósitos y Representaciones, 3*(1), 313-386. doi: http:// dx.doi.org/10.20511/pyr2015.v3n1.74

Luthar, S. S. (2006). Resilience in development: A synthesis of research across five decades. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology: Risk, disorder, and adaptation* (pp. 739-795). Hoboken, NJ: John Wiley. doi. 10.1002/9780470939406.ch20

Manciaux, M. (2003). *La resiliencia: resistir y rehacerse*. España: Gedisa

Martin, M. O., Mullis, I. V. S., & Hooper, M. (Eds.). (2017). *Methods and Procedures in PIRLS 2016*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/publications/pirls/2016-methods.html

Martín-Lagos, M. D. (2018). Educación y desigualdad: una metasíntesis tras el 50 aniversario del Informe Coleman [Education and inequality: a meta-synthesis after the 50th anniversary of Coleman's report]. *Revista de Educación*, *380*, 186-209. doi: 10.4438/1988-592X-RE-2017-380-377

Ministerio de Educación, Cultura y Deporte (2017). *PIRL 2016: Estudio internacional del progreso en competencia lectora. Informe español [International study of progress in reading competence. Spanish report]*. Madrid: Instituto Nacional de Evaluación Educativa. Recuperado de https://www.mecd.gob.es/inee/evaluaciones-internacionales/pirls/pirls-2016.html

Moffitt, T., Caspi, A., Rutter, M., & Silva, P. (2001). *Sex Differences in Antisocial Behaviour: Conduct Disorder, Delinquency, and Violence in the Dunedin Longitudinal Study* (Cambridge Studies in Criminology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511490057

Montes, I.C. & Lerner, J. (2011). *Rendimiento académico de los estudiantes de pregrado de la Universidad EAFIT: Perspectiva cuantitativa [Academic performance of undergraduate students at EAFIT University: A quantitative perspective]*. Grupo de estudios en economía y empresa, Departamento de Desarrollo Estudiantil, Universidad EAFIT.

Mullis, I. V. S., & Martin, M. O. (Eds.). (2015). *PIRLS 2016 Assessment Framework* (2nd ed.). Recuperado de Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu/pirls2016/framework.html

Mullis, I. V. S., Martin, I. M. O., Foy, P., & Hooper, M. (2017). *PIRLS 2016 International Results in Reading*. Recuperado de Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu/pirls2016/international-results/

Mullis, I. V. S., Martin, M. O., Goh, S., & Prendergast, C. (Eds.). (2017). PIRLS 2016 Encyclopedia: Education Policy and Curriculum in Reading. Recuperado de Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu/pirls2016/encyclopedia/

Muñoz-Izquierdo, C. & Guzmán, J. T. (2010). Una exploración de los factores determinantes del rendimiento escolar en la educación primaria [An exploration of the determinants of school performance in primary education]. *Revista Latinoamericana de Estudios Educativos (México), XL*(2), 167-191. Recuperado de http://www.redalyc.org/pdf/270/27018884008.pdf

Muñoz, V. & De Pedro, F. (2005). Educar para la resiliencia. Un cambio de mirada en la prevención de situaciones de riesgo social [Educate for resilience. A change of perspective in the prevention of social risk situations]. *Revista Complutense de educación, 16*(1), 107-124. Recuperado de http://revistas.ucm.es/index.php/RCED/article/view/16914

OECD (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education, PISA*. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264266490-en

OECD (2018). *The Resilience of Students with an Immigrant Background: Factors that Shape Well-being, OECD Reviews of Migrant Education.* OECD Publishing, Paris. doi. http://dx.doi.org/10.1787/9789264292093-en.

Real Academia Española. (2014). *Resiliencia [resilience]*. En Diccionario de la lengua española (24.a ed.). Recuperado de http://dle.rae.es/?id=WA5onlw

Robertson, D. & Symons, J. (2003). Do Peer Groups Matter? Peer Group versus Schooling Effects on Academic Attainment. *The London School of Economics and Political Science, 70*(277), 31-53. doi: 10.1111/1468-0335.d01-46

Rutter, M. (1993). Resilience: Some conceptual considerations. *Journal of Adolescent Health*, *14*(8), 626-631. doi. https://doi.org/10.1016/1054-139X(93)90196-V

Santos, M. A., Ferraces, M. J., Godas, A., Lorenzo, M. M. (2018). Do cooperative learning and family involvement improve variables linked to academic performance? *Psicothema, 30*, 212-217. doi: 10.7334/psicothema2017.311

Servicio de Evaluación Educativa. (2017). Éxito contra todo pronóstico: el alumnado académicamente resiliente [Success against all odds: academically resilient students]. *Informe Evaluación, 12*, 1-8. Recuperado de https://www.educastur.es/-/informe-evaluacion-n-12-exito-contra-todo-pronostico-el-alumnado-academicamente-resiliente

Suárez, J., Pedrosa, I., Lozano, L., García-Cueto, E., Cuesta, M. y Muñiz, J. (2018). Using reversed items in Likert scales: A questionable practice. *Psicothema, 30*, 149-158. doi: 10.7334/psicothema2018.33

von Davier, M., Gonzalez, E., & Mislevy, R. J. (2009). What are plausible values and why are they useful? *IERI Monograph Series. Issues and Methodologies in Large-Scale Assessments*, *2*, 9-36. Recuperado de 15 de Enero, 2017 http://www.ierinstitute.org/fileadmin/Documents/IERI_Monograph/IERI_Monograph_Volume_02.pdf

Waxman, H., Huang, S. & Padron Y. (1997). Motivation and Learning Environment Differences between Resilient and Nonresilient Latino Middle School Students. *Hispanic Journal of Behavioral Sciences, 19*(2), 137-155. doi: https://doi.org/10.1177/07399863970192003

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3.2. Segundo artículo

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2019a). Resilient and low performer students: Personal and family determinants in European countries. *Psicothema, 31*(4), 363-375. doi:10.7334/psicothema2019.245

El principal objetivo de este artículo es comprobar cómo se comportan las variables que tienen impacto en la condición de resiliencia (postiva o negativamente) en aquellos estudiantes que se consideran de muy bajo rendimiento. La principal aportación de este artículo a la Tesis Doctoral es demostrar que el efecto estadísticamente significativo en un sentido y en una de las probabilidades (resiliencia o muy bajo rendimiento), en la otra podrá ser estadísticamente significativo en sentido contrario o sin efecto.

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Resilient and low performer students: Personal and family determinants in European countries

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Abstract

Background: Students' academic achievement depends on their personal, family and sociocultural characteristics. This study aims to identify the personal and family factors of European students who do not perform as expected, whether by surpassing expectations (resilient) or by failing to meet them (low performers). **Method:** The sample was composed of 117,539 fourth grade students who completed the Progress in International Reading Literacy Study (PIRLS) test, from 23 European Union countries. Academic performance was evaluated via a reading comprehension test. For each country, two binary logistic regression models were used, one for resilient students and the other for low performers. Variables related to the students and their families were used as predictor variables. **Results:** Significant differences were found between European countries in terms of the proportion of resilient and low performing students. The two variables with the most predictive power were student confidence with reading, and having done early literacy activities. **Conclusions:** Students' personal characteristics and family conditions are instrumental in students being considered resilient or low performers.

Keywords: Resilience, academic low performing, reading comprehension, PIRLS.

Resumen

Estudiantes resilientes y de bajo rendimiento: determinantes personales y familiares en países europeos. **Antecedentes:** el rendimiento académico de los estudiantes depende de sus características personales, familiares y socioculturales. El presente trabajo trata de identificar los factores personales y familiares de los estudiantes europeos que no obtienen el rendimiento esperado, bien sea porque superan las expectativas previas (resilientes), o porque rinden por debajo de lo esperado (low performers). **Método:** la muestra está formada por 117.539 estudiantes de cuarto grado que realizaron la prueba de Progress in International Reading Literacy Study (PIRLS), pertenecientes a 23 países de la Unión Europea. El rendimiento académico se evaluó mediante una prueba de compresión lectora. Para cada país se utilizaron dos modelos de regresion logística binaria, uno para los alumnos resilientes y otro para los low performers. Como variables predictoras se utilizaron variables asociadas al alumno y a su familia. **Resultados:** se han obtenido diferencias importantes entre los países europeos en relación a la proporción de alumnos resilientes y low performers. La confianza de los estudiantes en la lectura y el haber realizado actividades de alfabetización temprana son las dos variables con mayor poder predictivo. **Conclusiones:** las características personales del alumnado y sus condiciones familiares son determinantes para que los estudiantes sean considerados resilientes y low performers.

Palabras clave: resiliencia, bajo rendimiento académico, comprensión lectora, PIRLS.

A deep understanding of what personal, social and family factors most affect academic performance is particularly important in improving student achievement and reducing academic failure (Barragán et al., 2016; Berliner, 2009; Carrillo, Civís, Blanch, Longás, & Riera, 2018; Henderson & Milstein, 2003; Jensen, 2013; Stockton, 2011). In this context, *resilient* students are those who achieve academic success despite adverse socioeconomic conditions, and *low performers* are those whose performance is worse than expected (García-Crespo, Galián, Fernández-Alonso, & Muñiz, 2019; Organisation for Economic Co-operation and Development (OECD), 2011; Servicio de Evaluación Educativa, 2017). Identifying the variables that promote resilience and reduce the proportion of low performers is fundamental in being able to help students and improve how education systems work. Choi and Calero (2013) indicated that students' capacity for resilience comes from the interaction between personal, family and school variables. Erberber, Stephens, Mamedova, Ferguson and Kroeger (2015), using results in science and mathematics from the TIMSS 2011, found that the factors that most affect student resilience were individual, such as the students' own expectations, whether they liked mathematics, or whether they were bullied at school, along with school-related factors, such as expectations of student performance, percentage of students with low socioeconomic levels, the school's interest in academic success, school safety and discipline, and the amount of academic resources. In general, most researchers have indicated that student's personal characteristics are the most significant. Martin and Marsh (2003) highlighted qualities such as self-confidence, the feeling of

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freedom and low anxiety accompanied by persistence and tenacity. Veas, López-López, Gilar, Miñano and Castejón (2017) had similar findings, and Jacob (2002) highlighted the capacity for attention, persistence, eagerness to learn and ability to work independently. González-Arratia and Valdez (2007) focused on a student's ability to maintain positive thinking about their vision of the future, which gives them more confidence in themselves, maintaining their ideals, and having autonomy and self-control. Kobasa, Maddi and Kahn (1982) underlined the importance of personal fortitude, Castejón, Gilar, Miñano and Veas (2016) highlighted that the difference lies in the student's intrinsic motivation, and Anwar, Shamim-ur-Rasool and Haq (2012) stated that creativity is decisive. Family can also be instrumental in achieving good results, as an association has been found with the academic expectations parents have for their children (Martín-Lagos, 2018). Fernández-Alonso, Álvarez-Díaz, Woitschach, Suárez-Álvarez and Cuesta (2017) proposed that students who presented a more distant or indirect profile of family involvement tended to have better results than students from more controlling homes. For Waxman, Huang and Padron (1997), the characteristics that make a student resilient were enthusiasm for and dedication to reading and homework, the students' academic objectives, their academic self-concept, and not repeating a school year. More specifically, what really marked the difference between good and poor student achievement was their motivation for reading, which also influenced their self-concept and general motivation (Vaknin-Nusbaum, Nevo, Brande, & Gambrell, 2017). Along similar lines, García-Crespo et al (2019) demonstrated that students' confidence with reading and a favorable school climate made it much more likely for a student to be resilient, but not the extent nor what values make a student a low performer. Identifying the variables associated with students getting lower than expected results is extremely important in order to reduce academic failure and improve education systems (Rodríguez-Rodríguez & Guzmán, 2019; Valle, Regueiro, Rodríguez et al., 2015).

Within this context, the objective of this research is to thoroughly analyze which personal and family variables are determinant when it comes to identifying resilient students and low performers. This general objective includes three specific objectives. First, examine whether the frequency of resilient students and low performers are homogeneously distributed in the 23 European Union countries that participated in the PIRLS-2016 test. This analysis will allow us to understand the behavior of European educational systems, and identify those that foster resilience and minimize low performers. Second, identify which personal and family variables are most significant in explaining resilient and low performing conditions, and check their invariance in relation to European Union countries. The third objective is to see what values of the variables identified as being significant make a student stop being a low performer and become resilient. Apart from the intrinsic scientific interest in these objectives, achieving them would have implications in application, which would on the one hand help students, increasing the proportion of resilient students compared to low performers, and on the other hand, improve how education systems work, making them more effective.

Method

Participants

The sample was composed of 117,539 students at 4,324 schools in 23 European Union countries (table 1).

Table 1
Sample description

Country	Number of students	Number of schools
Austria	4360	150
Belgium (Flemish)	5198	148
Belgium (French)	4623	158
Bulgaria	4281	153
Czech Republic	5537	157
Denmark	3508	185
England	5095	170
Finland	4896	151
France	4767	163
Germany	3959	208
Hungary	4623	149
Ireland	4607	148
Italy	3940	149
Latvia	4157	150
Lithuania	4317	195
Malta	3647	95
Netherlands	4206	132
North Ireland	3693	134
Poland	4413	148
Portugal	4642	218
Slovak Republic	5451	220
Slovenia	4499	160
Spain	14595	629
Sweden	4525	154
Total	117539	4324

The sampling was two-stage, sequential stratified by clusters, which is what is used in the PIRLS-2016 test. Each country determined which strata best represented the object population of the study, students who had had four years of compulsory schooling (4th grade). The two-stage model selected schools in the first stage, with a probability proportional to size. In the second stage, classes within the school were selected to participate. In this study, we used 24 samples, corresponding to the 23 European Union participants in PIRLS-2016, as Belgium included two samples, one Flemish-speaking and one French-speaking. Data from England could not be analyzed as they do not provide data from family questionnaires, which prevented us from creating an indicator of student socioeconomic level, something which is fundamental in this study to identify resilient students and low performers.

Instruments

Reading Comprehension test. In PIRLS, Reading aims and reading comprehension processes are evaluated (Mullis & Martin, 2015). To that end test booklets were created following the theoretical framework designed by the TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College, and IEA. Creating the test booklets begins with selection of the readings, from which the items are created. There are six literary readings and six informative readings with which 16 models of test booklets are constructed using an incomplete partially balanced design (Fernández-Alonso & Muñiz, 2011). Each student is assigned one test booklet comprising one literary text and one informative text, and the student must answer an average of 17 items per text. Some of the items are dichotomous, others partial credit, with three or four categories. Item Response Theory (IRT) models were used to assign scores to each scale with a mean of 500 and standard deviation 100, through five plausible values (Martin, Mullis, & Hooper, 2017). This process gives better population parameters than maximum likelihood procedures or *a posteriori* Bayesian methods (von Davier, González, & Mislevy, 2009). The psychometric properties of the test may be found in Martin, Mullis, & Hooper (2017).

Index of Economic, Social and Cultural Status (ESCS). This index was created from four variables included in the student and home context questionnaires: a) *Home possessions*, which has a value of 0 to 4 depending on whether the student responds that they have a computer or tablet, study desk, their own room, and internet connection, b) *books at home*, with five categories depending on the number of books, c) *parents' highest education level*, with five values based on the level of education that the students' parents have completed, d) *parents' highest occupation level*, with six categories: 0 (never had paid work), 1 (unskilled laborer), 2 (skilled worker), 3 (clerical), 4 (small business owner), and 5 (professional).

The ESCS index was obtained via Principal Component Analysis of the four variables, which explain 50.88% of the total variance, meaning it may be considered essentially unidimensional (Suárez-Álvarez et al., 2018; Villegas et al., 2018). According to this index, a student is resilient if they have an ESCS index below the first quartile in their country, and their performance in PIRLS 2016 is above the third quartile, once the individual ESCS is discounted. If their performance is below the first quartile of European Union achievement we can say that the student is an academic low performer.

Predictor variables of academic achievement. Ten variables were considered as predictor variables of academic achievement, eight student variables and two related to the family.

Student variables:

- *Gender:* female and male
- *Student attended preschool,* with two categories: 1 year or less, and two or more years
- *Students' sense of school belonging, s*tudents were asked how much they agreed with five statements about their attitude toward school, 1 (I like being in school), 2 (I feel safe when I am at school), 3 (I feel like I belong at this school), 4 (Teachers at my school are fair to me), and 5 (I am proud to go to this school)
- *Students engaged in reading lessons,* students were scored according to their level of agreement with nine statements related to their reading commitment.
- *Students like reading,* students were scored on this scale according to their level of agreement with eight statements and how often they did two reading activities outside of school
- *Students confident in reading*, students were scored according to their degree of agreement with six statements: 1 (I usually do well in reading), 2 (Reading is easy for me), 3 (I have trouble reading stories with difficult words), 4 (Reading is harder for me than for many or my classmates), 5 (Reading is harder for me than any other subject), and 6 (I am just not good at reading).
- *Early preschool literacy activities*, students were scored according to their parents' frequency of doing the nine activities: 1 (Read books), 2 (Tell stories), 3 (Sing songs), 4 (Play with alphabet toys, e.g., blocks with letters of the alphabet), 5 (Talk about things you had done…).
- *Early literacy tasks*, students were scored according to their parents' responses to how well their children could do the six tasks: 1 (Recognize most of the letters of the alphabet), 2 (Read some words), 3 (Read sentences), 4 (Read a story), 5 (Write letters of the alphabet), and 6 (Write some words).

Family variables:

- *Parents' perceptions of child's school*. Students were scored on this scale according to their parents' responses to six statements about the school: 1 (My child's school does a good job including me in my child's education), 2 (My child's school provides a safe environment), 3 (My child's school cares about my child's progress in school), 4 (My child's school does a good job informing me of their progress), 5 (My child's school promotes high academic standards), and 6 (My child's school does a good job in helping them become better in reading).
- *Parents like reading*. Students were scored on this scale according to their parents' responses to eight statements about reading, as well as how often they read for enjoyment.

Using IRT partial credit scaling, the variables were transformed to a scale with a central point of 10, corresponding to the mean of all the countries that completed the PIRLS test. The scale units were chosen so that two points in the score on the scale would correspond to the logit standard deviation in all countries (Martin, Mullis, & Hooper, 2017; Mullis, Martin, Foy, & Hooper, 2017). For the statistical analyses, all variables were normalized with a mean of 0 and standard deviation of 1 for all European Union countries participating in the study.

Procedure

The application of the PIRLS 2016 test followed the standards of the International Association for the Evaluation of Educational Achievement (IEA). The application was as follows: two 40-minute sessions with a 30 minute break and a student context questionnaire. (Martin, Mullis, & Hooper, 2017). It also included a home questionnaire (Learning to Read Survey), a teacher questionnaire and a school questionnaire.

Data analysis

In order to ensure the accuracy of the estimations of the combined distributions of populations or subpopulations, the PIRLS test uses plausible values, combining IRT models with latent regression techniques. The plausible values are not used to estimate individual student achievement, although the relative uncertainty is conserved. Therefore additional analytical procedures are needed to estimate student scores. In order to make estimations that are consistent with the population statistics, the context questionnaires must be considered (Martin, Mullis, & Hooper, 2017). To avoid bias and to be consistent with the above, PIRLS uses the student and class context variables to conserve the variability of the data. This variability is essential to be able to apply the models used in our study. The analysis procedures derived from the general classical linear model assume that cases are selected through simple random sampling. However, large-scale educational evaluations do not usually comply with the assumption of independence of the collected data (Iñiguez-Berrozpe, & Marcaletti, 2018). As previously stated, PIRLS 2016 used a complex sample design (two-stage stratified sequential sampling by clusters), where the observations are not independent, as the students (stage 2) within a single class or school (stage 1) are more similar to each other than to students in other schools (De la Cruz, 2008). In nested designs, each level of the hierarchy has a different variability and the errors are not independent, but classical general linear models do not address this interdependence of cases and so results from them will most likely exhibit bias.

All models were made with IEA's IDBAnalyzer© software which allows analysis using plausible and replica values. The reason for using replica values is determined by the correct calculation of the standard errors of estimation, the sampling method used brings with it a variability that is not found in simple random sampling, called sampling variability (Martin, Mullis, & Hooper, 2016). The most common procedure for calculating sampling variability in designs such as PIRLS is through a resampling scheme with balanced repetition and Jacknife technique (Johnson & Rust, 1992; Wolter, 1985). PIRLS uses a variation of Jacknife called Jacknife repeated replication (JRR) to estimate sampling variance. JRR is an easy to calculate method that gives unbiased estimations of sampling variances for the sampling errors of the means, totals and percentages. Because PIRLS uses probabilistic sampling of schools and students, any calculation must be weighted in accordance with the probabilities of selection, in this way each student will be appropriately represented depending on the probability of being selected in the sample. The variable SCHWGT was taken from the PIRLS 2016 database, which gives the student sampling weight, and will serve as the weighting for the student. There are a large number of methods for recovering missing data (Fernández-Alonso, Suárez-Álvarez, & Muñiz, 2012), and in this case we used the regression procedure implemented by the Missing Value Analysis module in SPSS, taking the class the student belongs to as the segmentation. In order to check whether levels of resilient and low performing students are distributed homogeneously throughout the European Union countries (the first objective), the ESCS of the students must be estimated. As already indicated in the *measurement instruments* section, the ESCS was obtained via a PCA of the four variables collected in the student and family questionnaires. Pearson correlations were calculated between the variables making up the ESCS, along with the weights of each variable in the extracted Principal Component.

In order to achieve the second objective, we used binary logistical regression for both the analysis of resilience and low performing students. The criterion variable was student academic achievement in reading comprehension in the PIRLS test, dichotomized in terms of resilience (resilient - not resilient) and low performing (low performer – not low performer). The predictor variables were all those related to the student and family described in the corresponding section.

The following indicators were used for the analysis of the statistical model used, along with its goodness of fit: Cox and Snell's R^2 (CSR) and Nagelkerke's R^2 (NKR), which indicate the part of the variance in the criterion variable explained by the predictor variable, b) β and its sign. Positive values of β indicate direct, positive impact of the predictor variable on the criterion variable, negative values indicate an opposite impact, c) the Odds ratio = e^{β}, which allows us to compare the odds of different values of a predictor variable, indicating the magnitude of the impact, with a value of 1 indicating that β has no impact. The further from 1, in either direction, the greater the impact, albeit direct or indirect (García-Crespo et al, 2019), d) significance of β, variables were selected that were significant at 5% and 10%.

Results

Index of Economic, Social and Cultural Status

Table 2 gives the Pearson correlations between the variables used to construct the ESCS.

The loadings for each of the four variables in the Principal Component extracted are 0.134 for home posessions, 0.541 for books at home, 0.709 for parents' highest education level and 0.652 for parents' highest occupation level, which explains 50.88% of the total variance (table 3). The principal component was normalized with a mean of 0 and standard deviation 1 for the combined 23 samples from the European Union.

Resilient and low performers in European Union countries

The results relating to the first research objective are presented in table 4, showing the ESCS and the percentages of academically resilient students and low performers by country, together with the standard errors of the estimated parameters.

Poland (42.22%) and Italy (40.53%) had the highest proportions of resilient students, while French-speaking Belgium (5.96%) and Malta (6.45%) had the lowest. There is a large difference in the numbers of resilient students between countries. When it

Table 2
Pearson correlations between the variables making up the "Index of Economic, Social and Cultural Status"

		1	2	3	4
Home posessions	(1)				
Books at home	(2)	0.133***			
Parents' highest education level	(3)	0.172***	0.468***		
Parents' highest occupation level	(4)	0.167***	0.395***	0.575***	

*** p < 0,01

comes to low performers, Malta (59.24%) and French-speaking Belgium (47.60%) had the highest proportion, while Italy (14.05%) and Poland (14.52%) had the lowest. Table 5 gives the values of Cox and Snell's R^2 (CSR) and Nagelkerke's R^2 (NKR) for each regression.

Table 3
Variance explained by "Index of Economic, Social and Cultural Status"

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of Variance	Cumulative %
ESCS	2.036	50.888	50.888	2.036	50.888	50.888
2	0.928	23.201	74.089			
3	0.622	15.548	89.637			
4	0.415	10.363	100.000			

Extraction Method: Principal Component Analysis

Taking the criterion variable low performer, the regression explaining most variance was for Lithuania (20%, 31%), which is very similar to Malta (19%, 25%) and Denmark (19%, 27%). The regression with least variance explained was for Germany (5%, 8%), which is about the same as for Austria (7%, 14%). Taking the dependent variable resilient, the regression with best fit was for Ireland (20%, 26%), which is about the same as for Poland (16%, 21%) and Lithuania (15%, 23%), while the regressions with worst fit were for Belgium (Fl.) (5%, 9%), Belgium (Fr.) (6%, 16%) and Bulgaria (6%, 9%).

Table 6 presents the data to identify which individual and family variables are most important for explaining the conditions of resilience and low performing (second objective), and to assess what values of those variables identified as important make a student move from being a low performer to being resilient (third

Table 4
Index of Economic, Social and Cultural Status, and percentage of resilient and Low performer students for the European Union countries

Country	ESCS	ESCS s.e.	Low performer percentage	Low performer percentage s.e.	Resilient percentage	Resiliente percentage s.e.
Austria	0.09	0.03	26.28	2.09	16.43	1.80
Belgium (Flemish)	0.25	0.03	28.00	2.08	12.80	1.25
Belgium (French)	0.11	0.03	47.60	2.38	5.96	0.77
Bulgaria	-0.24	0.06	27.66	2.91	27.48	3.40
Czech Republic	0.09	0.03	20.99	2.32	22.88	1.81
Denmark	0.65	0.03	28.68	1.67	17.45	1.56
Finland	0.49	0.02	15.35	1.41	32.76	1.95
France	0.01	0.03	38.73	1.94	11.88	1.21
Germany	0.01	0.04	32.59	3.05	20.00	1.86
Hungary	0.00	0.06	23.24	2.27	25.33	2.15
Ireland	0.23	0.03	17.88	1.68	36.23	1.90
Italy	-0.45	0.04	14.05	1.80	40.57	1.88
Latvia	0.30	0.03	16.39	1.70	27.18	1.77
Lithuania	0.11	0.03	21.97	2.22	23.14	1.76
Malta	-0.10	0.01	59.24	1.53	6.45	0.77
Netherlands	0.45	0.03	22.01	2.20	19.23	1.85
Northern Ireland	0.34	0.03	20.75	1.42	36.90	2.03
Poland	-0.04	0.03	14.52	1.66	42.22	2.20
Portugal	-0.20	0.03	20.76	1.66	24.95	1.80
Slovak Republic	-0.16	0.04	34.99	3.42	18.92	1.71
Slovenia	0.16	0.03	27.20	2.16	22.09	1.90
Spain	-0.02	0.03	22.24	1.33	20.93	1.10
Sweden	0.66	0.03	27.29	1.78	18.80	1.61

s.e.: Standard error

Table 5
Variance explained by the regressions

Low performers				Country	Resilients			
CSR	NKR	CSR.se	NKR.se		CSR	NKR	CSR.se	NKR.se
0.07	0.11	0.02	0.02	Austria	0.09	0.15	0.02	0.03
0.10	0.14	0.02	0.02	Belgium (Flemish)	0.05	0.09	0.02	0.03
0.13	0.18	0.03	0.04	Belgium (French)	0.06	0.16	0.02	0.04
0.10	0.14	0.03	0.04	Bulgaria	0.06	0.09	0.02	0.03
0.09	0.15	0.03	0.04	Czech Republic	0.09	0.14	0.02	0.02
0.19	0.27	0.02	0.03	Denmark	0.10	0.17	0.02	0.03
0.11	0.20	0.02	0.03	Finland	0.15	0.21	0.02	0.03
0.12	0.16	0.02	0.03	France	0.07	0.13	0.02	0.03
0.05	0.08	0.02	0.03	Germany	0.07	0.11	0.02	0.03
0.11	0.17	0.03	0.04	Hungary	0.11	0.17	0.02	0.03
0.12	0.20	0.02	0.04	Ireland	0.20	0.26	0.02	0.03
0.09	0.17	0.02	0.03	Italy	0.08	0.11	0.02	0.03
0.15	0.25	0.02	0.04	Latvia	0.12	0.18	0.02	0.04
0.20	0.31	0.03	0.04	Lithuania	0.15	0.23	0.03	0.04
0.19	0.25	0.02	0.03	Malta	0.07	0.17	0.02	0.04
0.09	0.14	0.03	0.04	Netherlands	0.13	0.21	0.03	0.04
0.14	0.24	0.03	0.05	Poland	0.16	0.21	0.03	0.04
0.13	0.21	0.02	0.04	Portugal	0.10	0.15	0.02	0.03
0.17	0.24	0.04	0.06	Slovak Republic	0.09	0.14	0.02	0.03
0.16	0.23	0.03	0.04	Slovenia	0.12	0.19	0.03	0.04
0.11	0.18	0.02	0.03	Spain	0.08	0.12	0.01	0.02
0.10	0.15	0.02	0.03	Sweden	0.10	0.16	0.02	0.04

CSR: Cox & Snell R^2; NKR: Nagelkerke R^2; se: Standard error

objective). Table 6 gathers together the regression parameters for each country or region, for each dependent variable, which are: the coefficients (β), the odds ratio ($Exp\beta=e^{\beta}$), the standard error of both (β.se y Expβ.se) and the significance of the coefficients (β.sig). Setting the level of significance at 95%, variables are statistically significant for the model when $0 \leq \beta.sig \leq 0.05$. In Table 6 they are identified with **. Setting the level of significance at 90%, variables are statistically significant for the model when $0.05 \leq \beta.sig \leq 0.10$. In Table 6 they are identified with *. In addition, predictor variables with a negative effect are given in dark grey, variables with a positive effect are marked in light grey.

Discussion

With respect to the first objective, the proportions of low performer and resilient students have been estimated and exhibit significant differences between EU countries or regions. Resilient students vary from 6% in French-speaking Belgium to 42% in Poland, and low performers vary from 14% in Italy to almost 60% in Malta. In terms of the second objective, it is clear that the effect of the predictor variables on the condition of being resilient or a low performer differs markedly from country to country. This may possibly be due to social and cultural differences, or the different educational systems in each country (Mullis, Martin, Goh, & Prendergast, 2017; OECD, 2018).

Table 7 gives a graphical indication of the effect of the predictor variables on the condition of low performing or resilience. It indicates whether the predictor variable has a positive impact (increases the probability) using ↑↑ if it is statistically significant at 95% and ↑ if it is statistically significant at 90%. If the variable has a negative effect (reduces the probability), that is indicated by ↓↓ if it is significant at 95%, or ↓ if it is significant at 90%. It is worth noting that students having confidence reading is statistically significant in every country for classifying students as resilient or low performers, except in Germany. A student with confidence in reading increases the likelihood of them being resilient by

Table 6
Summary of results of binary logistic analysis for the European Union countries

Low						Resilient			
B	**Expβ**	**β.se**	**Expβ.se**	**Country**	**Variable**	**β**	**Expβ**	**β.se**	**Expβ.se**
-0.25**	0.78	0.10	0.08	Austria	Students sense of school belonging				
0.25**	1.29	0.10	0.13		Students like reading				
-0.57**	0.57	0.10	0.06		Students confident in reading	0.84**	2.31	0.10	0.24
-0.15*	0.86	0.08	0.07		Parents like reading				
-0.32*	0.73	0.16	0.12		Gender(f)				
0.42**	1.53	0.20	0.31		Student attended preschool(1y or less)				
-0.23**	0.79	0.12	0.09	Belgium(Fl.)	Students sense of school belonging				
-0.65**	0.52	0.09	0.05		Students confident in reading	0.48**	1.62	0.11	0.19
0.34**	1.41	0.08	0.11		Early literacy tasks				
-0.33**	0.72	0.15	0.11		Gender(f)	0.57**	1.77	0.24	0.42
0.41*	1.51	0.22	0.34		Student attended preschool(1y or less)	-0.76**	0.47	0.38	0.18
				Belgium(Fr.)	Students like reading	0.38**	1.47	0.18	0.27
-0.80**	0.45	0.12	0.05		Students confident in reading	0.59**	1.81	0.17	0.31
-0.17*	0.84	0.10	0.08		Early literacy tasks				
					Parents like reading	0.31**	1.36	0.16	0.21
-0.44**	0.65	0.13	0.09		Gender(f)				
					Student attended preschool(1y or less)	-18.72**	0.00	0.29	0.00
-0.37**	0.69	0.13	0.09	Bulgaria	Students engaged in reading lessons	0.28**	1.32	0.12	0.17
0.25**	1.28	0.12	0.16		Students like reading	-0.26**	0.77	0.09	0.07
-0.51**	0.60	0.11	0.06		Students confident in reading	0.44**	1.56	0.12	0.18
					Gender(f)	0.37*	1.45	0.21	0.30
-0.29**	0.75	0.13	0.10	Czech Republic	Students sense of school belonging	0.27**	1.30	0.13	0.17
					Students engaged in reading lessons	-0.36**	0.70	0.11	0.07
-0.61**	0.55	0.12	0.06		Students confident in reading	0.64**	1.89	0.10	0.18
					Early literacy tasks	0.16*	1.18	0.10	0.12
-0.29**	0.75	0.10	0.08		Parents like reading	0.25**	1.29	0.09	0.12
-0.30*	0.74	0.16	0.12		Gender(f)				
0.99**	2.70	0.45	1.16		Student attended preschool(1y or less)	-0.91**	0.40	0.32	0.13
-0.27**	0.76	0.13	0.10	Denmark	Students sense of school belonging	0.26**	1.29	0.12	0.16
0.36**	1.43	0.17	0.24		Students engaged in reading lessons				
-1.03**	0.36	0.14	0.05		Students confident in reading	0.76**	2.14	0.11	0.24
-0.55**	0.58	0.14	0.08		Early literacy tasks	0.27**	1.31	0.13	0.17
1.11**	3.05	0.50	1.54		Student attended preschool(1y or less)	-1.67*	0.19	1.01	0.16

Table 6
Summary of results of binary logistic analysis for the European Union countries

Low						Resilient			
B	**Expβ**	**β.se**	**Expβ.se**	**Country**	**Variable**	**β**	**Expβ**	**β.se**	**Expβ.se**
-0.53**	0.59	0.16	0.09	Finland	Students sense of school belonging				
0.58**	1.79	0.18	0.33		Students engaged in reading lessons				
					Like reading	0.25*	1.28	0.14	0.18
-0.81**	0.44	0.14	0.06		Students confident in reading	0.63**	1.88	0.08	0.16
					Early literacy activities before school	-0.15*	0.86	0.09	0.08
-0.48**	0.62	0.10	0.06		Early literacy tasks	0.54**	1.71	0.07	0.12
-0.40**	0.67	0.21	0.14		Gender(f)				
				France	Students like reading	-0.20*	0.82	0.12	0.10
-0.65**	0.52	0.11	0.06		Students confident in reading	0.63**	1.88	0.10	0.18
-0.44**	0.64	0.12	0.08		Early literacy tasks	0.54**	1.72	0.15	0.25
-0.53**	0.59	0.17	0.10		Gender(f)	0.48*	1.62	0.26	0.42
-0.20*	0.82	0.12	0.10	Germany	Students sense of school belonging				
					Students engaged in reading lessons	-0.23**	0.79	0.11	0.09
					Students like reading	0.24*	1.27	0.14	0.17
					Students confident in reading	0.41**	1.51	0.11	0.17
-0.18*	0.83	0.11	0.09		Early literacy activities before school				
					Parents like reading	0.26**	1.30	0.12	0.16
0.50**	1.65	0.19	0.32		Student attended preschool(1y or less)	-0.35*	0.71	0.20	0.14
				Hungary	Students sense of school belonging	0.31**	1.36	0.13	0.18
-0.22*	0.80	0.13	0.10		Students engaged in reading lessons				
-0.96**	0.38	0.15	0.06		Students confident in reading	0.82**	2.26	0.12	0.27
0.21**	1.24	0.11	0.13		Parents perceptions of child school				
					Gender(f)	0.35**	1.42	0.17	0.24
0.91*	2.49	0.52	1.28		Student attended preschool(1y or less)				
				Ireland	Students sense of school belonging	0.32**	1.38	0.12	0.16
					Students engaged in reading lessons	-0.31**	0.74	0.12	0.09
-0.60**	0.55	0.19	0.10		Students confident in reading	0.57**	1.78	0.09	0.15
-0.70**	0.50	0.13	0.06		Early literacy tasks	0.62**	1.86	0.12	0.22
0.26*	1.29	0.15	0.19		Parents perceptions of child school				

Table 6
Summary of results of binary logistic analysis for the European Union countries

Low						Resilient			
B	**Expβ**	**β.se**	**Expβ.se**	**Country**	**Variable**	**β**	**Expβ**	**β.se**	**Expβ.se**
				Italy	Students sense of school belonging	0.16*	1.17	0.09	0.11
0.33**	1.39	0.13	0.19		Students like Reading	-0.26**	0.77	0.10	0.08
-1.00**	0.37	0.14	0.05		Students confident in reading	0.62**	1.86	0.10	0.19
-0.41**	0.66	0.12	0.08		Parents perceptions of child school	0.14*	1.15	0.08	0.09
-0.27**	0.76	0.14	0.11		Parents like reading				
-0.47**	0.63	0.22	0.14		Gender(f)				
-0.63**	0.53	0.20	0.10	Latvia	Students sense of school belonging				
0.40**	1.49	0.17	0.25		Students engaged in reading lessons	-0.32*	0.72	0.17	0.12
0.57**	1.77	0.18	0.32		Students like reading				
-1.10**	0.33	0.25	0.08		Students confident in reading	0.76**	2.14	0.14	0.29
-0.63**	0.53	0.17	0.09		Early literacy tasks	0.41**	1.51	0.13	0.19
-0.73**	0.48	0.22	0.10		Gender(f)	0.54**	1.71	0.21	0.36
-0.22*	0.80	0.13	0.11	Lithuania	Students engaged in reading lessons				
					Students like reading	-0.32**	0.73	0.15	0.11
-1.03**	0.36	0.17	0.06		Students confident in reading	0.69**	2.00	0.15	0.29
-0.84**	0.43	0.24	0.10		Early literacy tasks	0.69**	1.99	0.17	0.33
0.32*	1.38	0.17	0.23		Parents perceptions of child school				
					Gender(f)	0.38*	1.47	0.21	0.30
0.80**	2.24	0.27	0.60		Student attended preschool(1y or less)	-0.40**	0.67	0.20	0.13
-0.88**	0.41	0.10	0.04	Malta	Students confident in reading	0.87**	2.38	0.13	0.30
-0.38**	0.69	0.10	0.07		Early literacy tasks				
-0.25**	0.78	0.13	0.10		Parents perceptions of child school				
-0.45**	0.64	0.19	0.12		Gender(f)				
				Netherlands	Students sense of school belonging	0.29**	1.34	0.11	0.15
0.36*	1.43	0.21	0.30		Students engaged in reading lessons	-0.46**	0.63	0.17	0.11
					Students like reading	0.45**	1.57	0.16	0.25
-0.57**	0.57	0.12	0.07		Students confident in reading	0.54**	1.72	0.10	0.17
-0.37**	0.69	0.19	0.13		Early literacy tasks	0.28*	1.32	0.15	0.20
					Parents like reading	0.27*	1.31	0.16	0.20

Table 6
Summary of results of binary logistic analysis for the European Union countries

Low						Resilient			
B	**Expβ**	**β.se**	**Expβ.se**	**Country**	**Variable**	**β**	**Expβ**	**β.se**	**Expβ.se**
0.32*	1.38	0.18	0.24	Poland	Students sense of school belonging				
-0.38*	0.69	0.20	0.14		Students engaged in reading lessons				
0.43**	1.54	0.20	0.31		Students like reading	-0.28**	0.76	0.12	0.09
-0.65**	0.52	0.17	0.09		Students confident in reading	0.61**	1.83	0.10	0.18
					Early literacy activities before school	-0.24**	0.78	0.10	0.08
-0.83**	0.44	0.12	0.05		Early literacy tasks	0.53**	1.70	0.16	0.27
-0.28*	0.76	0.16	0.12		Parents perceptions of child school				
					Parents like reading	0.24**	1.27	0.12	0.15
					Gender(f)	0.54**	1.72	0.16	0.28
0.42**	1.52	0.12	0.18	Portugal	Students like reading	-0.32**	0.72	0.10	0.07
-1.24**	0.29	0.17	0.05		Students confident in reading	0.83**	2.30	0.11	0.24
-0.32**	0.73	0.11	0.08		Early literacy tasks				
-0.62**	0.54	0.10	0.05	Slovak Republic	Students confident in reading	0.55**	1.73	0.12	0.21
-0.18*	0.84	0.09	0.08		Early literacy activities before school				
-0.31**	0.73	0.10	0.08		Parents like reading	0.26**	1.29	0.11	0.14
0.56*	1.75	0.30	0.53		Student attended preschool(1y or less)	-0.78**	0.46	0.21	0.09
0.47**	1.60	0.12	0.20	Slovenia	Students engaged in reading lessons	-0.59**	0.56	0.16	0.09
-0.27*	0.76	0.14	0.11		Students like reading				
-0.81**	0.45	0.12	0.06		Students confident in reading	0.68**	1.98	0.11	0.22
-0.29*	0.75	0.16	0.12		Early literacy tasks				
0.37**	1.45	0.13	0.19		Parents perceptions of child school	-0.20*	0.82	0.11	0.09
-0.48**	0.62	0.13	0.08		Parents like reading				
-0.31*	0.74	0.18	0.13		Gender(f)	0.59**	1.80	0.22	0.40
				Spain	Students sense of school belonging	0.18**	1.20	0.08	0.09
					Students like reading	-0.12*	0.89	0.06	0.06
-0.83**	0.44	0.11	0.05		Students confident in reading	0.61**	1.85	0.08	0.14
-0.23**	0.79	0.10	0.08		Early literacy activities before school	0.19**	1.21	0.08	0.10
-0.46**	0.63	0.09	0.06		Early literacy tasks	0.32**	1.38	0.08	0.11
0.21**	1.23	0.07	0.08		Parents like reading				

Table 6
Summary of results of binary logistic analysis for the European Union countries

Low						Resilient			
B	**Expβ**	**β.se**	**Expβ.se**	**Country**	**Variable**	**β**	**Expβ**	**β.se**	**Expβ.se**
0.24**	1.28	0.11	0.14	Sweden	Students engaged in reading lessons	-0.39**	0.68	0.15	0.10
-0.58**	0.56	0.12	0.07		Students confident in reading	0.59**	1.80	0.13	0.24
					Early literacy activities before school	-0.21**	0.81	0.10	0.08
-0.53**	0.59	0.13	0.07		Early literacy tasks	0.54**	1.72	0.14	0.24
					Student attended preschool(1y or less)	-0.88**	0.42	0.37	0.15

** $0 \leq \beta.sig \leq 0.05$; * $0{,}05 \leq \beta.sig \leq 0.10$

	Positive impact
	Negative impact

Table 7
Effect of the variables on the probability of being low perfomer or resilient

Country	Students sense of school belonging		Students engaged in reading lessons		Students like reading		Students confident in reading		Early literacy activities before school		Early literacy tasks		Parents perceptions of child school		Parents like reading		Gender (f)		Student attended preschool(1y or less)	
Austria	↓↓				↑↑		↓↓	↑↑							↓				↑↑	
Belgium (Fl.)	↓↓						↓↓	↑↑			↑↑						↓↓	↑↑	↑	↓↓
Belgium (Fr.)						↑↑	↓↓	↑↑			↓					↑↑	↓↓			↓↓
Bulgaria			↓↓	↑↑	↑↑	↓↓	↓↓	↑↑										↑		
Czech Rep.	↓↓	↑↑		↓↓			↓↓	↑↑				↑			↓↓	↑↑	↓		↑↑	↓↓
Denmark	↓↓	↑↑	↑↑				↓↓	↑↑			↓↓	↑↑							↑↑	↓
Finland	↓↓		↑↑			↑	↓↓	↑↑		↓	↓↓	↑↑					↓↓			
France						↓	↓↓	↑↑			↓↓	↑↑					↓↓	↑		
Germany	↓			↓↓		↑		↑↑			↓					↑↑			↑↑	↓
Hungary		↑↑	↓				↓↓	↑↑					↑↑					↑↑	↑	
Ireland		↑↑		↓↓			↓↓	↑↑			↓↓	↑↑	↑							
Italy		↑			↑↑	↓↓	↓↓	↑↑					↓↓	↑	↓↓		↓↓			
Latvia	↓↓		↑↑	↓	↑↑		↓↓	↑↑			↓↓	↑↑					↓↓	↑↑		
Lithuania			↓			↓↓	↓↓	↑↑			↓↓	↑↑	↑					↑	↑↑	↓
Malta							↓↓	↑↑			↓↓		↓↓				↓↓			
Netherlands		↑↑	↑	↓↓		↑↑	↓↓	↑↑			↓↓	↑				↑				
Poland	↑		↓		↑↑	↓↓	↓↓	↑↑		↓↓	↓↓	↑↑	↓			↑↑		↑↑		
Portugal					↑↑	↓↓	↓↓	↑↑			↓↓									
Slovak Rep.							↓↓	↑↑	↓						↓↓	↑↑			↑	↓↓
Slovenia			↑↑	↓↓	↓		↓↓	↑↑			↓		↑↑	↓	↓↓		↓	↑↑		
Spain		↑↑				↓	↓↓	↑↑	↓↓	↑↑	↓↓	↑↑			↑↑					
Sweden			↑	↓			↓	↑		↓	↓	↑								↓
		Low performer							Resilient											

at least 50 percentage points, as is the case for Germany, but it could increase by up to 140 points, as happens with Malta. This same variable also has a statistically significant effect in terms of low performing, Bulgarian students with a high value in this index are 40 percentage points less likely to be low performers. The greatest reduction is for Portugal, where the probability of being a low performer is as much as 70 percentage points lower. This is in line with Jacob (2002) and Waxman, Huang and Padrón (1997), who stated that resilient students have more faith in their possibilities and are more consistent in their tasks. Having had early pre-school literacy activities, parents liking Reading, and parents' perceptions of the child's school exhibit no significant effects, on either resilience or low performing, or show effects only in a few countries. This contrasts with research from Martín-Lagos (2018), who underlined the importance of motivation in the home. This study, in line with the OECD (2018) indicating the positive effects of having done early literacy tasks, also found a positive effect, both increasing the likelihood of being resilient (11 countries), and reducing the likelihood of being a low performer (14 countries). The increased probability of being resilient ranged from the 18 additional percentage points in the Czech Republic, statistically significant at 90%, to the 99 additional percentage points for Lithuania. The reduction in the likelihood of being low performers ranged from 16 percentage points for French-speaking Belgium to 57 percentage points for Lithuanian students. The OECD (2018) noted that attending preschool is beneficial to students' later academic performance, and in line with that, our study found that attending a year or less of preschool had a statistically significant impact on future resilience in 8 countries, it also had a significant impact on low performing in 8 countries. More specifically, attending a year or less of preschool practically prevents students from being resilient in French-speaking Belgium, and reduces the likelihood by at least 33 percentage points in the case of Lithuania. The effect of attend a year or less of preschool triples the likelihood of being a low performer in Denmark and increases the probability by 51 percentage points in Flemish-speaking Belgium. *Gender* has an impact on resilience in 8 countries, and being a low performer in 10 countries. Being a girl increases the likelihood of being resilient by between 40 and 80 percentage points for students in those countries where the effect is statistically significant, and reduces the probability of being a low performer by between 26 and 52 percentage points. The results of the variable *students engaged in reading* are difficult to explain because the effect goes in one direction or the other depending on the country. It is, therefore, a variable about which we do not have sufficient information and would be a target for subsequent research. Students' sense of school belonging, on the other hand, is also statistically significant in a good number of countries, which indicates that a good school climate encourages resilience and reduces low performing. The increase or decrease in likelihood in either direction varies between 20 and 50 percentage points.

In relation to the third objective, we have confirmed that when the effect is statistically significant in one direction in the coefficient of a variable in one of the regressions (low performer or resilient dependent variable), in the other regression it may have a statistically significant effect in the opposite direction or not have any effect. The contextual variable which stands out most in this sense is students' confidence in reading; the higher the value for this index, the greater the likelihood of being resilient and the lower the likelihood of being a low performer. Taking France as an example, high values almost double the probability of being resilient and halve the probability of being a low performer. Analyzing the gender variable, we see that the results in those countries where the effect is statistically significant are similar to reading confidence, although this variable opens up three types of analysis. If we take the example of Flemish-speaking Belgium, being a girl increases the probability of resilience by 77 percentage points and reduces that of being a low performer by 38 points. However, if we look at Finland, being a girl does not increase the likelihood of resilience, but it does decrease the likelihood of being a low performer by 33 percentage points. And thirdly, in Poland, being a girl increases the probability of resilience by 72 percentage points but has no significant effect on reducing the probability of being a low performer. All of this indicates that investing in educational policies aimed at increasing student reading confidence will improve rates of resilience and reduce low performing. Policies aimed at preschool schooling will have the same impact, as will encourage early literacy tasks. All of that should help compensate academically for a disadvantaged socioeconomic situation at the beginning. Reducing the gender gap is also an important task, as well as making educational surroundings friendly, that students can identify with.

All of the results in this research are limited by the nature of the PIRLS study, which lacks student variables such as cognitive capacity and other non-cognitive skills that may have an impact on resilience or low-performing (Santos, Ferraces, Godas, & Lorenzo, 2018). Consequently it is not certain that these results can be generalized to other competencies or other times.

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References

Anwar, M. N., Shamim-ur-Rasool, S., & Haq, R. (2012). A comparison of creative thinking abilities of high and low achievers secondary school students. *International Interdisciplinary Journal of Education, 1*(1), 23-28.

Barragán, A. B., Pérez-Fuentes, M. C., Martos, Á., Simón M. M., Molero, M. M., Martínez-Sánchez, A., Sánchez-Beato, E. J., & Gázquez, J. J. (2016). Intervención y variables del personal docente y el centro escolar que modulan el rendimiento académico del alumno [Intervention and variables in the teaching staff and the school which modulate student academic performance]. *European Journal of Child Development, Education and Psychopathology, 4*(2), 89-97. doi: 10.1989/ejpad.v4i2.37

Berliner, D. C. (2009). Poverty and potential: Out-of-School factors and school success. National Education Policy Center. Retrieved from https://nepc.colorado.edu/publication/poverty-and-potential

Carrillo, E., Civís, M., Blanch, T.A., Longás, E., & Riera, J. (2018). Condicionantes del éxito y fracaso escolar en contextos de bajo nivel socioeconómico [Determinants of school success and failure in low

socioeconomic contexts]. *Revista de Estudios y Experiencias en Educación, 2*, 75-94. doi: 10.21703/rexe.Especial2_201875944

Castejón, J.L., Gilar, R., Miñano, P., & Veas, A. (2016). Identificación y establecimiento de las características motivacionales y actitudinales de los estudiantes con rendimiento académico menor de lo esperado según su capacidad (underachievement) [Identification and establishment of the motivational and attitudinal characteristics of students with less than expected academic performance according to their ability (underachievement)]. *European Journal of Education and Psychology, 9*, 63-71. doi: 10.1016/j.ejeps.2016.04.001

Choi, A., & Calero, J. (2013). Determinantes del riesgo de fracaso escolar en España en PISA-2009 y propuestas de reforma [Determinants of the risk of school failure in Spain in PISA-2009 and proposals for reform]. *Revista de Educación, 362*, 562-593. doi: 10.4438/1988-592X-RE-2013-362-242

De la Cruz, F. (2008). Modelos multinivel [Multi-level models]. *Revista Peruana de Epidemiología, 12*(3), 1-8.

Erberber, E., Stephens, M., Mamedova, S., Ferguson, S., & Kroeger, T. (2015). *Socioeconomically disadvantaged students who are academically successful: Examining academic resilience crossnationally*. IEA's Policy Brief Series, No. 5, Amsterdam, IEA. Retrieved from http://www.iea.nl/policy_briefs.html

Fernández-Alonso, R., & Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de las competencias básicas [Booklet designs for the evaluation of basic skills]. *Aula Abierta, 39*(2), 3-34.

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2012). Imputación de datos perdidos en las evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. *Psicothema, 24*(1), 167-175.

Fernández-Alonso, R., Álvarez-Díaz, M., Woitschach, P., Suárez-Álvarez, P., & Cuesta, M. (2017). Parental involvement and academic performance: Less control and more communication. *Psicothema, 29*(4), 453-461. doi: 10.7334/psicothema2017.181

García-Crespo, F.J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019). Educational resilience in reading comprehension: Determinant factors in PIRLS-Europe. *Revista de Educacion, 384*, 65-89. doi: 10.4438/1988-592X-RE-2019-384-413

González-Arratia, N., & Valdez, J. (2007). Resiliencia en niños [Children's Resiliency]. *Psicología Iberoamericana, 15*(2), 38-50.

Henderson, N., & Milstein, M. M. (2003). *Resiliency in schools: Making it happen for students and educators* (2nd ed). Housand Oaks, CA: Corwin Press.

Iñiguez-Berrozpe, T., & Marcaletti, F. (2018). Modelos lineales multinivel en SPSS y su aplicación en investigación educativa [Linear multilevel models in SPSS and its application in educational research]. *REIRE Revista d'Innovació i Recerca en Educació, 11*(1), 26-40. doi: 10.1344/reire2018.11.118984

Jacob, B. A. (2002). Where the boys aren't: Noncognitive skills, returns to school and the gender gap in higher education. *Economics of Education Review, 21*(6), 589-598.

Jensen, E. (2013). How poverty affects classroom engagement. *Faces in Poverty, 70*, 24-30.

Johnson, E. G., & Rust, K. F. (1992). Population inferences and variance estimation for NAEP data. *Journal of Educational Statistics, 17*(2), 175-190.

Kobasa, S. C., Maddi, S. R., & Kahn, S. (1982). Hardiness and health: A prospective study. *Journal of Personality and Social Psychology, 42*(1), 168-177. doi: 10.1037/0022-3514.42.1.168

Martin, A. J., & Marsh, H. W. (2003, November). *Academic resilience and the four Cs: Confidence, control, composure, and commitment*. Paper presented at the Joint AARE/NZARE Conference, Auckland, New Zeland.

Martín-Lagos, M. D. (2018). Educación y desigualdad: una metasíntesis tras el 50 aniversario del Informe Coleman [Education and inequality: a meta-synthesis after the 50th anniversary of Coleman's report]. *Revista de Educación, 380*, 186-209. doi: 10.4438/1988-592X-RE-2017-380-377

Mullis, I. V. S., & Martin, M. O. (Eds.). (2015). *PIRLS 2016 Assessment framework* (2nd ed.). Retrieved from http://timssandpirls.bc.edu/pirls2016/framework.html

Martin, M. O., Mullis, I. V. S., & Hooper, M. (Eds.) (2017). *Methods and procedures in PIRLS 2016* (pp. 4.1-4.22). Retrieved from https://timssandpirls.bc.edu/publications/pirls/2016-methods/chapter-4.html

Mullis, I. V. S., Martin, I. M. O., Foy, P., & Hooper, M. (2017). *PIRLS 2016 International results in reading*. Retrieved from http://timssandpirls.bc.edu/pirls2016/international-results/

Mullis, I. V. S., Martin, M. O., Goh, S., & Prendergast, C. (Eds.). (2017). *PIRLS 2016 Encyclopedia: Education policy and curriculum in reading*. Retrieved from http://timssandpirls.bc.edu/pirls2016/encyclopedia/

OECD (2011) *PISA in Focus nº 1, Does participation in pre-primary education translate into better learning outcomes at school?*. OECD-ilibrary. Retrieved from http://cort.as/-M3Ms

OECD (2018). *The resilience of students with an immigrant background: Factors that shape well-being*. *OECD Reviews of migrant education*. Paris, Francia: OECD Publishing. doi: 10.1787/9789264292093-en

Rodríguez-Rodríguez, D., & Guzmán, R. (2019). Socio-familial risk factors and personal protective variables of academic performance in secondary education students. *Psicothema, 31*(2), 142-148. doi: 10.7334/psicothema2018.213

Santos, M. A., Ferraces, M. J., Godas, A., & Lorenzo, M. M. (2018). Do cooperative learning and family involvement improve variables linked to academic performance? *Psicothema, 30*(2), 212-217. doi: 10.7334/psicothema2017.311

Servicio de Evaluación Educativa. (2017). Éxito contra todo pronóstico: el alumnado académicamente resiliente [Success against all odds: academically resilient students]. *Informe Evaluación, 12*, 1-8.

Stockton, T. (2011). *A look at the report-poverty and potential: Out-of-School factors and school success*. Colleagues. Retrieved from http://scholarworks.gvsu.edu/colleagues/vol6/iss1/9

Suárez-Alvarez, J., Pedrosa, I., Lozano, L. M., García-Cueto, E., Cuesta, M. & Muñiz, J. (2018). Using reversed items in Likert scales: A questionable practice. *Psicothema, 30*, 149-158. doi: 10.7334/psicothema2018.33

Vaknin-Nusbaum, V., Nevo, E., Brande, S., & Gambrell, L. (2018). Developmental aspects of reading motivation and reading achievement among second grade low achievers and typical readers. *Journal of Research in Reading, 41*(3), 438-454. doi: 10.1111/1467-9817.12117

Valle, A., Regueiro, B., Estévez, I., Piñeiro, I., Rodríguez, S., & Freire, C. (2015). Implicación y motivación hacia los deberes escolares en los estudiantes de Primaria según el rendimiento académico y el curso [Involvement and motivation towards school duties in Primary students according to academic performance and course]. *European Journal of Investigation in Health, Psychology and Education, 5*(3), 345-355. doi: 10.1989/ejihpe.v5i3.137

Veas, A., López-López, J. A., Gilar, R., Miñano, P., & Castejón, J. L. (2017). Differences in cognitive, motivational and contextual variables between under-achieving, normally-achieving, and over-achieving students: A mixed-effects analysis. *Psicothema, 29*(4), 533-538. doi: 10.7334/psicothema2016.283

Villegas, G., González-García, N., Sánchez-García, A., Sánchez-Barba, M., & Galindo-Villardón, M. P. (2018). Seven methods to determine the dimensionality of tests: application to the General Self-Efficacy Scale in twenty-six countries. *Psicothema, 30*, 442-448. doi: 10.7334/psicothema2018.113

von Davier, M., González, E., & Mislevy, R. J. (2009). What are plausible values and why are they useful? *IERI Monograph series. Issues and methodologies in large-scale assessments, 2*, 9-36.

Waxman, H., Huang, S., & Padron, Y. (1997). Motivation and learning environment differences between resilient and nonresilient latino middle school students. *Hispanic Journal of Behavioral Sciences, 19*(2), 137-155. doi: 10.1177/07399863970192003

Wolter, K. M. (1985). *Introduction to variance estimation*. New York: Springer-Verlag.

3.3. Tercer artículo

Clavel, J. G., García-Crespo, F. J., & Sanz San Miguel, L. (2021). Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts?. *Asia Pacific Journal of Education*. doi:10.1080/02188791.2021.1886905

El objetivo principal de este artículo es analizar el impacto de variables individuales (habilidades cognitivas y no-cognitivas), familiares y del entorno escolar sobre la condición de resiliencia en alumnado de 15 de años del Este y Sudeste asiático. La principal aportación de este artículo a la Tesis Doctoral es corroborar que en alumnado de 15 años en una zona socio-geográfica completamente distinta a la UE el comportamiento de las variables que fueron significativas en primaria también lo son en este alumnado.

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ARTICLE

Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts?

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ABSTRACT

The Programme for International Student Assessment, carried out every three years by the Organization for Economic Co-operation and Development across a large number of countries and economies, have shown that socioeconomically disadvantaged students are almost three times more likely than advantaged students not to attain the baseline level of proficiency in science. Some of those disadvantage students beat the odds and perform better than expected according to their low socio-economic background. They are called resilient students. Using data from 2015's science-focused assessment and a logistic multilevel model analysis, this study examined the relationships between academic resilience and other non-cognitive skills measured by the assessment across seven East Asian countries and regions. Although there are significant disparities between the countries and regions, the results indicate that enjoyment and interest in science are positively related to science resilience. By contrast, when the student has an instrumental motivation for learning science (he or she is interested in science because it is useful for his or her career plans), the relationship is negative. This provides useful guidance for policy-makers, educators, parents, and students on how to foster better Science results for students, and especially for disadvantaged students.

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Introduction

According to PISA 2015, socioeconomically disadvantaged students across the countries of the Organization for Economic Co-operation and Development (OECD) are almost three times more likely than advantaged students not to attain the baseline level of proficiency in science and, maybe due to this fact, they do not envisage themselves working in science-related occupations (OECD, 2016a). Fortunately, some of those disadvantage students beat the odds and perform better than expected according to their low socioeconomic background. They are called resilient students. In this paper, we analyse who those resilient students are and how resilience can be developed stressing the importance of the non-cognitive skills.

We found interesting the purpose of our study because resilient students are a sign of hope: their performance is an indication that poverty does not necessarily replicate itself. It is evidence that poor parents will not necessarily have poor children with poor academic performances and consequently poor jobs that lead to them being poor parents themselves (Heckman, 2011).

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We used the large-scale PISA 2015 assessment, where the Science performance was the main topic, to study the relationships between resilience and several other non-cognitive skills. If resilience is an attitude, it must be related to other attitudes towards science. These attitudes towards science, provided that they are related with academic resilience in science, are more easily changeable than other aspects that influence academic achievement, such as socioeconomic background, type of school, or the student/teacher ratio (see OECD, 2016b). If our findings are right, there is a shortcut to improve science results trough the modification of the attitudes thus contributing to the solution of skill shortages in STEM fields (Caprile, Palmen, Sanz, & Dente, 2015). For a recent summary of the implications of that lack of qualifications on the labour market, the competitiveness of the countries and the critical policy issues involved see Camilli and Hira (2019).

Given the outstanding results consistently reached by some East Asian and South-East Asian countries or regions, and the high percentage of resilient students they have, we decided to base our study on the PISA 2015 results in seven countries or regions of that region: Hong Kong, Japan, the Republic of Korea, Singapore, Macao, the Chinese provinces of Beijing, Shanghai, Jiangsu, and Guangdong (hereafter QCH), and Chinese Taipei.

The rest of the paper is structured as follows. In Section 2, we briefly present a literature review. Section 3 provides a description of the material and methods: we describe how non-cognitive skills were measured through the PISA 2015 questionnaires and how we augment our analysis by adding other information available in the PISA background variables, such as demographics, school conditions and management, and classroom and teacher factors. Given that the information comes from two sources (students' questionnaire and principals' questionnaire) and two levels of attribution (student level and school level), we chose a logistic regression because of the dependent variable analysed (resilient or non-resilient student) and we chose the multilevel approach due to the hierarchical structure of the data. Section 4 reports the main results. Finally, in Section 5 we discuss our main conclusions.

Literature review

Resilience is one of the non-cognitive skills related not only to academic performance but also to other life outcomes (Farrington et al., 2012; Heckman & Rubinstein, 2001). These non-cognitive skills include a set of behaviours, skills, attitudes, and strategies (Clavel, 2018) that are crucial to students but may not be reflected in their scores on cognitive tests. These skills form part of the knowledge that is not valued in our narrow measures of ability, especially given the pressure on students to perform in tests and the incorrect assumption that test performance must determine their intelligence and identity (Chua, 2009).

Generally speaking, resilience is the ability to cope with adversity and to reach outstanding goals. Academic resilience is just a facet of resilience itself. Perhaps the first document on academic resilience and PISA was OECD (2011), which is based on PISA 2006. The report examined the influence of three sets of factors on resilience: approaches to learning; participation in science courses and time spent learning science at school; and school characteristics. It was found that taking more science courses benefits disadvantaged students even more than it does their more advantaged peers. In addition, it was suggested that exposing disadvantaged students to science learning at school might help close performance gaps. The report also provides evidence that resilient students enjoy learning science and display a series of positive attitudes towards learning science.

The most recent report on PISA and academic resilience may be the one by Agasisti, Avvisati, Borgonovi, and Longobardi (2018). This paper, based on the PISA 2015 results, focuses on school-level correlates of resilience, looking for the school characteristics that contribute more to the probability that disadvantaged students will be academically resilient, and how much these factors vary across countries. They found that resilient students attend schools with a positive school climate, and that this climate, after accounting for demographic and social differences, is more easily found in schools where the turnover of teachers is low and where principals adopt a transformational leadership style (Tajasom & Ahmad, 2011).

In every study on resilience (see, for example, Banerjee, 2016), the research methodology includes two measures: how the disadvantaged situation is defined (the resilient student may grow up in a lower socioeconomic environment, face a language barrier, belong to an ethnic minority, or be an immigrant) and how the top performance is calculated; most of the time there is some sort of test or exam that provides the results.

Previous studies focusing on East Asian education systems have found diverse results depending on the type of resilience being measured and the instruments being used. For example, using the TIMSS,[1] dataset, it was found that high academic expectation and time spent on mathematics at home have a differential effect between disadvantaged and non-disadvantaged students in Singapore (Sandoval-Hernández & Bialowolski, 2016). For Korea, a study involving more than four hundred students that received support from social welfare agencies, Kim et al. (2005) point out that hope, teacher support, and what students consider the meaning of life distinguished resilient students from their counterparts. Using data from PISA 2009, Shen (2012) found that compared with disadvantaged low-achievers, resilient students tend to enjoy reading, develop reading strategies, and have more high-quality reading activities at school. Li (2017), using a questionnaire among 693 11th-grade students in China participating in the competitive college entrance examination, found three factors from family and school settings that promote resilience: parental supervision, school involvement and recognition, and school expectation of behaviour. He found that parents' supervision and school involvement and recognition are significantly and negatively associated with low school commitment and individual conflict attitude, thus they promote academic resilience. By way of summary, studies generally show that disadvantaged students develop academic resilience if they grew up in supportive families and it tended to be associated with better psychologic well-being and social-emotional behaviours (Cheung, Sit, Soh, Leong, & Mak, 2014).

Our paper attempts to add to the current evidence on students' academic resilience in two ways: first, following Sandoval-Hernandez, we focus on several countries that, although there are differences between them, share some similar background (Sandoval-Hernández & Bialowolski, 2016-); second, combining school and student level, we focus on non-cognitive skills and their relationships with resilience. It is easier to foster these skills than to try and change biographic or collective factors that depend on high-level policymaking or cannot be changed at all. (Gorard, See, & Davies, 2012). These skills have better "treatment" than biographic or collective factors that depend on higher decision-offices or cannot be modified at all.

There are many non-cognitive skills that influence students' science performance. Some of them are measured in the PISA 2015 context questionnaire. A group of non-cognitive skills is especially related to science, such as the students' interest in scientific knowledge or the students' pleasure when studying science. Other measured non-cognitive skills are common mental dexterities, in the sense that they influence a broad spectrum of young people's capacities, not only science performance. In this second group of attitudes, students' self-motivation and their ability to deal with test anxiety are included, for example.

Previous studies have already shown the influence of these non-cognitive skills on students' performance. See, for example, Humphries and Kosse (2017) for an overview of what these non-cognitive skills are influencing and why it matters, the literature review by Gutman and Schoon in 2013 for the Institute of Education, or Farrington et al. (2012). These skills form a group of interconnected mental dexterities that helps the student to reach his or her goals. If there is one species of bird in a forest, there are likely to be other species as well. If a student is resilient, he or she will also be more likely to have skills such as persistence, self-contentment, and motivation. The relationships within this set of non-cognitive skills are what we analyse in this paper.

Materials and methods

In the present study, there are two kinds of predictors of academic resilience: externally measurable predictors such as grade repletion or school type and self-reported predictors such as interest or

teaching behaviour. These serve as covariates in the logistic regression analyses in order to control for the effects of demographic variables on the probability of a disadvantaged student being classified as resilient in science literacy.

Three issues are dealt with in this section: (1) the characteristics of the large-scale PISA 2015 relevant to this study, (2) the definition of the dependent variable (i.e., a resilient student), and finally, (3) which are the variables that do have some influence on a student's resilience and how are they measured.

The sample: PISA 2015

Data were drawn from PISA 2015, conducted by the OECD. The target for PISA was the 15-year-old student population across 72 countries and economies. In addition to all OECD countries, the survey has been conducted in the following Asian regions: Beijing, Shanghai, Jiangsu, and Guangdong (China), Hong Kong (China), Indonesia, Macao (China), Malaysia, Singapore, Taipei, Thailand, and Vietnam.

The sample used for this study includes only socioeconomically disadvantaged students. It is intended to compare disadvantaged students who are "resilient" with disadvantaged students who are "non-resilient."

As stated previously, in addition the assessment of science, reading comprehension, and maths, PISA also covers information about the characteristics of schools, teachers, parents, and students. In PISA 2015, the main focus was science, which provides extra information on science instruction, including the measurement of some character skills that will be used in the analysis.

For the purpose of this study, analysis was limited to science performance in seven Asian countries and regions: Hong Kong, Japan, the Republic of Korea, Singapore, Macao, QCH, and Taipei.

The students were not only tested on their knowledge of science, maths, and reading comprehension, but also completed several questionnaires that provide interesting contextual information. The precise combination of several sets of information collected in PISA provides an index, the Economic, Social, and Cultural Status (ESCS), which is widely accepted as a measure of the socioeconomic background of the student. The ESCS was created on the basis of the following variables: the International Socio-Economic Index of Occupational Status (ISEI); the highest level of education of the student's parents, converted into years of schooling; the PISA index of family wealth; the PISA index of home educational resources; and the PISA index of possessions related to "classical" culture in the family home. See OECD (2017a) for detailed information.

PISA information is collected following several procedures that must be taken into account: the sampling weights, the replicates of the estimation for computing the standard errors, and the use of plausible values (see OECD, 2017b). This is worth mentioning here, because these procedures make the analysis of the PISA datasets more sophisticated. In our case, a multilevel analysis has been used as it includes the hierarchical structure of the data.

The weights used in this work were recalculated so that the sum of the weights of each student corresponded to the total of disadvantage students in the analysed sample. In this way, the weight of each school is the sum of the weights of its disadvantaged students. In this work, the weight of the student within the school was used in level 1 of the analysis, and the weight of the school in the second level (Rutkowski, Gonzalez, Joncas, & von Davier, 2010).

Dependent variable: who is a resilient student?

In this paper, a student who is resilient in science is someone with an ESCS in the lowest quarter within his or her country and with a performance in science in the highest quarter, once the effect of the ESCS has been considered.

From the PISA perspective, academically resilient students are those who come from an socioeconomic disadvantaged background but somehow perform much higher than what is predicted by

their ESCS (OECD, 2011). Operationally, there are three steps in the identification of academic resilient students. First, students located at the bottom quarter (i.e., below Q1, the twenty-fifth percentile) of the PISA ESCS index within their own countries or economies are identified as ESCS-disadvantaged students (see, for example, OECD, 2019, pag. 66 where the same criterion is used). Second, science performance scores as assessed in PISA are regressed on students' ESCS across all participating countries or economies to find out the international ESCS-performance relationship. Third, a student's residual performance is obtained by comparing the actual performance of each student with the performance predicted by the international ESCS-performance relationship.

Academically resilient students are identified as those ESCS-disadvantaged students whose residual performance is amongst the top quarter (i.e., above Q3, the seventy-fifth percentile) of students' residual performance from all countries or economies.

We replicated this identification strategy. First, we estimated the ordinary least squares linear regression by country or region that we have studied and the average regression within all those estimated results. The dependent variable was the 10 plausible values in science performance of each student. The independent variable was the ESCS index. The equation thus is:

$$PVSCIE_i = \beta_0 + \beta_1 ESCS_i + \varepsilon_i \tag{1}$$

where $\varepsilon_i$are the random errors that follow a distribution with mean equal to zero and variance equal to σ^2. The estimated coefficients are denoted as $\hat{\beta}_0$ and $\hat{\beta}_1$. Thus, the expected students' performance given their level of ESCS could be estimated as:

$$E\left[\widehat{PVSCIE_i}\right] = \hat{\beta}_0 + \hat{\beta}_1 . ESCS_i \tag{2}$$

In the second step, we translate the regression estimated to the third quartile, moving the centroid to a new position on the horizontal axis: the third quartile of all the participant countries, Q3PVSCIE. The model becomes:

$$\widehat{Q3}_{PVSCIE_i} = Q3_{PVSCIE} + \hat{\beta}_1 . ESCS_i + \varepsilon_i \tag{3}$$

Thus, the expected value is:

$$E\left[\widehat{Q3}_{PVSCIE_i}\right] = Q3_{PVSCIE} + \hat{\beta}_1 . ESCS_i \tag{4}$$

From now on, we use $E\left[\widehat{Q3}_{PVSCIE_i}\right]$ to obtain the cut point as a function of the ESCS. We designate as resilient those students with an ESCS in the lowest quartile of the students in their country and at least six out of the ten plausible values are above the expected value ($E\left[\widehat{Q3}_{PVSCIE_i}\right]$) according to their ESCS.

Independent variables

In addition to science performance, PISA provides extra information obtained through the context questionnaires that we will use as independent variables in our analysis. This kind of information can be used as it is presented (i.e., gender or immigration status) or summarized in an index (i.e., science self-efficacy or enjoyment of science). These transformed variables are constructed through the scaling of multiple items. The index was scaled using the item response theory and the values of the index correspond to Warm likelihood estimates. For details of how each scale index was constructed, see OECD (2017b).

A second classification of the independent variables is related to where they are embedded. Some of them are located at the student level, while others are located at the school level. The first level (student level or Level 1) includes variables that collect information about student demographic characteristics and students' perception of personal aspects, including their attitudes towards

science and their school environment. The second level (school level or Level 2) information is collected from the principals of the schools. It includes information on school management and the student/teacher ratio. We will describe each of these variables, which basic statistics are presented on Table 1, for the entire dataset.

Independent variables at student level (Level 1): science-related non-cognitive skills

Student attitudes towards science collected in PISA 2015 have been summarized in four indices. Three of them relate to students' motivation for learning science: enjoyment of science, interest in broad science topics, and instrumental motivation for learning science. A fourth index, students' science self-beliefs, reflects student's perceived ability to use their knowledge of science in real-world situations.

Enjoyment of science (*Joyscie*) is an index constructed from students' responses to a four-point Likert scale containing the categories "strongly agree", "agree", "disagree", and "strongly disagree". Higher values on the index reflect greater levels of agreement with these statements. The second self-measurement of students' science attitudes is the index of instrumental motivation to learn science (*Intscie*). Students reported on a four-point Likert scale with the categories "strongly agree", "agree", "disagree", and "strongly disagree" about the statements like "Making an effort in my science subject(s) is worth it because this will help me in the work I want to do later on" or "What I learn in my science subject(s) is important for me because I need this for what I want to do later on". Responses were reverse-coded, so that higher values of the index correspond to higher levels of instrumental motivation.

The index of science self-efficacy (*Scieeff*) was constructed with a similar four-point Likert scale. The statements "I could do this easily", "I could do this with a bit of effort", "I would struggle to do this on my own", and "I could not do this", were used to rate how they would perform in some science tasks, like recognizing the science question that underlies a newspaper report on a health issue, explaining why earthquakes occur more frequently in some areas than in others, or describing the role of antibiotics in the treatment of disease. Responses were reverse-coded so that higher values of the index correspond to higher levels of science self-efficacy.

Table 1. Description of the independent variables.

	Name	Description	Type	Min	Max	Mean	Sd
		FIRST LEVEL: STUDENTS					
Students' personal issues	*Sex*	Gender	categorical	0	1		
	Repeat	Grade repetition	categorical	0	1		
Students' percepction	*Adinst*	Adaptation of the instruction to the students needs and knowledge	index	−1.966	2.047	−0.037	0.892
	Teachsup	Teacher support in a science classes of students choice	index	−2.720	1.448	0.017	0.869
	Disclisc	Disciplinary climate in science classes	index	−2.416	1.884	0.294	0.882
Science related non-cognitive skills	*Scieeff*	Science self-efficacy	index	−3.757	3.278	−0.367	1.175
	Joyscie	Enjoyment of science	index	−2.115	2.164	0.031	0.956
	Intbrsci	Interest in broad science topics	index	−2.547	2.730	−0.015	0.938
	Instscie	Instrumental motivation for learning science	index	−1.930	1.736	0.217	0.828
Common non-cognitive skills	*Motivat*	Achiving motivation	index	−3.088	1.854	−0.173	0.894
	Anxtest	Anxiety before taking a text	index	−2.505	2.549	0.315	0.940
	Sociact	Students' ICT as a topic in Social Interaction	index	−2.136	2.428	−0.095	0.892
	Intict	Students' ICT interest	index	−2.988	2.680	−0.210	0.954
		SECOND LEVEL: SCHOOLS					
School nature	*Schooltype*	Public or private school	categorical	0.000	1.000		
	Stchratio	Students/teacher ratio	continuous	1	100	13.088	7.802
Principals' perception	*Teachbeha*	Teacher behaviour hindering learning	index	−2.118	4.259	0.140	1.187
	Stubeha	Student behaviour hindering learning	index	−2.387	3.891	−0.337	1.399

Descriptive statistics for the whole sample: minimum (Min), maximum (Max), sample mean (Mean) and standard deviation (Sd) for the numerical variables.

Finally, the interest in broad science topics (*Intbrsc*) was obtained from the interest expressed by the students ("not interested", "hardly interested", "interested", or "highly interested") on several topics relating to science like the biosphere (e.g., ecosystem services, sustainability), or motion and forces (e.g., velocity, friction, magnetic and gravitational forces). A fifth response offered students the possibility to report that "[they] do not know what this is".

More information on the variables described above can be found in the PISA Technical Report (OECD, 2017b).

Independent variables at student level (and school level): control variables

At student level, in addition to science attitudes, we worked with control variables. They include gender, grade repetition (*Repeat*), the level of anxiety shown by students before a test or when solving a school task (*Anxtest*), and achieving motivation (*Motivat*). We did away with *Grade* because of its very low variance in the countries included in the analysis and its expected reiteration with the information provided by *Repeat*.

In relation to their teachers, students were asked about the adaptation of the instruction to the students' needs and knowledge (*Adinst*), about the level of support, interest, and help in students' learning (*Teachsup*), and the level of discipline in science classes (*Disclisci*).

Finally, as the countries and regions analysed chose to implement an international ICT familiarity questionnaire (ICQ), we used, among the variables related to familiarity in ICT,[2] the students' ICT interest (*Intict*) and the students' use of ICT as a topic in social interaction (*Soiaict*).

Independent variables at school level

At the school level (Level 2), we included four variables related to school environment: one to distinguish whether it is a public or private school (*Schtype*); a second variable reporting the student/teacher ratio (*Stchratio*); a third variable reporting the behaviour of a teacher making learning difficult (*Teachbeha*), including teacher absenteeism, teacher resisting change, teachers who are too strict with students, teachers who are not well prepared, and teachers who do not adequately meet the needs of students. Finally, a fourth variable reports the students' behaviour that hinders their learning (*Stubeha*), including students' absenteeism, students who do not respect teachers, the use of alcohol or illegal drugs, and if students intimidate or bully other students.

Statistical analysis

First, the sample characteristics (i.e., demographic and other characteristics elucidated earlier) for the resilient vs. non-resilient students in each of the seven East Asian countries or regions were examined. Secondly, a logistic multilevel regression was carried out for the student classification, as a function of the demographic and school characteristics.

A multilevel regression analysis was used to determine and distinguish the factors relating to resilience. Readers interested in this method will find a complete but accessible explanation in de Leeuw and Meijer (2008) or in Goldstein (2011).

Obviously, the students are nested within classes, which are nested within schools, which could be nested within school districts or countries or regions. All these relations often imply a hierarchical structure. In this paper, we will consider only two levels: students and schools. We are interested in the variables that cause a student to be resilient. It also makes sense that different school characteristics can have an impact. Different schools with different characteristics would affect students differently.

Multilevel modelling provides a useful framework that recognizes the existence of such a hierarchical data structure by allowing for residual components at each level in the hierarchy. Observations are not independent within clusters. Students within schools tend to share similar characteristics. One of the benefits of this methodology is that it distinguishes effects between and

within schools. The multilevel models account this clustered sample design. It was used as an alternative to the replicate weights provided by the PISA database.

The hierarchical logistic regression, based on maximum likelihood estimates, does not make assumptions regarding normality, homoscedasticity, and measurement level of the variables. However, it does require observations to be independent, and quite large sample sizes are needed for the estimation of the parameters. To find out whether there is evidence of an association between predictor variables and academic resilience or slackening, an odds ratio has been calculated to describe the probability of the event occurring for each predictor variable in the logistic regression equation. This ratio will be used as an effect-size measure to compare the influences of risk and protective factors of academic resilience across countries and regions.

The multilevel analysis was performed, following OECD standards, using HLM6: Hierarchical Linear and Nonlinear Modelling (Raudenbush, Bryk, Cheong, & Congdon, 2004). A two-level logistic regression analysis was carried out, with students serving as level 1, schools as level 2. The model coefficients and statistics were estimated using a full maximum likelihood procedure. Normalized student final weights were used, so that the sum of the weights was equal to the number of students in the dataset, and each country contributed equally to the analysis. An uncentered model was used as second-level coefficients provide correct estimates of the individual and the contextual effects when the contextual predictor variable is included in the second-level model (Kreft, De Leeuw, & Aiken, 1995). Measure of model fit was assessed using the negative log-likelihood and the Cox-Snell statistics. These two goodness-of-fit statistics are testing whether one can do even better by making the model more elaborate and complicated. The negative log-likelihood is an entropy-based measure (Theil, 1970), and the Cox-Snell's pseudo-R-squared attempts to mimic the OLS R-squared statistic as a measure of improvement from the null model (i.e., a model with no predictor variable) to the fitted model (Cox & Snell, 1989). A significance level of $\alpha = 0.05$ was chosen as the criterion for evaluating the statistical significance of the results. Because of the complicated rotated PISA 2015 questionnaire design, special treatment of missing data was needed. Based on the iterative Markov Chain Monte Carlo (MCMC) method, missing values were imputed by the SPSS multiple regression imputation procedures. Multiple imputations of five datasets were done in accordance with Rubin (1987).

The intra-class correlation coefficient (ICC) measures the degree of data dependence. It describes how strongly units in the same group resemble each other. If ICC = 0, the responses of students within schools are uncorrelated; if ICC = 1, responses within schools are identical. Given that the variance of the random variable depends on the values of the explanatory variables, some adaptation is needed in our case. Following Hosmer and Lemeshow (2005) we fix that variance in $\pi^2/3$, thus the ICC is:

$$ICC = \frac{\sigma_u^2}{\sigma_u^2 + \pi^2/3}$$

where σ_u^2 is the residual variance in the second level of the general model:

$$logit\{\Pr(y_{ij} = 1|x_{ij}, \xi_j)\} = \beta_{oj} + \sum_k \beta_{1k} x_{k,ij} + \varepsilon_{ij} \quad \text{(L1)}$$

$$\beta_{oj} = \gamma_{00} + \sum_m \gamma_{01,m} g_{m,j} + u_{0j} \quad \text{(L2)}$$

where $x_{k,ij}$ are the factors related to students' characteristics (Level 1) and $g_{m,j}$ variables related with school characteristics (Level 2). Random disturbances u_{0j} are supposed to be independent and identically distributed, following a $N(0, \psi)$ distribution, independent of x_{ij}. Given u_{0j} and x_{ij}, we consider that y_{ij} response from student *i*, in school *j* follows a Bernoulli distribution independent of the others.

The intra-class correlation coefficients (ICC) for the null model were obtained for each country or region. We observed some variability between the results obtained, the ICC of Singapore (0.061) being the lowest, which would indicate that there is practically no correlation between the responses of the students within a school. On the opposite side is Japan, whose ICC is 0.294, indicating a moderate correlation between the responses of students from the same school.

Results

Descriptive analysisPlease remove the number.

Table 2 includes, for each country and region, some descriptive statistics of the variables included in the analysis: sample size of students and schools used for calculations, percentages of resilient students, male students, students who had repeated at least one grade, and percentage of privately owned schools.

For the rest of variables included in our analysis, we used the indices built through the responses of students and principals (see Table 2) that are part of the PISA outcomes (OECD, 2017a). Each index is constructed with mean 0 and standard deviation 1 for all OECD countries and economies, and Table 2 shows the mean of each index for the countries and regions analysed.

High variability can be observed between countries or regions in almost all variables used in the analysis. The percentages of resilient students range from 44% in Korea to 69% in Hong Kong, whereas the share of students who have repeated at least a grade is practically nil in Japan but reaches 45% of students in Macao.

As we have pointed out in the methodological description, it is resilience variability within countries that we want to explain, using mainly the non-cognitive skills. The differences within countries and regions are summarized in Table 2. Beginning with science-related non-cognitive skills, all countries and regions analysed show on average low levels of self-efficacy in science (*Scieeff*), ranging from −0.72 in Japan to −0.14 in Taipei. High variability between countries or regions can be observed with respect to the other variables related with science and, in some case, also within a country or region. For example, students in Korea show a high level of interest only in broad science topics (*Intbrsc*) but not in enjoyment of science (*Joysci*) or in instrumental motivation (*Intscie*) whereas Singapore shows positive figures 1 in these variables.

Regarding common non-cognitive skills, positive figures in (*Motivat)* and in (*Anxtest*) denote relatively high levels of motivation and control of test anxiety, respectively. As can be seen in Table 2, the variability in these two variables is high between countries or regions, but it may be noted that in all countries and regions the average of anxiety is positive, showing that students report feeling nervous or anxious when they have to do a school test or homework, ranging from the lowest (0.07) in Korea to the highest (0.65) in Singapore.

Finally, high variability between countries or regions can be observed with respect to the general non-cognitive skills dealing with the students' ICT interest (*Intict*) and students' use of ICT as a topic in social interaction (*Soiaict*). Students in Japan report the lowest levels, similar to QCH only in ICT interest, following Korea, whereas the highest levels are in Singapore, together with Taipei only in the use of ICT as a topic in social interaction.

At school level, the indices come from the school principal questionnaire. In relation to school climate, negative figures show that the learning of students is not hindered by the teachers' behaviour (*Teachbeha*), as is the case in Korea, whereas positive figures indicate that teachers' behaviour hinders, to some extent, students' learning, such as in Macao and QCH. Student behaviour (*Stubeha*) also influences their learning in different ways depending on the country or region: relatively low in Japan or Singapore and highest in Korea and Taipei.

Other information from the school principals used in our models has to do with school ownership and human resources. The lowest student/teacher ratios (*Stchratio)* are in Japan and Singapore

Table 2. Descriptive statistics per country: Sample size of students and schools, percentages of resilient students, males, students who have repeated at least a grade, and means for the rest of the variables included in the analysis.

	HKG	JPN	KOR	MAC	QCH	SGP	TAP
FIRST LEVEL: STUDENTS							
Sample size	764	1.434	1.153	977	1.501	1.340	1.573
% Resilient	69%	50%	44%	67%	55%	52%	48%
%Male Q1	53%	49%	51%	54%	53%	54%	51%
% Repeat	24%	– –	4%	45%	29%	6%	1%
Adinst	0.01	−0.36	−0.08	−0.12	−0.04	0.33	0.03
Teachsup	−0.01	−0.20	−0.10	−0.08	0.11	0.22	0.03
Dsiclisc	0.32	0.73	0.56	0.14	0.17	−0.04	0.12
Science related non-cognitive skills							
Scieff	−0.16	−0.72	−0.30	−0.25	−0.27	−0.22	−0.14
Joysci	0.38	−0.52	−0.08	0.18	0.20	0.43	−0.25
Intbrsci	0.32	−0.24	0.56	0.04	0.37	0.19	−0.15
Intscie	0.36	−0.17	−0.05	0.23	0.52	0.49	0.18
Common non-cognitive skills							
Motivat	0.14	−0.67	−0.10	−0.66	−0.00	0.33	−0.25
Anxtest	0.26	0.21	0.07	0.42	0.26	0.65	0.37
Sociact	0.04	−0.63	−0.54	0.13	−0.06	0.19	0.20
Intict	−0.01	−0.61	−0.46	0.12	−0.64	0.43	−0.02
SECOND LEVEL: SCHOOLS							
Sample size	114	182	154	38	207	158	196
Schtype	8%	74%	68%	5%	91%	97%	71%
Stchratio	0.01	−0.23	0.17	−0.07	−0.03	−0.18	0.20
Teachbeha	0.32	0.30	−0.51	0.71	0.81	0.07	0.06
Stubeha	−0.73	−0.55	−0.25	0.06	0.27	−0.56	−0.64

ISO codes: JPN: Japan; KOR: Korea; HKG: Hong Kong (China); MAC: Macao (China); SGP: Singapore; TAP: Taipei. OECD code: QCH: refers to the four PISA-participating Chinese provinces: Beijing, Shanghai, Jiangsu, and Guangdong.

whereas the highest are observed in Korea and Taipei. Moreover, the school type (*Schtype*) shows a high variability in the ratio of private/public schools between the countries or regions.

To conclude with this brief descriptive analysis, Table 2 shows the mean values reported by the students about their perceptions on educational environment, such as the adaptation to the instruction of their teachers (*Adinst*), the interest and support given by their teachers (*Teachsup*), and the level of order and discipline in science classes (*Disclisci*). Except for Singapore, the students reported a high level of discipline in science classes, being the highest in Japan. However, the students in Singapore report the highest level of teacher's interest and support and, in turn, the students in Japan report the lowest level. Concerning the adaptation of instruction by teachers to the students' level, Japan has the lowest level and Singapore the highest.

Multilevel regression analysis

For each country or region, a model was selected that presented all the coefficients of the predictor variables statistically significant to at least 90% (p-value<0.1). Table 3 shows the coefficients of the independent variables of the multilevel regression for each country and indicates their level of statistical significance. We only present the final models, although intermediate results are available on demand.

The independent variables of the school level have a different behaviour depending on what they measure and the country or region of the research (Table 3). A bad school climate (*Stubeha*) has a negative impact on resilience in Hong Kong, Japan, Korea, and Singapore, while high values of the student/teacher ratio (*Stchratio*) have a positive impact on resilience in Hong Kong, Macao, Singapore, and Taipei. Attending a private school (*School Type*) has a positive effect on resilience.

With regard to the students' science-related non-cognitive skills, the enjoyment of science (*Joyscie*) and interest in science (*Intbrsci*) have a positive impact on the countries and regions analysed. With regards to common non-cognitive skills: the social interaction (*Soiaict*) of students

Table 3. Final selected resilient model for each country or region.

	HKG	JPN	KOR	MAC	QCH	SGP	TAP
FIRST LEVEL: STUDENTS							
Gender				0.605***		0.431***	
				(0.219)		(0.098)	
Repeat	−0.840***			−1.574***	−0.626***	−1.522***	
	(0.240)			(0.199)	(0.176)	(0.286)	
Adinst			−0.299**			0.241***	−0.226**
			(0.116)			(0.075)	(0.101)
Teachsup	0.248* (0.130)	−0.365***					0.236**
		(0.089)					(0.104)
Disclisc		0.212**		0.241**	0.231**	0.393***	
		(0.089)		(0.102)	(0.089)	(0.077)	
Science related non-cognitive skills							
Scieeff		0.108**	0.228***			0.143**	0.187**
		(0.050)	(0.063)			(0.072)	(0.083)
Joyscie	0.518***	0.280***	0.705***	0.379***		0.588***	
	(0.102)	(0.089)	(0.087)	(0.087)		(0.073)	
Intbrsci	0.303***	0.574***		0.316***	0.238**		0.269**
	(0.088)	(0.111)		(0.094)	(0.113)		(0.109)
Instscie		−0.235**	−0.253*			−0.261***	−0.167*
		(0.101)	(0.146)			(0.091)	(0.099)
Common non-cognitive skills							
Motivat	0.227**	0.234***			0.453***		0.451***
	(0.109)	(0.065)			(0.122)		(0.088)
Anxtest	−0.262***				−0.450***	−0.183***	−0.198**
	(0.095)				(0.115)	(0.068)	(0.084)
Soiaict	−0.506***	−0.176**	−0.196**	−0.568***	−0.239**	−0.520***	−0.319***
	(0.126)	(0.086)	(0.087)	(0.104)	(0.105)	(0.078)	(0.104)
Intict		0.439***	0.229**	0.462***	0.528***	0.188***	0.272***
		(0.081)	(0.092)	(0.127)	(0.098)	(0.072)	(0.095)
SECOND LEVEL: SCHOOLS							
Intercept1							
Intercept2	0.726***	−0.860***	−0.267**	1.013***	0.049 (0.358)		−1.146***
	(0.175)	(0.208)	(0.116)	(0.227)			(0.303)
Stubeha	−0.372**	−0.652***	−0.495***			−0.193**	
	(0.153)	(0.115)	(0.080)			(0.088)	
Teachbeha		0.520***					
		(0.152)					
Stchratio	1.516* (0.856)			0.791***		0.695**	1.020***
				(0.213)		(0.295)	(0.339)
Schtype		1.043***			0.717 (0.334)		1.507***
		(0.215)					(0.352)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

is statistically significant and negative in all countries and regions analysed, the interest in ICT (*Intict*) is also significant but positive in all except Hong Kong, and motivation (*Motivat*) has a positive impact on a large number of countries and regions analysed. It is important to note that students' anxiety towards exams (*Anxtest*) has a negative influence on resilience.

Table 4 presents the odds ratio for resilience together with its 95% confidence interval for each of the selected variables. The odds ratios reported here compare the probability of being resilient for two groups of students. These two groups are identified by a one unit increase in the variable measuring the factor of interest. Odds ratios over one indicate that higher values of a particular factor are associated with a greater likelihood that a disadvantaged student will be resilient, while an odds ratio below one is suggestive of a negative relationship between that factor and resilience.

After analysing the school level, it is observed that one additional point in the index of bad school climate (*Stubeha*) reduces the probability of resilience in Japan by half and lowers it by 18 percentage points in Singapore and 31 and 39 in Hong Kong and Korea, respectively. High values of the student/

Table 4. Odds ratio for resilient together with its 95% confidence interval for each of the selected variables.

	HKG	JPN	KOR	MAC	QCH	SGP	TAP
FIRST LEVEL: STUDENTS							
Gender				1.831		1.539	
				(1.193; 2.812)		(1.271; 1.863)	
Repeat	0.432			0.207	0.535	0.218	
	(0.270; 0.691)			(0.140; 0.306)	(0.379; 0.755)	(0.125; 0.382)	
Adinst			0.742			1.272	0.798
			(0.591; 0.930)			(1.097; 1.475)	(0.654; 0.973)
Teachsup	1.282	0.694					1.267
	(0.993; 1.655)	(0.583; 0.827)					(1.033; 1.553)
Disclisc		1.237		1.272	1.259	1.481	
		(1.039; 1.473)		(1.042; 1.553)	(1.058; 1.499)	(1.275; 1.721)	
Science related non-cognitive skills							
Scieeff		1.114	1.256			1.154	1.206
		(1.011; 1.228)	(1.110, 1.421)			(1.002; 1.329)	(1.026; 1.417)
Joyscie	1.679	1.324	2.023	1.461		1.801	
	(1.375; 2.051)	(1.111; 1.577)	(1.706; 2.400)	(1.232; 1.733)		(1.561; 2.079)	
Intbrsci	1.354	1.776		1.372	1.268		1.308
	(1.139; 1.609)	(1.428; 2.208)		(1.141; 1.650)	(1.016; 1.583)		(1.056; 1.621)
Instscie		0.790	0.777			0.770	0.846
		(0,648; 0.964)	(0.584; 1.033)			(0.645; 0.920)	(0.697; 1.026)
Generic non-cognitive skills							
Motivat	1.255	1.264			1.572		1.570
	(1.015; 1.553)	(1.112; 1.436)			(1.239; 1.995)		(1.321; 1.867)
Anxtest	0.769				0.637	0.833	0.820
	(0.639; 0.927)				(0.509; 0.798)	(0.729; 0.953)	(0.696; 0.967)
Soiact	0.603	0.839	0.822	0.567	0.788	0.595	0.723
	(0.471; 0.772)	(0.709; 0.992)	(0.693, 0.974)	(0.462; 0.695)	(0.642; 0.967)	(0.510; 0.693)	(0.592; 0.892)
Intict		1.552	1.257	1.588	1.695	1.207	1.313
		(1.325; 1.817)	(1.050; 1.504)	(1.239; 2.035)	(1.399; 2.055)	(1.048;1.391)	(1.091; 1.580)
SECOND LEVEL: SCHOOLS							
Intercept1							
Intercept2	2.066	0.423	0.766	2.753	1.050		0.318
	(1.461; 2.922)	(0.281; 0.637)	(0.609; 0.963)	(1.740; 4.358)	(0.519; 2.124)		(0.175; 0.578)
Stubeha	0.690	0.521	0.610			0.825	
	(0.509; 0.934)	(0.415; 0.653)	(0.521; 0.714)			(0.694; 0.980)	
Teachbeha		1.683					
		(1.248; 2.269)					
Stchratio	4.554			2.206		2.005	2.774
	(0.837; 24.778)			(1.433; 3.398)		(1.121; 3.586)	(2.256; 9.021)
Schtype		2.838			2.045		4.511
		(1.856; 4.339)			(1.062; 3.954)		(2.256; 9.021)

teacher ratio (*Stchratio*) double the probability of student resilience in Singapore and multiplies this probability by 4.5 in the case of Hong Kong.

Analysing science-related non-cognitive skills, the enjoyment of science (*Joyscie*) by students increases the probability of being resilient in Japan by 32 percentage points and doubles this probability in Korea. Something similar occurs in the case of the variable that measures the interest in student sciences (*Intbrsci*); high values increase the probability of resilience by 26 percentage points in QCH and it reaches 77 in Japan.

In the case of common non-cognitive skills, the probability of being resilient is reduced by a minimum of 16 percentage points (Japan) to a maximum of 43 (Macao) when studying the social interaction of students (*Soiaict*). However, when the interest in ICT (*Intict*) is taken into account, the probability of being resilient is increased by between 20 and 70 (Singapore and QCH) percentage points. High values in the motivation index (*Motivat*) translate to a variation of between 25 and 57 additional percentage points on the probability of resilience. Previously, the negative impact caused by anxiety towards tests (*Anxtest*) on the condition of resilience was indicated; this is reflected in

countries or regions such as Singapore, whose students who have high anxiety values are 17 percentage points less likely to be resilient, and which reaches 37 points less in QCH.

The rest of the variables have a disparate impact from some countries or regions to others (Table 4).

Discussion

We have seen that there are important differences on the level of non-cognitive skills within countries and regions. Regarding those skills closely related with science, all the countries and regions have in common a negative level of self-efficacy on science. This self-efficacy (measured by *Scieff*) is used to describe students' belief that they can, with their actions, achieve a particular goal. These negative values mean that the Asia region's level is below that of the OECD average, thus the students underestimate their talents. Alternatively, they believe that science is so difficult that they would not be able to accomplish their goal. It is important to change this perception of science as this science self-efficacy is a powerful incentive to act or to persevere in the face of difficulties.

The influence of non-cognitive skills on resilience has been clearly demonstrated through the model estimated. In every educational system except for the four Chinese provinces (QCH) and Taipei the enjoyment of science (*Joyscie*) has a positive influence on resilience. The other two aspects related to motivation for learning science (interest in broad science topics, *Intbrsci*, and instrumental motivation for learning science, *Intscie*) follow an interesting pattern. For the broad interest in science topics, the effect, when it is relevant (all the countries and regions but Korea and Singapore), is positive, meaning that the chances of being an academic resilient student increase when the student has a genuine interest on the topic. By contrast, when the student has an instrumental motivation for learning science (he or she is interested on science because it is useful for his or her career plans), the influence is negative. The finding that resilience is linked with the kind of motivation related with scientific curiosity (*Intbrsci*) is an important message to educators, sometime too focus on the utilitarian part of the students formation.

On the group of common (generic) non-cognitive skills, we would like to put the focus on the impact of the ICT on resilience. The index *Soiaict* measures the degree to which ICT (information communication technology) is a part of the daily social life of the students, an index informed by question such as "I like to share information about digital devices with my friends" or "I like to meet friends and play computer and video games with them". In all the studied countries and regions, the effect of this socialization through ICT on resilience is both significant and negative. Actually, it is the only factor that all countries and regions have in common. But fortunately, to promote resilience the authorities do not have to go against the grain on ICT. As the relation between *Intict*, a measure of the student's ICT interest shows, with positive coefficients for all the countries and regions but Hong Kong, the resilient students are interested on ICT but, we can conclude, they prefer not to use technology in their daily interactions with their friends. This is an interesting finding for parents and teachers for the times to come: the ICT is already part of the daily life on schools. Indeed, due to external circumstances, it might be the only available solution. But, having said this, if we want to promote resilience students, we have to promote people caring for others. And not only caring but also "physically" interacting with them.

Although resilience is an individual property, the finding that resilience varies across schools suggests that their environment also have influence. Consequently, the policymakers have a key role in mitigating the risk of low achievement for disadvantaged students, for example, promoting education policies and school practices that promote a good disciplinary climate (*Stubeha* and *Disclisc)*.

Countries need qualified students on STEM careers wherever they might be found. It is known the role that social class plays in choosing a career, and how disadvantage families do not have the resources to allow adequate orientation of the students. The promotion of resilience by education

authorities could allow students to obtain good results in science despite their low socioeconomic status, promoting equity and, in the long run, quality on the education system.

The results of this study should be evaluated in light of some limitations, derived from the adequacy between our data, and the purpose of our research. Being the academic resilience a multifaceted subject, we decided to focus just in the non-cognitive surface, leaving many others aspects for future research. Even for such a limited approach, not all the potential explanatory variables described on the literature were available in PISA. Specifically, the information regarding personality profile or family background, not available in PISA for every country, might contain information relevant to student resilience.

A second limitation of the study is derived from the lack of temporal perspective of PISA datasets. We do not have longitudinal data where observations are for the same subjects. If we had, it would be very interesting, once a student is identified as resilient, to follow the unfolding of her career and answer questions like: if someone is resilient at 15, is then resilience forever? Or what is the impact of resilience on the long run?

Finally, the model we have adopted study academic resilience based on science performance for countries on East and South-East Asian zone. We do not know whether our results for science would be generalizable to other areas of academic performance such as reading comprehension or mathematics; neither we know which of the findings could be significative in other parts of the world. These could be potentially interesting directions for future research to pursue.

Notes

1. TIMSS: Trends in International Mathematics and Science Studies.
2. ICT: Information and Communications Technology.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Agasisti, T., Avvisati, F., Borgonovi, F., & Longobardi, S. (2018). Academic resilience: What schools and countries do to help disadvantaged students succeed in PISA. *OECD Education Working Papers* (pp. 167).

Banerjee, P.A. (2016). A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools. *Cogent Education*, *3*(1), 1178441.

Camilli, G., & Hira, R. (2019). Introduction to special issue—STEM workforce: STEM education and the post-scientific society. *Journal of Science Education and Technology*, *28*(1), 1–8.

Caprile, M., Palmen, R., Sanz, P., & Dente, G. (2015). *Encouraging STEM studies labour market situation and comparison of practices targeted at young people in different member states*. European Parliament. Brussels: Directorate General for Internal Policies.

Cheung, K., Sit, P., Soh, K., Leong, M., & Mak, S. (2014). Predicting academic resilience with reading engagement and demographic variables: Comparing Shanghai, Hong Kong, Korea, and Singapore from the PISA perspective. *The Asia-Pacific Education Researcher*, *23*(4), 895–909.

Chua, J. (2009). Saving the Teacher's Soul: Exorcising the Terrors of Performativity. *London Review of Education*, *7*(2), 159–167.

Clavel, J.G. (2018). Una Propuesta de Clasificación de Las Habilidades No Cognitivas a La Luz de Los Clásicos. *Presupuesto Y Gasto Público*, *90*, 89–100.

Cox, D.R. and Snell, E.J. (1989) *Analysis of Binary Data. 2nd Edition*, Chapman and Hall/CRC, London.

de Leeuw, J., & Meijer, E. (2008). Introduction to multilevel analysis. In J. de Leeuw & E. Meijer (Eds.), *Handbook of multilevel analysis* (pp. 1–75). Toronto, Canada: Springer Science.

Farrington, C.A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T.S., Johnson, D.W., & Beechum, N.O. (2012). *Teaching adolescents to become learners: The role of noncognitive factors in shaping school performance–A critical literature review*. Chicago, USA: Consortium on Chicago School Research.

Goldstein, H. (2011). *Multilevel statistical models*. London, UK: John Wiley & Sons.

Gorard, S., See, B.H., & Davies, P. (2012). *The impact of attitudes and aspirations on educational attainment and participation*. Washington, USA: Joseph Rowntree Foundation.

Heckman, J.J. (2011). *Integrating personality psychology into economics*. Working Paper 17378. National Bureau of Economic Research.

Heckman, J.J., & Rubinstein, Y. (2001). The importance of noncognitive skills: Lessons from the GED testing program. *The American Economic Review*, *91*(2), 145–149.

Hosmer, D.W., & Lemeshow, S. (2005). *Applied logistic regression* (pp. 47–90). Toronto: John Wiley & Sons, Ltd.

Humphries, John & Kosse, Fabian. (2017). On the interpretation of non-cognitive skills – What is being measured and why it matters. *Journal of Economic Behavior & Organization*, 136, 174–185.

Kim, Tack-Ho, Lee, Sang, Yu, Kumlan, Lee, Seungkook & Puig, Ana. (2005). Hope and the meaning of life as influences on Korean adolescents' resilience: Implications for counselors. *Asia Pacific Education Review*, 6, 143–152.

Kreft, I.G., De Leeuw, J., & Aiken, L.S. (1995). The effect of different forms of centering in hierarchical linear models. *Multivariate Behavioral Research*, *30*(1), 1–21.

Li, H. (2017). The 'Secrets' of Chinese Students' academic success: Academic resilience among students from highly competitive academic environments. *Educational Psychology*, *37*(8), 1001–1014.

OECD. (2011). *Against the Odds: Disadvantaged Students Who Succeed in School*. Author. doi:10.1787/9789264090873-en

OECD. (2016a). *PISA 2015 Results (Volume I)*. Retrieved from https://www.oecd-ilibrary.org/education/pisa-2015-results-volume-i_9789264266490-en

OECD. (2016b). Students' attitudes towards science and expectations of science–related careers. In *PISA 2015 Results (Volume I): Excellence and equity in education,* 109–144. Paris: Author.

OECD. (2017a). *PISA 2015 Assessment and Analytical Framework*. Retrieved from https://www.oecd-ilibrary.org/content/publication/9789264281820-en

OECD. (2017b). *PISA 2015 Technical Report*.

OECD. (2019). *PISA 2018 Results (Volume II): Where All Students Can Succeed*. Paris: Author.

Raudenbush, S.W., Bryk, A.S., Cheong, Y.F., & Congdon, R.T., Jr. (2004). *HLM 6: Hierarchical Linear and Nonlinear Modeling*. Lincolnwood, Ill: Scientific Software International, Inc.

Rubin, Donald B. (1987). *Multiple Imputation for Nonresponse in Surveys*. Chichester, New York, Brisbane, Toronto, Singapore: John Wiley & Sons.

Rutkowski, L., Gonzalez, E., Joncas, M., & von Davier, M. (2010). International large scale assessment data: Issues in secondary analysis and reporting. *Educational Researcher*, *39*(2), 142–151.

Sandoval-Hernández, A., & Bialowolski, P. (2016). Factors and conditions promoting academic resilience: A TIMSS-based analysis of five Asian education systems. *Asia Pacific Education Review*, *17*(3), 511–520.

Shen, X. (2012). Shanghai resilient students' learning characteristics: Evidence-based research with PISA 2009 data. *Exploring Education Development*, *18*, 25–36.

Tajasom, A., & Ahmad, Z. (2011). Principals' leadership style and school climate: Teachers' perspectives from Malaysia. *The International Journal of Leadership in Public Services*, *4*(7), 314–333.

Theil, H. (1970). On the Estimation of Relationships Involving Qualitative Variables. *American Journal of Sociology*, *76*(1), 103–154.

3.4. Cuarto artículo

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2021). Academic resilience in European countries: The role of teachers, families, and student profiles. *PLoS ONE*, *16*(7).

El objetivo de este artículo es analizar variables individuales y familiares del estudiante junto con variables del maestro, tanto individuales como de práctica docente para conocer el impacto de la actividad docente sobre la condición de resiliencia. La principal aportación de este artículo a la Tesis Doctoral es comprobar que en presencia de variables del docente las variables del alumno se siguen comportando igual y se concluye que la práctica docente también puede potenciar que un estudiante tenga mayor probabilidad de ser resiliente.

Factor de Impacto JCR 2020 = 3.240; Q2

Factor de Impacto 5 años = 3.788

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RESEARCH ARTICLE

Academic resilience in European countries: The role of teachers, families, and student profiles

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Abstract

Academic resilience is a student's ability to achieve academic results significantly higher than would be expected according to their socioeconomic level. In this study, we aimed to identify the characteristics of students, families, and teacher activities which had the greatest impact on academic resilience. The sample comprised 117,539 fourth grade students and 6,222 teachers from 4,324 schools in member states of the European Union that participated in the PIRLS 2016 study. We specified a two-level hierarchical linear model in two phases: in the first level we used the students' personal and family background variables, in the second level we used the variables related to teaching activity. In the first phase we used the complete model for all countries and regions, in the second phase we produced a model for each country with the highest possible number of statistically significant variables. The results indicated that the students' personal and family variables that best predicted resilience were the reading self-confidence index, which increased the probability of student resilience by between 62 and 130 percentage points, a feeling of belonging to the school, which increased the chances of being resilient by up to 40 percentage points, and support from the family before starting primary school (Students from Lithuania who had done early literary activities in the family setting were twice as likely to be resilient than those who had not). The teaching-related factors best predicting resilience were keeping order in the classroom, a safe and orderly school environment (increasing chances of resilience by up to 62 percentage points), and teaching focused on comprehension and reflection, which could increase the probability of resilience by up to 61 percentage points.

Introduction

Evaluations of education systems are a key tool for describing the development of students' skills and how schools help in improving learning [1]. Identifying the contextual factors of the teaching process that have the greatest impact on academic performance may help to prevent school failure, and may also help to guide policy decisions towards the continual improvement of the education system [2–5]. Because of their usefulness, more and more countries are participating in comparative studies of education systems run by international organizations such as

available for Stata): P16_SPSSData_pt1.zip (AADGEO 100MB) and P16_SPSSData_pt2.zip (HKGZA5 100MB). The data files are public and without access restrictions. It is also possible to download the supporting documents (User Guide and Supplements files) to replicate the analyzes.

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the Organization for Economic Co-operation and Development (OECD), the International Association for the Evaluation of Educational Achievement (IEA), and the European Commission (EC), among others [6]. In this context, the study of academic resilience is a thriving area of growing interest in current educational research [7–13].

Academically resilient students are those who achieve academic success despite adverse socioeconomic conditions [14, 15]. As Choi & Calero [16] noted, students' capacity for resilience comes from the interaction between personal, family, and school variables. Academic resilience is closely connected to the student's personality characteristics such as socio-affective variables, self-concept, academic expectations, causal attributions, and confidence in their own abilities [17–22]. There is also a broad consensus among researchers that academic resilience is strongly linked to motivational variables such as effort, persistence, personal strength, the ability to work autonomously, enthusiasm for learning, and enjoyment of reading [19–21, 23–25].

The family context also seems to be associated with the likelihood of being academically resilient, and parents' academic expectations have been shown to be a key predictor of educational results [26]. Fernández-Alonso, Álvarez-Díaz, Woitschach, Suárez-Álvarez, & Cuesta [27] found that students whose parents had a more distant or indirect profile of family involvement tended to demonstrate better results than students from homes with more controlling styles. Using the TIMSS 2011 database, Sandoval & Bialowolski [28] found that high academic expectations and time spent on mathematics in the home had a positive effect on Singaporean students. In a sample of Chinese students participating in university entrance exams, Li [29] found that supervision by parents and school involvement and recognition strengthened resilience. Studies such as Cheung et al. [30], reported that students with family support tended to have better psychological wellbeing, and were more likely to be resilient.

Educational research has accumulated evidence relating the school learning context to academic resilience. Erberber et al. [17], found that the school factors most strongly related to resilience in mathematics and science subjects included teacher expectations of student performance, the school's interest in academic success, a safe school atmosphere, school discipline, and the amount of educational resources available. On similar lines García-Crespo et al. [14], found that a favorable school environment notably increased student academic resilience. Another line of research that has produced very consistent results indicates teachers as a key factor in academic resilience [31–35]. Although the concept of teaching quality is multidimensional [36–39], researchers have been able to summarize a set of teaching practices and didactic strategies with real potential for improving student motivation, and improving their learning outcomes [33, 40–47]. Variables such as teachers satisfaction with their work also play an important role in their performance, and consequently in the students' academic performance [48–50]. In addition, better quality education systems are able to attract highly trained, skilled teachers, offering them careers which recognize and enable teacher development and training [51–53], which suggests that initial and continued teacher training would also be associated with students' academic resilience. Consequently, there is great political interest in assessing whether participation in continual professional development activities is driving changes in teaching practices and in student performance, and whether some types of activities are more effective than others [33, 54–56]. Research has found that participation in professional development activities is linked to individual motivation and the desire to improve teaching skills in order to be able to help students [57]. This participation has a direct positive impact on improving student performance [56], and increasing the likelihood of resilience closing the gap between students [58].

Within this context, the main objective of this current study is to identify and assess the influence of two types of variables on students' academic resilience: students' personal and family variables, and the teachers' teaching practices.

Materials and methods

Participants

We defined the target population as students in the 4th year of compulsory education in the European Union countries and regions taking part in PIRLS 2016. PIRLS is designed to describe and summarize student performance, which is why it aims for the target population to have complete coverage. However, in some cases, for political, geographical, or operational reasons, complete national coverage is not achieved. For this reason, in some exceptional situations, they permit schools to be excluded (inaccessibility due to a geographically remote location, extremely small size, offering a radically different grade structure or curriculum to the mainstream educational system or providing instruction solely to students in the student-level exclusion categories below) or the exclusion of students within schools (students with functional or intellectual disabilities) [59]. Within each country, the sampling, which was in accordance with international test standards [59], was stratified, sequential by cluster, and two-stage. In the first stage, schools were selected with a probability proportional to their size within each stratum. In the second stage the class or classes to participate within the school were selected. The sample was made up of 117,539 students and 6,222 teachers from 4,324 schools (Table 1). Table 1 gives a description of the sample. In this study, we used 23 samples

Table 1. Sample description.

Country	Number of Students	Number of Teachers	Number of Schools	Number of home questionnaires	Coverage of the national target population	Coverage of home
Austria	4,360	257	150	4,074	94.4%	94.2%
Belgium (Flemish)	5,198	277	148	4,560	98.4%	87.6%
Belgium (French)	4,623	254	158	3,971	94.0%	85.6%
Bulgaria	4,281	214	153	4,206	95.7%	97.8%
Czech Republic	5,537	269	157	5,202	96.6%	94.4%
Denmark	3,508	186	185	3,214	91.2%	91.0%
England	5,095	210	170	0	96.3%	0.0%
Finland	4,896	295	151	4,535	97.6%	93.2%
France	4,767	284	163	4,218	94.6%	89.6%
Germany	3,959	221	208	2,668	95.8%	66.8%
Hungary	4,623	209	149	4,374	95.5%	94.4%
Ireland	4,607	219	148	4,254	96.9%	92.3%
Italy	3,940	217	149	3,586	95.1%	91.3%
Latvia	4,157	218	150	3,882	92.1%	93.4%
Lithuania	4,317	243	195	3,623	95.8%	86.4%
Malta	3,647	207	95	3,155	92.1%	86.5%
Netherlands	4,206	226	132	2,246	96.9%	53.4%
Northern Ireland	3,693	160	134	1,445	97.0%	37.7%
Poland	4,413	246	148	4,290	96.1%	97.4%
Portugal	4,642	318	218	4,514	92.5%	97.4%
Slovak Republic	5,451	334	220	5,210	95.2%	95.7%
Slovenia	4,499	253	160	4,256	97.6%	95.1%
Spain	14,595	678	629	13,402	95.2%	91.1%
Sweden	4,525	227	154	3,758	94.8%	84.8%
Total	117,539	6,222	4,324	98,643		

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from 22 EU countries, as Belgium has two samples, one Flemish-speaking and the other French-speaking. England was not included in the analysis as they did not provide data for the family questionnaire, which prevented the creation of student socioeconomic and sociocultural indices, something that was essential for identifying resilient students.

Procedure

The PIRLS 2016 test was applied following the standards outlined by the International Association for the Evaluation of Educational Achievement (IEA) [59]. The test was applied on a single day, structured in two 40-minute sessions with a 30-minute break in the middle. Each session involved reading a literary text and an informative text (not necessarily in that order) and answering a series of items about them. The test was specified according to the theoretical framework established in Mullis and Martin [60], and comprised a total of 12 readings (half informative, half literary) distributed in 16 different test booklets following a partially balanced incomplete block design [61]. Because each student only completed a single test booklet, when the test was given, test-booklets were distributed so that each item was answered by a similar number of students. Once the reading sessions were finished, the students completed a background questionnaire (Student Questionnaire) which would be used to complement the information about student reading comprehension. The process also included a Home Questionnaire (Learning to Read Survey) for families, a Teacher Questionnaire which was completed by the language teacher, and a School Questionnaire which was completed by the heads of the schools. It should be noted that due to the data collection procedure for the Home Questionnaire, it was not available for all of the students who participated in the study because some families did not return a completed questionnaire. Regardless of this, the number of questionnaires available was sufficient to perform the analysis for this study as it achieved sufficient coverage with the application of missing data recovery techniques detailed below.

Measurement instruments and variables

Academic resilience. A student is considered to show resilience if they meet two conditions: a) their score in the *Index of Economic, Social and Cultural Status (ESCS)* is in the lowest quarter of the ESCS in their country, and b) their score in the PIRLS 2016 *Reading Comprehension* is higher than the third quartile of overall achievement once the individual ESCS is discounted. The full method of calculation may be found in García-Crespo et al. [14].

The ESCS index is essentially unidimensional [62–65] and is constructed from four items in the student context and family questionnaires: home possessions, books at home, parents' highest education level, and parents' highest occupation level.

The score in *Reading Comprehension* was calculated from the responses to the cognitive reading tests and information in the background questionnaires. It was constructed by applying models derived from Item Response Theory (IRT), assigning five plausible values as scores on a scale with a mean of 500 and standard deviation of 100 [59].

Predictor variables of academic resilience. We considered 24 variables to predict academic resilience, eight related to students, two to families, and fourteen to teaching practices.

Student-related variables. The variables *Gender* and *Attended a preschool educational program* (less than 2 years; two years or more) are dichotomous, the remaining variables were constructed using IRT partial credit scaling [59, 66]. For this analysis they were normalized with a mean of 0 and standard deviation of 1 *[N(0,1)]*. The six remaining variables (and their labels in brackets) in the student questionnaire were as follows:

Sense of school belonging (Sensebel). Students were asked how much they agreed with five statements about their attitude toward school, 1 (I like being in school), 2 (I feel safe when I

am at school), 3 (I feel like I belong at this school), 4 (Teachers at my school are fair to me), and 5 (I am proud to go to this school).

Engaged in reading lessons (Engagedr). Students were scored according to their degree of agreement with nine statements related to their reading commitment: 1 (I like what I read about school), 2 (My teacher gives me interesting things to read), 3 (I know what my teacher expects me to do), 4 (My teacher is easy to understand), 5 (I am interested in what my teacher says), 6 (My teacher encourages me to say what I think about what I have read), 7 (My teacher lets me show what I have learned), 8 (My teacher does a variety of things to help us learn), and 9 (My teacher tells me how to do better when I make a mistake).

Like reading (Likeread). Students were scored on this scale according to their degree of agreement with eight statements and how often they did two reading activities outside of school: 1 (I like talking about what I read with other people), 2 (I would be happy if someone gave me a book as a present), 3 (I think reading is boring), 4 (I would like to have more time for reading), 5 (I enjoy reading), 6 (I learn a lot from reading), 7 (I like to read things that make me think), and 8 (I like it when a book helps me imagine other worlds).

Confident in reading (Confiden). Students were scored according to their degree of agreement with six statements: 1 (I usually do well in reading), 2 (Reading is easy for me), 3 (I have trouble reading stories with difficult words), 4 (Reading is harder for me than for many of my classmates), 5 (Reading is harder for me than any other subject), and 6 (I am just not good at reading).

Early literacy activities before school (Litactiv). Students were scored according to how often their parents' did the nine activities: 1 (Read books), 2 (Tell stories), 3 (Sing songs), 4 (Play with alphabet toys, e.g., blocks with letters of the alphabet), 5 (Talk about things you had done), . . .

Early literacy tasks (Littask). Students were scored according to their parents' responses about how well their children could do the six tasks: 1 (Recognize most of the letters of the alphabet), 2 (Read some words), 3 (Read sentences), 4 (Read a story), 5 (Write letters of the alphabet), and 6 (Write some words).

Family-related variables. We extracted two variables from the family questionnaire, constructed and scored in the same way [*N(0,1)*] as the variables from the student questionnaire.

Parents' perceptions of child's school (Parentsp). Students were scored on this scale according to their parents' responses to six statements about the school: 1 (My child's school does a good job including me in my child's education), 2 (My child's school provides a safe environment), 3 (My child's school cares about my child's progress in school), 4 (My child's school does a good job informing me of their progress), 5 (My child's school promotes high academic standards), and 6 (My child's school does a good job in helping them become better in reading).

Parents like reading (Parentsl). Students were scored on this scale according to their parents' responses to eight statements about reading and how often they read for enjoyment: 1 (I read only if I have to), 2 (I like talking about what I read with other people), 3 (I like to spend my spare time reading), 4 (I read only if I need information), 5 (Reading is an important activity in my home), 6 (I would like to have more time for reading), 7 (I enjoy reading), and 8 (Reading is one of my favorite hobbies)

Teaching-related variables. We extracted 14 variables from the teacher questionnaire. Gender was dichotomous, the others were expressed on a continuous, normalized scale [*N (0,1)*].

Teachers' basic training (Basictraining). Students were scored on this scale according to their teachers' responses (Not at all / Overview or introduction to topic / It was an area of emphasis) to four statements about their formal education and training and the extent to

which they studied the following areas: 1 (language of test), 2 (Literature), 3 (Pedagogy/teaching Reading), and 4 (Educational psychology).

Teachers' complimentary training (Complime). Students were scored on this scale according to their teachers' responses (Not at all / Overview or introduction to topic / It was an area of emphasis) to three statements about their formal education and training regarding the extent to which they studied the following areas: 1 (Remedial reading), 2 (Reading theory), and 3 (Assessment methods in reading).

School emphasis on academic success (Emphasis). Students were scored according to their teachers' responses characterizing twelve aspects of the School Emphasis on Academic Success scale: 1 (Teachers' understanding of the school's curricular goals), 2 (Teachers' degree of success in implementing the school's curriculum), 3 (Teachers' expectations for student achievement), 4 (Teachers' ability to inspire students), 5 (Collaboration between school leadership (including master teachers) and teachers for planning instruction), 6 (Parental involvement in school activities), 7 (Parental commitment to ensure that students are ready to learn), 8 (Parental expectations for student achievement), 9 (Parental support for student achievement), 10 (Students' desire to do well in school), 11 (Students' ability to reach the school's academic goals), and 12 (Students' respect for classmates who excel academically).

Safe and orderly school (Security). Students were scored according to their teachers' degree of agreement with eight statements on the Safe and Orderly School scale: 1 (This school is located in a safe neighborhood), 2 (I feel safe at this school), 3 (This school's security policies and practices are sufficient), 4 (The students are well behaved), 5 (The students are respectful of the teachers), 6 (The students respect school property), 7 (This school has clear rules about student conduct), and 8 (This school's rules are fairly and consistently enforced)

Teacher interaction (Interact). Students were scored on this scale according to their teachers' responses to four statements about different types of interaction with other teachers in terms of how often they occurred: 1 (Share what I have learned about my teaching experiences), 2 (Observe another classroom to learn more about teaching), 3 (Work together to improve how to teach a particular topic), 4 (Work with teachers from other schools on the curriculum), and 5 (Work with teachers from other grades to ensure continuity in learning).

Teacher job satisfaction (Satisfac). Students were scored according to how often their teachers responded positively to the five statements on the Teacher Job Satisfaction scale: 1 (I am content with my profession as a teacher), 2 (I find my work full of meaning and purpose), 3 (I am enthusiastic about my job), 4 (My work inspires me), and 5 (I am proud of the work I do).

Classroom instruction limited by student attributes (Limitat). Students were scored according to their teachers' responses about seven attributes of their students that could limit how they teach their class in the Classroom Instruction Limited by Student Attributes scale: 1 (Students lacking prerequisite knowledge or skills), 2 (Students suffering from lack of basic nutrition), 3 (Students suffering from not enough sleep), 4 (Students absent from class), 5 (Disruptive students), 6 (Uninterested students), 7 (Students with mental, emotional, or psychological impairment), and 8 (Lack of support for using information technology)

Routine strategies for reading (Routinare). Students were scored on this scale according to their teachers' responses to three statements about reading activities regarding how often they did them: 1 (Read aloud to students), 2 (Ask students to read aloud), and 3 (Ask students to read silently on their own).

Systematic strategies for reading (Sistemat). Students were scored on this scale according to their teachers' responses to four statements about reading activities regarding how often they did them: 1 (Teach students strategies for decoding sounds and words), 2 (Teach students new vocabulary systematically), 3 (Teach students how to summarize the main ideas), and 4 (Teach or model skimming or scanning strategies).

Use of comprehension reading techniques (Comprehe). Students were scored on this scale according to their teachers' responses to three statements about how often they did things to help develop reading comprehension skills: 1 (Locate information within the text), 2 (Identify the main ideas of what they have read), and 3 (Explain or support their understanding of what they have read).

Use of reflective reading techniques (Reflecti). Students were scored on this scale according to their teachers' responses to six statements about how often they did things to help develop reading strategies: 1 (Compare what they have read with experiences they have had), 2 (Compare what they have read with other things they have read), 3 (Make predictions about what will happen next in the text they are reading), 4 (Make generalizations and draw inferences based on what they have read), 5 (Describe the style or structure of the text they have read), and 6 (Determine the author's perspective or intention).

Homework tracking (Homework). Students were scored on this scale according to their teachers' responses to three statements about how often they did the following with the reading homework assignments for their class: 1 (Correct assignments and give feedback to students), 2 (Discuss the homework in class), and 3 (Check whether the homework was completed).

Selection of adapted readings (Readings). Students were scored on this scale according to their teachers' responses to three statements about how often they did the following in teaching reading to their class: 1 (Provide reading materials that match the students' interests), 2 (Provide materials that are appropriate for the reading levels of individual students), and 3 (Give students time to read books of their own choosing).

The variables *Emphasis*, *Security*, *Satisfact*, and *Limitati* were constructed using the IRT partial credit scaling model [59, 66], while the remaining variables were constructed via Principal Component Analysis (PCA)

The TIMSS & PIRLS International Study Center thoroughly reviewed the items to assess and evaluate their psychometric characteristics. This review allowed them to detect items with unusual properties that could indicate problems or errors for a particular country. Countries are expected to exhibit some variation in the item responses, however, when that variation is large there is said to be item-country interaction, and measures need to be taken to resolve the problem. To detect these interactions, the TIMSS & PIRLS International Study Center produced a graphical display for each item showing the difference between the Rasch difficulty of a parameter for an item in a country and for the item in the international average. In each of these item-by-country interaction displays, the difference in the Rasch difficulty for each country is presented as a 95% confidence interval, including a Bonferroni correction for multiple comparisons between participating countries [59].

Data analysis

We used multilevel logistic regression models to analyze the influence of the predictor variables on the criterion (academic resilience) [67–69]. The use of hierarchical linear models is due to the structure of the data matrices in the international evaluations of education systems. Analysis procedures derived from the classical general linear model assume that the cases are selected via simple random sampling, however, in large scale educational evaluations, the assumption of independence of collected data is not usually met [70]. In fact, PIRLS 2016 used a complex sampling design, in which the observations are definitely not independent, as the students (level 1) within the same class or school (level 2) are more similar to each other than to the students in other classes or schools [71]. In added designs, each level of the hierarchy has a different variability and the errors are not independent. Because the analytical procedures derived from the classical general linear model do not consider this interdependence of

cases, their results may very well be biased due to underestimating standard errors which may cause false significance. Multilevel models, by addressing this grouped sample design, are a valid alternative to the replicated weightings offered initially by the PIRLS 2016 database. For each of the countries analyzed, we specified two multilevel logistical regression models. In the first iteration, the model included all of the predictor variables. It followed a non-centered model, as the second-level coefficients provide correct estimations of individual effects and the contextual effect when the contextual predictor variable is included in the second level of the model [72]. In the second iteration, the model was specified which retained the predictors that were statistically significant in the initial model for each country. This means that we produced as many models as participating countries. That will allow a comparison of which variables were significant in within each country and to what extent.

We considered the following parameters to analyze and evaluate the models obtained:

a. Coefficients (β_i, i = 1, . . ., 10; γ_{0j}, j = 1, . . ., 14) and their signs. Positive values would indicate direct positive impact of the predictor variable on the criterion variable, negative values would indicate an inverse impact.

b. P-value of the coefficients (β_i, i = 1, . . ., 10; γ_{0j}, j = 1, . . ., 14): marginal level of significance. We selected the variables that were significant at 10% and at 5%.

c. Odds ratio (e^{β_i}, $e^{\gamma_{0j}}$). This allows comparison of the odds of different values of a β_i or γ_{0j} predictor variable, indicating the amount of impact, with a value of 1 indicating that β_i or γ_{0j} have no impact. The further from 1, the greater the impact, whether direct or inverse (García-Crespo et al., 2019).

To specify the models, we used HLM6© software and cases were weighted by the original weightings of students and schools in the PIRLS 2016 database. These weightings, which reflect the probabilities of selecting students and schools in the study, allow proper reproduction of the population size and optimize the representativeness of the results [73]. The response rate of the questionnaires from which the indices were constructed was very high, over 95% for the student, teacher, and school head questionnaires and over 85% for the family questionnaire. There were no concentrations of missing data by country or school, which means it did not bias the responses. Due to the construction of the indices, they did not give anomalous data, as all of the continuous indices were from standardized distributions with a mean of 0 and a standard deviation of 1. Although there are many methods for recovering missing data [74], in this study we used the linear trend at point process in the Missing Value Analysis module in SPSS, using the class the student belonged to as segmentation.

Results

Table 2 shows the ESCS and the percentages of academically resilient students in reading by country, along with the standard errors of the estimated parameters.

The countries with the highest proportions of resilient students, according to the estimations produced from the definition of resilience used in this study, were Poland (42.22%) and Italy (40.57%). The French-speaking area of Belgium (5.96%) and Malta (6.45%) had the lowest proportions. This indicates a great variation in the proportions of resilient students between the different countries analyzed.

Before presenting the results of this study, the bilateral correlations between the variables in the model are provided, in order to reject excessive correlation that would prevent the true impact of each variable from being seen independently. Table 3 shows the bivariate correlations between the student and family contextual variables, while Table 4 shows the correlations

Table 2. Index of economic, social and cultural status, and percentage of resilient students for the European Union countries.

Country	ESCS	ESCS s.e.	Resilient percentage	Resiliente percentage s.e.
Austria	0.09	0.03	16.43	1.80
Belgium (Flemish)	0.25	0.03	12.80	1.25
Belgium (French)	0.11	0.03	5.96	0.77
Bulgaria	-0.24	0.06	27.48	3.40
Czech Republic	0.09	0.03	22.88	1.81
Denmark	0.65	0.03	17.45	1.56
Finland	0.49	0.02	32.76	1.95
France	0.01	0.03	11.88	1.21
Germany	0.01	0.04	20.00	1.86
Hungary	0.00	0.06	25.33	2.15
Ireland	0.23	0.03	36.23	1.90
Italy	-0.45	0.04	40.57	1.88
Latvia	0.30	0.03	27.18	1.77
Lithuania	0.11	0.03	23.14	1.76
Malta	-0.10	0.01	6.45	0.77
Netherlands	0.45	0.03	19.23	1.85
Northern Ireland	0.34	0.03	36.90	2.03
Poland	-0.04	0.03	42.22	2.20
Portugal	-0.20	0.03	24.95	1.80
Slovak Republic	-0.16	0.04	18.92	1.71
Slovenia	0.16	0.03	22.09	1.90
Spain	-0.02	0.03	20.93	1.10
Sweden	0.66	0.03	18.80	1.61

s.e.: Standard error

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between the teaching process variables. Although the correlation was statistically significant in all cases, the values, as shown below were almost all low.

The tables below provide the results of the models that only conserved the statistically significant variables to the resilience condition by country, models from the second iteration. Table 5 gives the contextual variables from the students and their families, and Table 6 gives the teaching context variables. Both tables contain the parameters of the logistical regression by country and dependent variable: the coefficients and their standard errors, the odds ratio, and the p-value (level of significance).

Table 3. Correlations of student and family contextual variables.

	SenseBelonging	EngagedReading	LikeReading	Confident	LitActivities	LitTask	ParentsPercep	ParentsLikeRead
SenseBelonging	1	.580**	.428**	.103**	.051**	.088**	.183**	.044**
EngagedReading		1	.527**	.139**	.057**	.075**	.167**	.032**
LikeReading			1	.171**	.080**	.135**	.114**	.089**
Confident				1	.106**	.139**	.022**	.074**
LitActivities					1	.290**	.135**	.314**
LitTask						1	.143**	.164**
ParentsPercep							1	.101**
ParentsLikeRead								1

** The correlation is significant at the 0.01 level (bilateral)

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Table 4. Correlations of variables related to teaching.

	BasicTraining	CompleTraining	Emphasis	Security	Interaction	Satisfaction	Limitations	Rutinare	Sistemat	Comprehensive	Reflective	Homework	Readings
BasicTraining	1	.448**	.103**	.131**	.119**	.069**	-.035**	.072**	.099**	.074**	.104**	.042**	.104**
CompleTraining		1	.092**	.064**	.139**	.120**	.035**	.021**	.155**	.070**	.157**	.077**	.082**
Emphasis			1	.554**	.380**	.345**	.342**	.123**	.146**	.075**	.164**	.057**	.209**
Security				1	.260**	.301**	.384**	.053**	.058**	.011**	.086**	.012**	.166**
Interaction					1	.339**	.139**	.179**	.356**	.248**	.344**	.192**	.224**
Satisfaction						1	.238**	.148**	.227**	.144**	.212**	.099**	.223**
Limitations							1	.005*	.067**	.013**	.087**	.066**	.019**
Rutinare								1	.376**	.369**	.306**	.163**	.246**
Sistemat									1	.523**	.627**	.346**	.324**
Comprehensive										1	.591**	.275**	.273**
Reflective											1	.295**	.323**
Homework												1	.089**
Readings													1

** The correlation is significant at the 0.01 level (bilateral).

* The correlation is significant at the 0.05 level (bilateral)

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Tables 7 and 8 show the percentages of countries in which the coefficient of the corresponding variable was statistically significant.

The first notable result is that the teaching context variables had less impact on the probability of resilience than the student context variables. In this regard, in every country, students with greater confidence in reading tended to be more likely to be resilient that those who did not. It is also worth highlighting that in around half of the countries, the sense of belonging to the school, positive attitudes in reading classes, liking reading, and having done reading tasks in the family setting had a positive impact on the capacity for resilience. Teaching in secure settings, having had complementary training, and greater emphasis on academic results were the aspects of the teaching context that increased the chances of students being resilient in the greatest number of countries.

Discussion and conclusions

The main objective of our study was to analyze the extent to which students' personal and family characteristics and their teachers' teaching activities were linked to the students' academic resilience. Students show academic resilience when, despite unfavorable socioeconomic and sociocultural levels, they have good academic performance. Our results show that the weight of the predictor variables in academic resilience varied considerably between countries, which may be, as Mullis, Martin, Goh, & Prendergast [75], noted, due to social and cultural differences, and the differences between different countries' education systems. The student-related variable that was most strongly linked to academic resilience was *confidence in reading*, which was statistically significant and positive in all countries, a finding that is in line with data from Martin & Marsh [19], Vaknin-Nusbaum, et al. [20], Veas, et al. [21], and Wosman, et al. [22]. Nonetheless, it is worth noting that studies such as Marsh & Craven [76], via research based on a reciprocal effects model and a meta-analysis showed that prior academic self-concept (rather than self-esteem) and prior success had positive effects on subsequent self-concept and subsequent success. The next most strongly linked variable was the *students' sense of school belonging*, which also agrees with previous results [17]. Other student personal characteristics were statistically significant in a good number of countries, such as being a boy or girl, or having attended pre-primary school. Students being engaged in reading lessons demonstrated

Table 5. Coefficient, p-value, and odds ratio of student and family contextual variables.

		Gender	Preprimary	Sensebelonging	Engagedreading	Likereading	Confident	LitActivities	LitTask	ParentsPercep	ParentsLikeRead
Austria	Coefficient				-0.27		0.83	0.22			
	Coeff_s.e.				0.11		0.09	0.13			
	P-value				**0.01**		**0.00**	**0.08**			
	Odds Ratio				0.76		2.30	1.24			
Belgium Flemish	Coefficient	-0.61	0.71	0.19			0.48				
	Coeff_s.e.	0.21	0.38	0.11			0.10				
	P-value	**0.01**	**0.06**	**0.09**			**0.00**				
	Odds Ratio	0.54	2.03	1.21			1.62				
Belgium French	Coefficient					0.42	0.62				0.30
	Coeff_s.e.					0.19	0.18				0.15
	P-value					**0.03**	**0.00**				**0.05**
	Odds Ratio					1.52	1.85				1.35
Bulgaria	Coefficient			-0.22	0.30	-0.24	0.48		0.15		
	Coeff_s.e.			0.11	0.09	0.09	0.11		0.09		
	P-value			**0.05**	**0.00**	**0.01**	**0.00**		**0.09**		
	Odds Ratio			0.80	1.34	0.79	1.62		1.16		
Czech Republic	Coefficient		0.80	0.27	-0.38		0.66				0.21
	Coeff_s.e.		0.28	0.11	0.10		0.10				0.09
	P-value		**0.01**	**0.02**	**0.00**		**0.00**				**0.02**
	Odds Ratio		2.23	1.31	0.69		1.94				1.23
Denmark	Coefficient		1.71	0.18			0.76		0.31		
	Coeff_s.e.		0.75	0.09			0.09		0.12		
	P-value		**0.02**	**0.06**			**0.00**		**0.01**		
	Odds Ratio		5.51	1.19			2.14		1.36		
Finland	Coefficient					0.30	0.65		0.53		
	Coeff_s.e.					0.11	0.11		0.08		
	P-value					**0.01**	**0.00**		**0.00**		
	Odds Ratio					1.35	1.91		1.70		
France	Coefficient						0.68		0.57		
	Coeff_s.e.						0.09		0.13		
	P-value						**0.00**		**0.00**		
	Odds Ratio						1.97		1.78		
Germany	Coefficient		0.31		-0.23		0.54	0.22			0.23
	Coeff_s.e.		0.19		0.11		0.09	0.13			0.12
	P-value		**0.09**		**0.04**		**0.00**	**0.09**			**0.07**
	Odds Ratio		1.37		0.79		1.71	1.25			1.26
Hungary	Coefficient			0.25			0.79			-0.18	
	Coeff_s.e.			0.09			0.09			0.11	
	P-value			**0.01**			**0.00**			**0.10**	
	Odds Ratio			1.28			2.21			0.84	
Ireland	Coefficient			0.36	-0.26		0.59		0.68		
	Coeff_s.e.			0.11	0.10		0.09		0.12		
	P-value			**0.00**	**0.01**		**0.00**		**0.00**		
	Odds Ratio			1.44	0.77		1.81		1.97		
Italy	Coefficient			0.19		-0.24	0.71			0.16	
	Coeff_s.e.			0.11		0.12	0.11			0.09	
	P-value			**0.08**		**0.05**	**0.00**			**0.07**	
	Odds Ratio			1.21		0.79	2.04			1.17	
Latvia	Coefficient	-0.57		0.22	-0.32		0.78		0.37		
	Coeff_s.e.	0.20		0.13	0.16		0.12		0.13		
	P-value	**0.01**		**0.09**	**0.05**		**0.00**		**0.01**		
	Odds Ratio	0.57		1.24	0.72		2.19		1.44		
Lithuania	Coefficient	-0.38				-0.25	0.68		0.70		
	Coeff_s.e.	0.22				0.10	0.13		0.14		
	P-value	**0.08**				**0.02**	**0.00**		**0.00**		
	Odds Ratio	0.68				0.78	1.97		2.01		

(*Continued*)

Table 5. (Continued)

		Gender	Preprimary	Sensebelonging	Engagedreading	Likereading	Confident	LitActivities	LitTask	ParentsPercep	ParentsLikeRead
Malta	Coefficient	-0.39			0.27		0.82		0.23		
	Coeff_s.e.	0.24			0.12		0.12		0.14		
	P-value	**0.10**			**0.03**		**0.00**		**0.09**		
	Odds Ratio	0.68			1.31		2.27		1.26		
Netherlands	Coefficient			0.27	-0.53	0.61	0.50		0.34		0.29
	Coeff_s.e.			0.13	0.17	0.15	0.09		0.15		0.13
	P-value			**0.03**	**0.00**	**0.00**	**0.00**		**0.02**		**0.03**
	Odds Ratio			1.31	0.59	1.83	1.65		1.40		1.34
Northen Ireland	Coefficient			0.19	-0.41	0.31	0.78				
	Coeff_s.e.			0.11	0.12	0.11	0.09				
	P-value			**0.09**	**0.00**	**0.00**	**0.00**				
	Odds Ratio			1.21	0.67	1.36	2.19				
Poland	Coefficient	-0.58				-0.28	0.61	-0.26	0.57		0.28
	Coeff_s.e.	0.18				0.11	0.09	0.10	0.14		0.11
	P-value	**0.00**				**0.01**	**0.00**	**0.01**	**0.00**		**0.01**
	Odds Ratio	0.56				0.76	1.84	0.77	1.77		1.32
Portugal	Coefficient					-0.23	0.83				
	Coeff_s.e.					0.07	0.09				
	P-value					**0.00**	**0.00**				
	Odds Ratio					0.80	2.29				
Slovak Republic	Coefficient		0.83				0.60				0.17
	Coeff_s.e.		0.24				0.07				0.09
	P-value		**0.00**				**0.00**				**0.06**
	Odds Ratio		2.30				1.83				1.18
Slovenia	Coefficient	-0.70		0.29	-0.50		0.74	0.29		-0.20	
	Coeff_s.e.	0.21		0.12	0.13		0.10	0.10		0.11	
	P-value	**0.00**		**0.02**	**0.00**		**0.00**	**0.00**		**0.06**	
	Odds Ratio	0.49		1.33	0.61		2.09	1.34		0.82	
Spain	Coefficient			0.15		-0.15	0.60	0.17	0.32		
	Coeff_s.e.			0.08		0.06	0.08	0.08	0.08		
	P-value			**0.06**		**0.01**	**0.00**	**0.03**	**0.00**		
	Odds Ratio			1.17		0.86	1.82	1.18	1.38		
Sweden	Coefficient		0.86		-0.34		0.62	-0.20	0.61		
	Coeff_s.e.		0.33		0.13		0.12	0.10	0.13		
	P-value		**0.01**		**0.01**		**0.00**	**0.05**	**0.00**		
	Odds Ratio		2.37		0.71		1.85	0.82	1.84		

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divergent results, with different effects from one country to another, and something similar occurred with *reading for pleasure*.

For the family-related variables, we found that in most countries (18 out of 23), at least one of the following variables was statistically significant in the prediction of academic resilience: having done early literacy activities in the family environment, having done literacy activities before starting schooling, and parents' reading for pleasure. The first of these was significant in more than half of the countries.

In general, the results with regard to teaching-related variables indicated a smaller predictive capacity for academic resilience than those related to students or their family characteristics. The two variables demonstrating greatest predictive capacity were *a safe and orderly school environment* and *co-existence in schools*, confirming the results reported by Erberber, et al. [17]. There was a mix of instructional type variables which accumulated positive effects in a notable number of countries, particularly classroom work being oriented towards achieving academic objectives and some characteristics of teaching practices. In this regard, teaching

Table 6. Coefficient, p-value, and odds ratio of variables related to teaching.

		Gender	BasicTraining	CompleTraining	Emphasis	Security	Interaction	Satisfaction	Limitation	Rutinare	Sistemat	Comprehensive	Reflective	Homework	Readings
Austria	Coefficient				0.50						-0.21				
	Coeff_s.e.				0.16						0.12				
	P-value				**0.00**						**0.10**				
	Odds Ratio				1.64						0.81				
Belgium Flemish	Coefficient					0.27			0.21			-0.23	0.27	-0.20	
	Coeff_s.e.					0.12			0.12			0.12	0.16	0.10	
	P-value					**0.02**			**0.08**			**0.05**	**0.09**	**0.04**	
	Odds Ratio					1.31			1.24			0.79	1.31	0.82	
Belgium French	Coefficient			0.33	0.62								0.25		
	Coeff_s.e.			0.19	0.21								0.14		
	P-value			**0.08**	**0.00**								**0.08**		
	Odds Ratio			1.39	1.86								1.28		
Bulgaria	Coefficient					0.41		-0.28					0.48		-0.34
	Coeff_s.e.					0.18		0.17					0.21		0.16
	P-value					**0.02**		**0.10**					**0.03**		**0.03**
	Odds Ratio					1.50		0.75					1.61		0.71
Czech Republic	Coefficient								0.27						-0.18
	Coeff_s.e.								0.12						0.10
	P-value								**0.02**						**0.09**
	Odds Ratio								1.31						0.84
Denmark	Coefficient			-0.18	0.24		-0.28					0.17			
	Coeff_s.e.			0.11	0.14		0.15					0.09			
	P-value			**0.10**	**0.08**		**0.08**					**0.08**			
	Odds Ratio			0.83	1.28		0.76					1.18			
Finland	Coefficient			-0.27				-0.13	0.22						
	Coeff_s.e.			0.09				0.08	0.13						
	P-value			**0.01**				**0.10**	**0.10**						
	Odds Ratio			0.77				0.88	1.24						
France	Coefficient					0.42	-0.31	0.20							0.24
	Coeff_s.e.					0.12	0.12	0.12							0.11
	P-value					**0.00**	**0.01**	**0.10**							**0.04**
	Odds Ratio					1.52	0.74	1.22							1.27
Germany	Coefficient				0.30	0.27							0.28		
	Coeff_s.e.				0.19	0.14							0.13		
	P-value				**0.11**	**0.06**							**0.04**		
	Odds Ratio				1.35	1.31							1.32		
Hungary	Coefficient								0.31						
	Coeff_s.e.								0.14						
	P-value								**0.03**						
	Odds Ratio								1.36						
Ireland	Coefficient	-0.40				0.15				-0.28		0.18			
	Coeff_s.e.	0.23				0.08				0.13		0.09			
	P-value	**0.08**				**0.05**				**0.04**		**0.05**			
	Odds Ratio	0.67				1.17				0.76		1.20			
Italy	Coefficient	-1.09		0.23		0.48	-0.25	-0.21				0.45			-0.22
	Coeff_s.e.	0.41		0.07		0.15	0.10	0.11				0.15			0.11
	P-value	**0.01**		**0.00**		**0.00**	**0.02**	**0.06**				**0.00**			**0.06**
	Odds Ratio	0.34		1.26		1.62	0.78	0.81				1.57			0.80

(*Continued*)

Table 6. (Continued)

		Gender	BasicTraining	CompleTraining	Emphasis	Security	Interaction	Satisfaction	Limitation	Rutinare	Sistemat	Comprehensive	Reflective	Homework	Readings
Latvia	Coefficient												0.29		
	Coeff_s.e.												0.17		
	P-value												**0.10**		
	Odds Ratio												1.34		
Lithuania	Coefficient										0.46				
	Coeff_s.e.										0.24				
	P-value										**0.06**				
	Odds Ratio										1.58				
Malta	Coefficient		-0.39	0.33	0.32		-0.33								
	Coeff_s.e.		0.19	0.15	0.13		0.18								
	P-value		**0.04**	**0.03**	**0.01**		**0.06**								
	Odds Ratio		0.67	1.40	1.37		0.72								
Netherlands	Coefficient				0.34	0.33						0.33	-0.47		
	Coeff_s.e.				0.17	0.16						0.18	0.22		
	P-value				**0.04**	**0.04**						**0.06**	**0.03**		
	Odds Ratio				1.41	1.39						1.40	0.63		
Northen Ireland	Coefficient			0.20	-0.20		0.21		0.38	0.30	-0.28				
	Coeff_s.e.			0.12	0.12		0.11		0.13	0.15	0.15				
	P-value			**0.10**	**0.10**		**0.06**		**0.01**	**0.05**	**0.07**				
	Odds Ratio			1.22	0.82		1.24		1.46	1.35	0.76				
Poland	Coefficient					-0.21									
	Coeff_s.e.					0.11									
	P-value					**0.06**									
	Odds Ratio					0.81									
Portugal	Coefficient			0.16		0.18			0.24						
	Coeff_s.e.			0.09		0.09			0.10						
	P-value			**0.07**		**0.05**			**0.01**						
	Odds Ratio			1.17		1.19			1.27						
Slovak Republic	Coefficient	-0.56			0.30							0.30			
	Coeff_s.e.	0.27			0.14							0.17			
	P-value	**0.04**			**0.03**							**0.09**			
	Odds Ratio	0.57			1.35							1.35			
Slovenia	Coefficient						-0.28						0.43		
	Coeff_s.e.						0.13						0.13		
	P-value						**0.03**						**0.00**		
	Odds Ratio						0.76						1.53		
Spain	Coefficient								0.12	-0.28		0.16			
	Coeff_s.e.								0.08	0.07		0.07			
	P-value								**0.10**	**0.00**		**0.03**			
	Odds Ratio								1.13	0.76		1.18			
Sweden	Coefficient		-0.25	0.33					0.49					0.24	
	Coeff_s.e.		0.15	0.13					0.12					0.13	
	P-value		**0.10**	**0.01**					**0.00**					**0.06**	
	Odds Ratio		0.78	1.39					1.63					1.27	

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Table 7. Percentage of countries where the coefficient was significant for student and family contextual variables.

Variable	Percentage
Gender	26.1%
Preprimary	26.1%
Sensebelonging	52.2%
Engagedreading	47.8%
Likereading	43.5%
Confident	100.0%
LitActivities	26.1%
LitTask	52.2%
ParentsPercep	13.0%
ParentsLikeRead	26.1%

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which more often used comprehension and reflective reading techniques predicted greater likelihood of resilience than teaching practices for reading based on routine, systematic, repetitive procedures. These results are in line with previous evidence indicating the importance of teaching practices in school performance [33, 40–43, 45, 46]. Finally, it is worth noting that in more than a quarter of the countries there was a positive, significant relationship between academic resilience and teacher participation in complementary training activities in areas such as reading theory, corrective reading, and reading evaluation methods. These results are in line with previous studies which have highlighted the role of continued teacher training in improving students' learning outcomes [51–53].

In terms of the weight of the predictor variables, we saw that the confidence in reading index increased the probability of student resilience between 62 percentage points (Belgium–Flemish community) and 130 percentage points (Austria and Poland). Students who had a strong sense of belonging to the school they attended generally had a better chance of being resilient than those who did not, up to 40 percentage points higher, as in Ireland. Being a boy was associated with lower likelihood of resilience, up to 50% lower in the case of Slovenia. Early literacy activities in the family setting increased the chances of being academically resilient, in Lithuania for example, students in unfavorable socioeconomic situations who had

Table 8. Percentage of countries where the coefficient was significant for variables related to teaching.

Variable	Percentage
Gender	13.0%
BasicTraining	8.7%
CompleTraining	34.8%
Emphasis	34.8%
Security	39.1%
Interaction	26.1%
Satisfaction	17.4%
Limitation	34.8%
Rutinare	13.0%
Sistemat	13.0%
Comprehensive	30.4%
Reflective	30.4%
Homework	8.7%
Readings	17.4%

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done these kinds of activities were twice as likely to be resilient than those who had low scores in this index. Similarly, as in Denmark, attending preprimary school multiplied the chances of being resilient by 5.5. With regard to the teacher-related variables, we estimate that working in a safe environment can increase the likelihood of students being resilient by up to 62 percentage points, as we saw in Italy. In addition, students whose teachers had received complementary training, understood as improvements in understanding the theory of reading, reading evaluation, and corrective reading procedures, were 40 percentage points more likely to be resilient (Malta). Students attending schools with a strong academic emphasis were almost twice as likely to be resilient (Belgium–French-speaking community). Teachers who reported feeling limited by the characteristics of their students were associated with between 13 and 64 percentage points increase in the probability of students being resilient. Teaching practices associated with reading comprehension and reflective reading were linked to increases in the probability of resilience of up to 57 points (Italy) and 61 points (Bulgaria), which confirms the results from Lavy [44] and Rjosk et al. [47].

In summary, educational measures aimed at increasing student confidence, studying in safe environments that increase a sense of school belonging, and a strong academic emphasis, increase students' academic resilience. Good initial training which allows teachers to deliver teaching practices that encourage student learning will increase the number of resilient students, and consequently will improve the education system. It is worth noting a limitation of our study, which is that there are variables that we did not evaluate in this study but which may be important when predicting and explaining academic resilience. These include *grit*, *emotional intelligence*, and other non-cognitive variables [77, 78]. Similarly, there are variables that were not collected in this study, such as IQ or a background of mental issues (mild intellectual disabilities that do not stop the students from taking the test), which might have an impact on the capacity for resilience, as well as the fact of having repeated a school year or not, which is indicative of prior performance. Nor should it be forgotten that context questionnaires on very many occasions refer to a respondents' perceptions which may not correspond to the reality of the social surroundings, responses may be associated with social desirability, or socio-cultural perceptions that are deep-rooted in the students' environment.

Author Contributions

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References

1. García Sanz MP. La evaluación de programas en la intervención socioeducativa. [The evaluation of programs in socio-educational intervention] Murcia: DM; 2003.
2. Barragán AB, Pérez-Fuentes MC, Martos Á, Simón MM, Molero MM, Martínez-Sánchez A, et al. Intervención y variables del personal docente y el centro escolar que modulan el rendimiento académico del

alumno [Intervention and variables in the teaching staff and the school which modulate student academic performance]. European Journal of Child Development, Education and Psychopathology. 2016; 4(2): p. 89–97.

3. Carrillo E, Civís M, Blanch TA, Longás E, Riera J. Condicionantes del éxito y fracaso escolar en contextos de bajo nivel socioeconómico [Determinants of school success and failure in low socioeconomic contexts]. Revista de Estudios y Experiencias en Educación. 2018; 2: p. 75–94.
4. Jensen E. How poverty affects classroom engagement. Faces in Poverty. 2013;: p. 24–30.
5. Henderson N, Milstein MM. Resiliency in schools: Making it happen for students and educators (2nd ed.) Thousand Oaks: Corwin Pres; 2003.
6. Cordero JM, Manchón C. Factores explicativos del rendimiento en educación primaria: un análisis a partir de TIMSS 2011. [Explanatory Factors for Achievement in Primary Education: An Analysis Using TIMSS 2011]. Estudios sobre evaluación. 2014; 27: p. 9–35.
7. Aldridge JM, Fraser BJ, Fozdar A, Ala'i K, Earnest J, Afari E. Students' perceptions of school climate as determinants of wellbeing, resilience and identity. Improving Schools. 2015; 19(1): p. 5–26.
8. Doll B. Enhancing Resilience in Classrooms. In Handbook of Resilience in Children. Boston, MA: Springer US; 2013. p. 399–409.
9. Howard S, Johnson B. What Makes the Difference? Children and teachers talk about resilient outcomes for children 'at risk. Educational Studies. 2000; 26(3): p. 321–337.
10. Matin A. Motivation and Academic Resilience: Developing a Model for Student Enhancement. Australian Journal of Education. 2002; 46(1): p. 34–49.
11. McTigue E, Washburn E, Liew J. Academic Resilience and Reading: Building Successful Readers. The Reading Teacher. 2009; 62(5): p. 422–432.
12. Steward D, Sun J, Patterson C, Lemerle K, Hardie M. Promoting and Building Resilience in Primary-School Communities: Evidence from a Comprehensive 'Health Promoting School' Approach. International Journal of Mental Health Promotion. 2004; 6(3): p. 26–33.
13. Yeager D, Dweck C. Mindsets That Promote Resilience: When Students Believe That Personal Characteristics Can Be Developed. Educational Psychologist. 2012; 47(4): p. 302–314.
14. García-Crespo FJ, Galián B, Fernández-Alonso R, Muñiz J. Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. Revista de Educación. 2019; 384: p. 65–89.
15. OECD. PISA in Focus n˚ 1, Does participant in pre-primary education translate into better learning outcomes at school? Paris:; 2011.
16. Choi A, Calero J. Determinantes del riesgo de fracaso escolar en España en PISA-2009 y propuestas de reforma [Determinants of the risk of school failure in Spain in PISA-2009 and proposals for reform]. Revista de Educación. 2013; 362: p. 562–593.
17. Erberber E, Stephens M, Mamedova S, Ferguson S, Kroeger T. Socioeconomically disadvantaged students who are academically successful: Examining academic resilience crossnationally. IEA'S Policy Brief Series. 2015; 5.
18. García-Crespo FJ, Fernández-Alonso R, Muñiz J. Resilient and low performers students: Personal and family determinats en european countries. Psicothema. 2019; 31(4): p. 363–375. https://doi.org/10.7334/psicothema2019.245 PMID: 31634080
19. Martin AJ, Marsh HW. Academic resilience and the four Cs: Confidence, control, composure, and commitment. In Joint AARE/NZARE Conference; 2003; Auckland, New Zeland.
20. Vaknin-Nusbaum V, Nevo E, Brande S, Gambrell L. Developmental aspects of reading motivation and reading achievement among second grade low achievers and typical readers. Journal of Resarch in Reading. 2018; 41(3): p. 438–454.
21. Veas A, López-López JA, Gilar R, Miñano P, Castejón JL. Differences in cognitive, motivational and contextual variables between under-achieving, normally-achieving, and over-achieving students: A mixed-effects analysis. Psicothema. 2017; 29(4): p. 533–538. https://doi.org/10.7334/psicothema2016.283 PMID: 29048315
22. Waxman H, Huang S, Padrón Y. Motivation and learning environment differences between resilient and nonresilient latino middle school students. Hispanic Journal of Behavioral Sciences. 1997; 19(2): p. 137–155.
23. Jacob BA. Where the boys aren't: Noncognitive skills, returns to school and the gender gap in higher education. Economics of Education Review. 2002; 21(6): p. 589–598.
24. Kobasa SC, Maddi SR, Kahn S. Hardiness and health: A prospective study. Journal of Personality and Social Psychology. 1982; 42(1): p. 168–177. https://doi.org/10.1037//0022-3514.42.1.168 PMID: 7057354

25. Postigo Á, Cuesta M, Fernández-Alonso R, García-Cueto E, Muñiz J. Temporal Stability of Grit and School Performance in Adolescents: A Longitudinal Perspective. Psicología Educativa. 2021; 27(1): p. 77–84.

26. Martín-Lagos MD. Educación y desigualdad: una metasíntesis tras el 50 aniversario del Informe Coleman [Education and inequality: a meta-synthesis after the 50th anniversary of Coleman's report]. Revsita de Educación. 2018; 380: p. 186–209.

27. Fernández-Alonso R, Álvarez-Díaz M, Woitschach P, Suárez-Álvarez P, Cuesta M. Parental involvement and academic performance: Less control and more communication. Psicothema. 2017; 29(4): p. 453–461. https://doi.org/10.7334/psicothema2017.181 PMID: 29048303

28. Sandoval-Hernández A, Bialowolski P. Factors and Conditions Promoting Academic Resilience: A TIMSS-Based Analysis of Five Asian Education Systems. Asia Pacific Education Review. 2016; 17(3): p. 511–520.

29. Li H. The 'Secrets' of Chinese Students' Academic Success: Academic Resilience among Students from Highly Competitive Academic Environments. Educational Psychology. 2017; 37(8): p. 1001–1014.

30. Cheung K, Sit P, Soh K, Leong M, Mak S. Predicting Academic Resilience with Reading Engagement and Demographic Variables: Comparing Shanghai, Hong Kong, Korea, and Singapore from the PISA Perspective. The Asia-Pacific Education Researcher. 2014; 23(4): p. 895–909.

31. Barber M, Mourshed M. Shaping the Future: How Good Education Systems Can Become Great in the Decade Ahead. In Report on the International Education Roundtable, 7 July 2009, Singapore.: McKinsey & Company, London; 2009.

32. Darling-Hammond L. Teacher education around the world: What can we learn from international practice? European Journal of Teacher Education. 2017; 40(3): p. 291–309.

33. Hattie J. Visible Learning: A Synthesis of over 800 Meta-Analyses Relating to Achievement: Routledge, London; 2009.

34. OECD. Teachers matter: attracting, developing and retaining effective teachers.: Organisation for Economic Co-operation and Development; 2005.

35. OECD. Effective Teacher Policies: Insights from PISA. In PISA.: OECD Publishing, Paris; 2018.

36. Fauth B, Decristan J, Rieser S, Klieme E, Büttner G. Student ratings of teaching quality in primary school: Dimensions and prediction of student outcomes. Learning and Instruction. 2014; 29: p. 1–9.

37. Kane TJ, Cantrell S. Learning about Teaching: Initial Findings from the Measures of Effective Teaching Project About the Measures of Effective Teaching Project: Bill & Melinda Gates Foundation, Seattle, WA; 2010.

38. Kunter M, Voss T. The model of instructional quality in COACTIV: A multicriteria analysis. In Kunter M, Baumert J, Blum W, Klusmann U, Krauss S, Neubrand M, editors. Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers.: Springer, New York, NY; 2013. p. 97–124.

39. Wagner W, Göllner R, Helmke A, Trautwein U, Lüdtke O. Construct validity of student perceptions of instructional quality is high, but not perfect: Dimensionality and generalizability of domain-independent assessments. Learning and Instruction. 2013; 28: p. 1–11.

40. Baumert J, Kunter M, Blum W, Brunner M, Voss T, Jordan A, et al. Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. American Educational Research Journal. 2010; 47(1): p. 133–180.

41. Creemers B, Kyriakides L. The Dynamics of Educational Effectiveness: A Contribution to Policy, Practice and Theory in Contemporary Schools: Routledge, Abingdon; 2008.

42. Isac MM, Dinis da Costa P, Araujo L, Soto Calvo E, Albergaria-Almeida P. Teaching Practices in Primary and Secondary Schools in Europe: Insights from Large-Scale Assessments in Education—JRC Science and Policy Report: Publications Office of the European Union, Luxembourg; 2015.

43. Kunter M, Klusmann U, Baumert J, Richter D, Voss T, Hachfeld A. Professional competence of teachers: Effects on instructional quality and student development. Journal of Educational Psychology. 2013; 105(3): p. 805–820.

44. Lavy V. What Makes an Effective Teacher? Quasi-Experimental Evidence. CESifo Economic Studies. 2016; 62(1): p. 88–125.

45. Nilsen T, Gustafsson JE(), editors. Teacher Quality, Instructional Quality and Student Outcomes. Relationships Across Countries, Cohorts and Time: IEA Research for Education; 2016.

46. O'Dwyer LM, Wang Y, Shields KA. Teaching for conceptual understanding: A cross-national comparison of the relationship between teachers' instructional practices and student achievement in mathematics. Large-scale Assessments in Education. 2015; 3(1): p. 3–30.

47. Rjosk C, Richter D, Hochweber J, Lüdtke O, Klieme E, Stanat P. Socioeconomic and language minority classroom composition and individual reading achievement: The mediating role of instructional quality. Learning and Instruction. 2014; 32: p. 63–72.

48. Caprara GV, Barbaranelli C, Borgogni L, Steca P. Efficacy beliefs as determinants of teachers' job satisfaction. Journal of Educational Psychology. 2003; 95(4): p. 821–832.

49. Klassen R, Wilson E, Siu AFY, Hannok W, Wong MW, Wongsri N, et al. Preservice teachers' work stress, self-efficacy, and occupational commitment in four countries. European Journal of Psychology of Education. 2013; 28(4): p. 1289–1309.

50. Tschannen-Moran M, Hoy AW. Teacher efficacy: Capturing an elusive construct. Teaching and Teacher Education. 2001; 17(7): p. 783–805.

51. Barber M, Mourshed M. How the world's best-performing school systems come out on top; 2007.

52. Darling-Hammond L, Burns D, Campbell C, Goodwin AL, Hammerness K, Low EL, et al. Empowered Educators: How High-Performing Systems Shape Teaching Quality Around the World: Jossey-Bass, San Francisco; 2017.

53. OECD. More than the sum of their parts: Human resource policies for effective schools: OECD Reviews of School Resources, Paris; 2019.

54. Desimone L. Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. Educational Researcher. 2009; 38(3): p. 181–199.

55. Ingvarson L, Meiers M, Beavis A. Factors affecting the impact of professional development programs on teachers' knowledge, practice, student outcomes and efficacy. Education Policy Analysis Archives. 2005; 13(10): p. 1–28.

56. Yoon KS, Duncan T, Lee SW, Scarloss B, Shapley KL. Reviewing the Evidence on How Teacher Professional Development Affects Student Achievement. Regional Educational Laboratory Southwest, U. S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance; 2007. Report No.: 033.

57. Scribner J. Professional development: Untangling the influence of work context on teacher learning. Educational Administration Quarterly. 1999; 35(2): p. 238–266.

58. Meissel K, Parr J, Timperley H. Can professional development of teachers reduce disparity in student achievement? Teaching and Teacher Education. 2016; 58: p. 163–173.

59. Martin MO, Mullis IVS, Hooper M. Methods and Procedures in PIRLS 2016: Boston College, TIMSS & PIRLS International Study Center; 2017.

60. Mullis IVS, Martin MO. PIRLS 2016 Assessment Framework (2nd ed.): Boston College, TIMSS & PIRLS International Study Center; 2015.

61. Fernández-Alonso R, Muñiz J. Diseños de cuadernillos para la evaluación de las competencias básicas [Booklet designs for the evaluation of basic skills]. Aula Abierta. 2011; 39(2): p. 3–34.

62. Peña-Suárez E, Fernández-Alonso R, Muñiz J. Estimación del valor añadido de los centros escolares. Aula Abierta. 2009; 37(1): p. 3–18.

63. Suárez J, Pedrosa I, Lozano L, García-Cueto E, Cuesta M, Muñiz J. Using reversed items in Likert scales: A questionable practice. Psicothema. 2018; 30: p. 149–158. https://doi.org/10.7334/psicothema2018.33 PMID: 29694314

64. Vigil-Colet A, Navarro-González D, Morales-Vives F. To reverse or to not reverse Likert-type items: That is the question. Psicothema. 2020; 32(1): p. 108–114. https://doi.org/10.7334/psicothema2019.286 PMID: 31954423

65. Villegas G, González-García N, Sánchez-García A, Sánchez-Barba M, Galindo-Villardón MP. Seven methods to determine the dimensionality of tests: application to the General Self-Efficacy Scale in twenty-six countries. Psicothema. 2018; 30: p. 442–448. https://doi.org/10.7334/psicothema2018.113 PMID: 30353847

66. Mullis I, Martin M, Foy P, Hooper M. PIRLS 2016 International Results in Reading: Boston College, TIMSS & PIRLS International Study Center; 2017.

67. Cohen J, Cohen P, West SG, Aiken LS. Applied multiple regression/correlation analysis for the behavioral sciences New York: Routledge; 2013.

68. Gelman A, Hill J. Data analysis using regression and multilevel/hierarchical models Cambridge: Cambridge University Press; 2006.

69. Snijders TAB, Bosker RJ. Multilevel analysis: An introduction to basic and advanced multilevel modeling London: Sage; 2012.

70. Iñiguez-Berrozpe T, Marcaletti F. Modelos lineales multinivel en SPSS y su aplicación en investigación educativa [Linear multilevel models in SPSS and its application in educational research]. REIRE Revista d'Innovació i Recerca en Educació. 2018; 11(1): p. 26–40.

71. De la Cruz F. Modelos multinivel [Multi-level models]. Epidemiol. 2008; 12(3): p. 1–8.

72. Kreft IG, De Leeuw J, Aiken LS. The effect of different forms of centering in hierarchical linear models. Multivariate behavioral research. 1995; 30(1): p. 1–21. https://doi.org/10.1207/s15327906mbr3001_1 PMID: 26828342

73. Rutkowski L, González E, Joncas M, von Davier M. International largescale assessment data: Issues in secondary analysis and reporting. Educational Researcher. 2010; 39(2): p. 142–151.

74. Fernández-Alonso R, Suárez-Álvarez J, Muñiz J. Imputación de datos perdidos en la evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. Psicothema. 2012; 24(1): p. 167–175. PMID: 22269381

75. Mullis IVS, Martin MO, Goh S, Prendergast C. PIRLS 2016 Encyclopedia: Education policy and curriculum in reading Boston: Boston College, TIMSS & PIRLS International Study Center; 2017.

76. Marsh HW, Craven RG. Reciprocal Effects of Self-Concept and Performance From a Multidimensional Perspective: Beyond Seductive Pleasure and Unidimensional Perspectives. Perspectives on Psychological Science. 2006; 1(2): p. 133–163. https://doi.org/10.1111/j.1745-6916.2006.00010.x PMID: 26151468

77. Fernández-Lasarte O, Ramos-Díaz E, Goñi-Palacios E, Rodríguez-Fernández A. The role of social support in school adjustment during Secondary Education. Psicothema. 2020; 32(1): p. 100–107. https://doi.org/10.7334/psicothema2019.125 PMID: 31954422

78. Morales-Vives F, Camps E, Dueñas JM. Predicting academic achievement in adolescents: The role of maturity. Psicothema. 2020; 32(1): p. 84–91. https://doi.org/10.7334/psicothema2019.262 PMID: 31954420

3.5. Quinto artículo

García-Crespo, F. J., Suárez-Álvarez, J., & Fernández-Alonso, R. (2022). Resiliencia Académica en Matemáticas y Ciencias: Datos de Europa TIMSS-2019 [Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data]. ***Psicothema*****.**

En este artículo se fijó como objetivo analizar variables individuales y de centro que tengan impacto en la condición de resiliencia en matemáticas y ciencias en alumnado de la UE en 4º grado. También se añadieron los Objetivos ET2020 para estimar el impacto que tiene el grado de consecución de estos objetivos. La principal aportación de este artículo a la Tesis Doctoral es comprobar que las variables individuales del estudiante se comportan de manera similar al caso de análisis de la competencia lectora, excepto la variable género cuya aportación es en sentido inverso. Además, se observa que es imprescindible orientar políticas educativas a la reducción del porcentaje de alumnado de bajo rendimiento.

Factor de Impacto JCR 2020 = 3.890; Q1

Factor de Impacto 5 años = 3.551

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Estimado/a colega:

Nos complace informarle que el manuscrito titulado: "***Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data***", cuyos autores son: D. Francisco Javier García-Crespo, D. Javier Suárez-Álvarez y D. Rubén Fernández-Alonso, ha sido aceptado para su publicación en Psicothema.

Le estamos muy agradecidos de que haya elegido la revista Psicothema como medio de publicación.

Reciba un cordial saludo.

José Muñiz
Director

Rebeca Cerezo
Gestora

Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data

Resiliencia Académica en Matemáticas y Ciencias: Datos de Europa TIMSS-2019

Academic Resilience in Mathematics and Science

Resiliencia Académica en Matemáticas y Ciencias

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Resumen

Antecedentes. El alumnado académicamente resiliente es aquel que obtiene un alto rendimiento partiendo de una situación socioeconómica desaventajada. Esta investigación pretende identificar los factores personales, escolares y nacionales que están asociados a la resiliencia académica en la Unión Europea (UE). **Método.** La muestra fue de 96556 estudiantes de 4º grado de 21 países de la UE participantes en TIMSS-2019. Para el conjunto de la muestra se ajustaron dos modelos de regresión logística multinivel de tres niveles. **Resultados**. La UE tiene un promedio de 25.67% de alumnado resiliente en matemáticas y 24.16% en ciencias. La confianza de los estudiantes y haber realizado tareas lingüísticas previas a la escuela son las variables con mayor poder predictivo después de tener en cuenta el género y los antecedentes inmigrantes de los estudiantes. Los países europeos analizados compensan en buena medida la situación doblemente desaventajada del alumnado inmigrante. Aquellos países que poseen un mayor porcentaje de alumnado con bajo rendimiento tienen menos estudiantes resilientes. **Conclusiones**. Las políticas educativas de los estados miembros de la UE son capaces de compensar en gran medida las situaciones desfavorecidas de partida. Fundamentalmente aquellas de carácter social como el apoyo al alumnado inmigrante, a la familia o las instituciones educativas.

Palabras clave: resiliencia, rendimiento académico, competencia matemática y científica, ET2020, TIMSS

Abstract

Background. Academically resilient students are those who obtain a high performance starting from a disadvantaged socioeconomic situation. This study aims to identify the personal, school, and national factors that are associated with that resilience in the European Union (EU). **Method.** The sample comprised 96556 fourth grade students from 21 EU countries participating in TIMSS-2019. Two three-level logistic regression models were specified for the overall sample. **Results.** The EU has an average of 25.67% resilient student in mathematics and 24.16% in science. Student confidence and having done prior linguistic tasks at school were the variables with the most predictive power after accounting for gender and students' immigrant background. The European countries analyzed largely compensated for the doubly-disadvantaged situation of immigrant students. Those countries with higher proportions of low-performing students had fewer resilient students. **Conclusions.** The educational policies in the EU member states are able to largely compensate for unfavorable starting positions; fundamentally, policies of a social nature such as support for immigrant students, families, or schools.

Keywords: resilience, academic performance, mathematics and science skills, ET2020, TIMSS

Resilience, understood as the human capacity to overcome or adapt to adverse situations, has been widely studied in recent years (Agasisti & Longobardi, 2017; OECD, 2010; OECD, 2011b; OECD, 2018) and has become particularly important in the current COVID-19 pandemic. In educational research, a student is considered academically resilient if, despite coming from an unfavorable socioeconomic or cultural background, they perform much better than their initial circumstances might suggest (Agasisti et al., 2018; García-Crespo et al., 2019a; García-Crespo et al., 2019b; OECD, 2010; OECD, 2011a; OECD, 2011b; Servicio de Evaluación Educativa, 2017). Resilience has been linked to academic performance and other areas of life (Heckman & Rubinstein, 2001). Resilient students have more opportunities to develop their potential, greater likelihood of social growth, and lower risks of poverty (OECD, 2016). One way of increasing equity in education systems comes from supporting and strengthening academic resilience (Agasisti et al., 2016). However, resilience can be associated with academic failure and socioeconomic disadvantage, Coronado & Paneque (2016) propose a revision to improve resilience in the face of failure and social disadvantage. For their part, Edwards & Ashkanasy (2018) adapt a five-level emotion model and explore the potential role of emotions in experiences of academic failure to build resilience.

Various studies have explored the personal and school variables that encourage students' academic or educational resilience. With regard to personal and family variables, Erberber, et al. (2015) using data from 28 countries participating in the *Trends in International Mathematics and Science Study* (TIMSS) 2011, found that the variables with the greatest impact on resilience were enjoying mathematics, absence of bullying at school, and academic expectations. Using an Asian sample from TIMSS

2011, Sandoval & Białowolski (2016) reported that the variables with the greatest possibilities for resilience were positive student attitudes towards mathematics and time spent on mathematics in the home. Recently, using data from 4th grade students from 18 European participants in TIMSS 2015 and the *Progress in International Reading Literacy Study* (PIRLS) 2016, Cordero & Mateos-Romero (2021) reported that the factors contributing most to resilience were the skills learned by students before starting school and the socioeconomic levels of their peers. Using data from the *Programme for International Student Assessment* (PISA) 2015 and 2018 from Spain, Greece, and Italy, Gabrielli et al. (2021) reported that beliefs in self-efficacy, a positive family environment, and language attitudes at home favored resilience in students from immigrant backgrounds. Furthermore, for this group, the "double origin gap" (socioeconomic and migratory) makes them more dependent on the school environment than their native peers. Gender does not seem to be associated with resilience, except in the study by Clavel et al. (2021), using science data from PISA 2015 and samples from Southeast Asia. They found that boys were more likely to be resilient in Macao and Singapore. In any case, the literature review by López-Zambrano et al. (2021) concluded that the evaluation data and the data from student interactions with the learning environment were the most important variables for early predictions of academic success.

The teaching and educational environment has also been shown to be a key element in increasing the likelihood of academic resilience (García-Crespo et al., 2021). Erberber et al. (2015) found that schools' interest in students' academic success, provision of educational resources, a safe, orderly school climate, and school discipline were the school-related variables that were most strongly associated with the condition

of academic resilience. Sandoval & Białowolski (2016) reported that the chances of academic resilience were greater in schools with lower rates of bullying and higher levels of teacher expectations of student performance. Caprara et al. (2003), Klassen et al. (2013), and Tschannen-Moran & Hoy (2001) reported a positive effect between teachers' job satisfaction and student academic performance, which indicates that some characteristics of the teachers may increase the likelihood of resilience.

As the above indicates, there is relatively abundant evidence about the personal and school factors associated with academic resilience. Comparatively little is known, however, about the relationship between academic resilience and the characteristics of national education systems and their educational policies. Supra-national co-operative organizations have established Sustainable Development Goals (UNESCO, 2021) and Education and Training 2020 targets (European Comission, 2020), but there is hardly any evidence about whether indicators of educational policy increase the probability of academic resilience.

In this context, the present study has two main objectives. The first is to determine the prevalence of academically resilient students in mathematics and science in the European Union countries. The second is to analyze the individual, school, and national factors that are associated with the condition of resilience, either reinforcing it or weakening it. Understanding these two issues raised by our objectives is key in being able to improve the effectiveness of European education systems. To the best of our knowledge, this is the first study to examine the relationship between how well countries have met the Education and Training 2020 targets and the resilient students that there are in those countries. In summary, with this work we intend to shed light on

the current situation regarding resilience in mathematics and science and its contextual predictors. As well as, quantitatively estimating the efforts of countries to achieve the European Commission's objectives for 2020.

Method

Participants

The participating population was defined as students in the 4th grade of compulsory education in the 22 European Union countries participating in TIMSS 2019. The sample was made up of 96556 students with a mean age of 10.24 years (s.d. 0.48) from 5714 classes in 3794 schools. The study also used responses from teachers (5649 mathematics teachers and 5487 science teachers) and 3665 questionnaires completed by school principals (table 1).

Table 1

Study Sample Data (by Country and EU Total)

Country	Schools	Classes	Students	Math teachers	Science teachers	Principals
Austria	193	302	4464	303	303	192
Belgium (Fl.)	147	256	4655	283	276	138
Bulgaria	151	211	4268	209	210	151
Croatia	153	263	3785	263	263	151
Cyprus	151	236	4062	229	168	147
Czech Republic	152	263	4692	264	257	151
Denmark	166	195	3227	190	190	145
Finland	158	316	4730	326	317	158
France	155	300	4186	300	300	151
Germany	203	211	3437	216	218	189
Hungary	149	252	4571	252	249	144
Ireland	150	231	4582	231	231	150
Italy	162	229	3741	229	229	159
Latvia	154	211	4481	203	189	152
Lithuania	207	250	3741	249	250	202

Malta	98	226	3630	210	209	98
Netherlands	112	182	3355	182	182	79
Poland	149	269	4882	225	189	149
Portugal	181	314	4300	314	314	181
Slovak Republic	157	269	4247	268	251	156
Spain	501	504	9555	509	514	487
Sweden	145	224	3965	194	178	135
Total UE	3794	5714	96556	5649	5487	3665

Students were selected by two-stage stratified cluster sampling (Martin et al., 2020). Schools were selected in the first stage with a probability proportional to their size, and within the schools, the second stage was full class-groups which made up the clusters in TIMSS 2019. The data from the Netherlands was excluded as information from the family questionnaire was not provided, and so prevented the students' socioeconomic indicator from being determined, which was essential for the study to identify resilient students.

Instruments

Variables for Determining Academically Resilient Students

Mathematics and Science test. The test booklets for Mathematics and Science were produced following the framework established by Mullis & Martin (2017). The full bank of items is composed of 32 item blocks (16 for each subject) with approximately 10 items in each. The items, which were binary and partial credit, were distributed over 14 models of test booklet using a partially balanced incomplete matrix design (Fernández-Alonso & Muñiz, 2011). Each student completed a test booklet with approximately 40 items containing two blocks for each subject. Five plausible values per student are used for each Item Response Theory (IRT) scale with a mean of 500 and standard deviation of 100 (Martin et al., 2020).

Home Resources for Learning Normalized Index (HRLN). The HRLN index was constructed using IRT methodology from the responses to two items in the Student Questionnaire (Number of books in the home and Number of home study supports) and three items from the Home Questionnaire: Number of children's books in the home, Highest level of education of either parent; and Highest level of occupation of either parent (Martin et al., 2020; Mullis et al., 2020). The HRLN index is expressed in standardized points (Z) for the EU as a whole. Table 2 shows the mean and standard error for the index by country.

Table 2

Home Resources for Learning Normalized Index

	Mean	Standard error
Austria	0.04	0.03
Belgium (Fl.)	0.13	0.03
Bulgaria	-0.58	0.06
Croatia	-0.36	0.03
Cyprus	0.23	0.03
Czech Republic	0.16	0.02
Denmark	0.46	0.02
Finland	0.40	0.02
France	0.14	0.04
Germany	0.18	0.03
Hungary	0.04	0.04
Ireland	0.34	0.03
Italy	-0.45	0.04
Latvia	0.06	0.03
Lithuania	-0.10	0.03
Malta	0.17	0.02
Poland	0.05	0.03
Portugal	-0.18	0.03
Slovak Republic	-0.17	0.05
Spain	-0.07	0.03
Sweden	0.42	0.05

Predictors of Academic Resilience

Thirty-one variables were included in the prediction of academic resilience: 11 related to students, one related to families, nine related to teachers, four related to school principals (Mullis et al., 2020), and six related to country (European Comission, 2020). These variables, classified at the student, classroom, and country level, are as follows:

Student variables (Level 1):

Gender: (0-Female and 1-male)

Immig: (0-Native and 1-immigrant)

Bullying: Student Bullying. TIMSS asked students about how often they experienced various bullying behaviors by their school peers. High values in this index indicate an absence of bullying.

M_Like: Students Like Learning Mathematics and *S_Like*: Students Like Learning Science. The scales cover students' attitudes toward mathematics/science and studying mathematics/science. High values in this index indicate more positive attitudes towards mathematics and science and learning them.

M_Confident: Students Confident in Mathematics and *S_Confident:* Students Confident in Science. These scales measure how well students think they can do mathematics or science. Greater self-confidence is measured with higher values in this index.

M_Clarity: Instructional Clarity in Mathematics Lessons and *S_Clarity:* Instructional Clarity in Science Lessons. Students were asked about aspects such as whether they

know what their teacher expects them to do, whether their teacher is easy to understand, or has clear answers to their questions. Students who percieve more clarity in their teachers' expectations have higher scores in this scale.

Task_Literary: Could Do Literacy Tasks When Beginning Primary School and *Task_Numeracy:* Could Do Numeracy Tasks When Beginning Primary School. Students were scored according to their parents' answers about how well they could do some Early Literacy and Numeracy Tasks such as read some words, write letters of the alphabet, or count by themselves when they began primary school. Students who were able to do more tasks before beginning primary school have higher scores in these scales.

Family variables (Level 1):

Perceptions: Parents Perceptions of Their Child's School. TIMSS 2019 asked students' parents about the extent to which they were satisfied that their child's school promoted academic standards and fostered a positive school climate. Higher scores in this scale indicate the students' families being more satisfied with the school.

Teacher variables (Level 2)

M_Emphasis and *S_Emphasis:* School Emphasis on Academic Success-Mathematics and Science Teachers. This index collects information about the school's expectations towards academic achievement. Higher expectations are reflected in higher scores in this index.

M_Safe_Orderly and *S_Safe_Orderly:* Safe and Orderly Schools-Mathematics and Science Teachers. Students' teachers were asked how much they agreed or disagreed

with a set of statements on the Safe and Orderly School scale. High scores in this scale are associated with safer schools.

M_JobSatisfaction and *S_JobSatisfaction:* Mathematics and Science Teacher Job Satisfaction. The TIMSS 2019 Teachers' Job Satisfaction scale is based on teachers' responses to questions about how they feel about being a teacher. Greater teacher job satisfaction means higher scores in the scale.

M_Limited_St_Not_Ready and *S_Limited_St_Not_Ready:* Classroom Mathematics/Sciences Teaching Limited by Students Not Ready for Instruction. The scale presents teachers' answers about the extent to which their classroom teaching is limited by students not being ready to learn (i.e., lacking prerequisite knowledge or skills, lacking basic nutrition, being sleep deprived, or having learning impairments). Teachers who report their teaching not being affected by these limitations score more highly in this index.

S_Science_Investigation: Teachers Emphasis on Science Investigation. Those teachers whose students participate more frequently in activities related to scientific investigation and experiments have higher scores in this index.

Principal variables (Level 2)

M_Shortage and *S_Shortage:* Instruction Affected by Math/Science Resource Shortages. The scale presents principals' answers about the extent to which school teaching is limited by resource shortages. Principals who report resource shortages as not being a problem for teaching have high scores in this index.

Sc_Discipline: School Discipline-Principal. TIMSS 2019 asked school principals for their perceptions about the extent that discipline, disorder, and bullying behaviors were problems in their school. Higher values in the scale indicate principals who do not see these problems in their schools.

Enter_Lit_Num_Skills: Students Enter with Literacy and Numeracy Skills. This index measures the percentage of students who begin primary education with literacy and numeracy skills. Schools with higher percentages of students with those skill have higher scores in this scale.

Country variables (Level 3)

U_Mat19 and U_Sci19: Underachievement in mathematics/science in the digital age. The share of low-achieving students in reading, mathematics and science should be less than 15%.

EarlyLeavers: Early leavers from education and training. The indicator is defined as the percentage of the population aged 18-24 with at most lower secondary education and who were not in further education or training during the last four weeks preceding the survey. The share of early leavers from education and training should be less than 10%.

Employment2019: The employment rate of recent graduates, 2010-2019. The share of employed graduates (20-34 year-olds) having left education and training 1-3 years before the reference year should be at least 82%.

Adultlearning2016: Adult (aged 25-64) participation in learning, 4-week reference period, 2010 and 2019. An average of at least 15% of adults should participate in lifelong learning.

Tertiary: Tertiary educational attainment (30-34). The share of 30-34 year-olds with tertiary educational attainment should be at least 40%.

Using IRT partial credit scaling, the variables were transformed to a scale with a central point of 10, corresponding to the average from all the countries participating in the TIMSS 2019. The units of the scale were chosen so that two points on the scale would correspond to the logit standard deviation in all countries (Martin et al., 2020; Mullis et al., 2020). For the statistical analysis in this study, all of the variables in level 1, except Gender and Immig, and the variables in level 2 were standardized with a mean of 0 and standard deviation of 1 for all of the participating EU countries. The level 3 variables were left as percentages (European Comission, 2020).

Procedure

TIMSS 2019 was applied following the standards of the International Association for the Evaluation of Educational Achievement (IEA) (Martin et al., 2020). Each student completed a booklet of cognitive items in two 36-minute sessions split by a 30-minute break. They then completed the context questionnaire. In addition, the Home Questionnaire was given to families, the Teacher Questionnaire was given to math and science teachers, and the School Questionnaire was completed by the school principals (Martin et al., 2020).

Data Analysis

The first study objective required the identification of academically resilient students in mathematics or science. For this study, students were considered resilient if they met two conditions; being socioeconomically disadvantaged and having a score in

mathematics or science above the third quartile of the EU as a whole, once the individual HRLN was discounted. Students were considered socioeconomically disadvantaged if their score in the HRLN index was below the first quartile for their country. Once academically resilient students were identified, the percentages of this group were calculated by country and for the EU as a whole.

To pursue the second objective, analyzing the influence of the predictor variables on resilience in mathematics or science, multilevel logistic regression models were used (Cohen et al., 2013; Gelman & Hill, 2006; Snijders & Bosker, 2012), which appropriately model the variability of the data in the sampling designs of international large-scale assessments (De la Cruz, 2008; Iñiguez-Berrozpe & Marcaletti, 2018), while at the same time avoid the use of the replicated weightings in the TIMSS 2019 database (Fishbein et al., 2021). Two models were specified for the set of EU countries (one for each subject evaluated) with three levels: student, school, and country. Analysis of the models considered the following parameters for each predictor: magnitude and regression coefficient; p-value of the coefficients or level of marginal significance of the variable; and odds ratio and its confidence interval (García-Crespo et al., 2019a). The models were specified with HLM6© and the cases were weighted with the original school and student weightings. These weightings, which reflect the probability of selecting the students and school in the study, allow proper reproduction of the population size and enhance the representativeness of the results (Rutkowski et al., 2010).

Missing contextual data was recovered using the linear trend process from the Missing Value Analysis module in SPSS, taking the class the student belonged to as segmentation (Fernández-Alonso et al., 2012).

Results

Resilient Students in Mathematics and Science in European Union Countries

Responding to the first study objective, Table 3 shows the percentage (and standard error) of academically resilient students in mathematics and science by country along with the EU average.

Table 3

Percentage of Academically Resilient Students in Mathematics and Science in TIMSS 2019 by Country and for the EU Overall.

	Mathematics		Science	
	Percentage	pct_se	Percentage	pct_se
Austria	30.14	1.60	16.79	1.53
Belgium (Fl.)	27.16	1.56	10.93	1.18
Bulgaria	28.35	4.65	24.97	3.68
Croatia	23.54	1.97	31.89	2.30
Cyprus	28.65	1.65	19.58	1.35
Czech Republic	29.71	1.98	29.69	1.81
Denmark	27.72	2.54	21.00	2.06
Finland	25.53	1.61	39.13	2.02
France	8.34	1.23	8.07	1.12
Germany	25.07	2.09	23.14	2.00
Hungary	20.54	1.68	26.25	2.00
Ireland	32.56	1.78	19.76	1.65
Italy	32.15	2.28	26.79	1.91
Latvia	37.23	2.50	37.43	2.19
Lithuania	27.41	1.83	25.99	1.76
Malta	21.03	1.57	13.95	1.35
Poland	22.52	1.56	31.07	1.89

Portugal	30.87	1.68	22.45	1.44
Slovak Republic	20.32	1.91	25.00	2.27
Spain	19.89	1.57	25.83	1.92
Sweden	20.28	2.02	27.74	1.98
Average EU	25.67	1.96	24.16	1.87

Table 3 shows that the percentages of academically resilient students in mathematics varied by country from 8.34% in France to 37.23% in Latvia. Only France (8.34%) and Spain (19.89%) had less than 20% resilient students in mathematics. In science, the percentages of resilient students varied between 39.13% (Finland) and 8.07% (France). If we take 20% as a limit, below which there is a low percentage of resilient students, six countries were below that: France (8.07%), Belgium (Fl.) (10.93%), Malta (13.95%), Austria (16.79%), Cyprus (19.58%) and Ireland (19.76%). The average proportion of resilient students in the EU countries that participated in TIMSS 2019 was 25.67% in mathematics and 23.16% in science.

Factors Associated With Academic Resilience

Tables 4 and 5 show the regression coefficients for the predictors, together with the p-value and the odds ratio with the 95% confidence intervals for the regressions with criterion variables of mathematics and science resilience. They allow the identification of which factors, for each of the three levels examined, had greatest impact on the criterion variables.

Table 4

Summary of Results in Mathematics of Multilevel Binary Hierarchical Logistic Analysis for the European Union

Mathematics	Coefficient	p-value	Odds Ratio	Confidence Interval
Level 1				
Gender	0.34	0.00	1.405	(1.324,1.491)
Immig	0.87	0.00	2.377	(2.186,2.584)
Bullying	0.04	0.02	1.037	(1.006,1.069)
M_Like	0.07	0.00	1.069	(1.028,1.112)
M_Confident	0.24	0.00	1.267	(1.221,1.314)
M_Clarity	-0.08	0.00	0.919	(0.888,0.950)
Task_Literary	0.14	0.00	1.146	(1.106,1.188)
Task_Numeracy	0.03	0.06	1.033	(0.998,1.069)
Perceptions	0.21	0.00	1.234	(1.195,1.274)
Level 2				
M_Emphasis	-0.21	0.00	0.811	(0.777,0.847)
M_Safe_Orderly	0.09	0.00	1.096	(1.050,1.144)
M_JobSatisfaction	-0.01	0.73	0.993	(0.956,1.032)
M_Limited_St_Not_Ready	-0.04	0.03	0.960	(0.926,0.996)
M_Shortage	0.04	0.02	1.042	(1.006,1.079)
Sc_Discipline	-0.02	0.42	0.985	(0.948,1.023)
Enter_Lit_Num_Skills	-0.05	0.02	0.947	(0.906,0.989)
Level 3				
U_Mat19	-0.06	0.00	0.944	(0.935,0.953)
EarlyLeavers	0.00	0.93	1.001	(0.979,1.024)
Employment2019	-0.01	0.08	0.994	(0.987,1.001)
Adultlearning2016	-0.02	0.00	0.984	(0.978,0.990)
Tertiary	-0.01	0.03	0.989	(0.979,0.999)

Table 5

Summary of Results in Science of Multilevel Binary Hierarchical Logistic Analysis for the European Union

Science	Coefficient	p-value	Odds Ratio	Confidence Interval
Level 1				
Gender	0.22	0.00	1.247	(1.177,1.320)
Immig	0.60	0.00	1.822	(1.667,1.992)
Bullying	0.08	0.00	1.089	(1.057,1.121)
S_Like	0.02	0.39	1.018	(0.978,1.059)
S_Confident	0.04	0.06	1.036	(0.998,1.076)
S_Clarity	0.02	0.20	1.023	(0.988,1.058)
Task_Literary	0.10	0.00	1.104	(1.066,1.144)
Task_Numeracy	-0.02	0.16	0.976	(0.944,1.009)
Perceptions	0.17	0.00	1.187	(1.151,1.224)
Level 2				
S_Emphasis	-0.20	0.00	0.818	(0.783,0.854)
S_Safe_Orderly	0.09	0.00	1.095	(1.048,1.145)
S_JobSatisfaction	0.02	0.43	1.015	(0.977,1.055)
S_Limited_St_Not_Ready	-0.08	0.00	0.922	(0.888,0.956)
S_Science_Investigation	0.07	0.00	1.067	(1.031,1.105)
S_Shortage	-0.01	0.41	0.985	(0.952,1.020)
Sc_Discipline	0.03	0.17	1.027	(0.989,1.066)
Enter_Lit_Num_Skills	-0.01	0.71	0.992	(0.949,1.036)
Level 3				
U_Sci19	-0.06	0.00	0.937	(0.927,0.947)
EarlyLeavers	0.00	0.78	1.003	(0.979,1.028)
Employment2019	0.00	0.93	1.000	(0.992,1.007)
Adultlearning2016	-0.02	0.00	0.984	(0.977,0.991)
Tertiary	-0.01	0.02	0.988	(0.978,0.998)

Table 6

Effect of the Variables on the Probability of Being Resilient

	Mathematics	**Science**
Level 1		
Gender	↑↑↑	↑↑↑
Immig	↑↑↑	↑↑↑
Bullying	↑↑	↑↑↑
Like	↑↑↑	
Confident	↑↑↑	↑
Clarity	↓↓↓	
Task_Literary	↑↑↑	↑↑↑
Task_Numeracy	↑	
Perceptions	↑↑↑	↑↑↑
Level 2		
Emphasis	↓↓↓	↓↓↓
Safe_Orderly	↑↑↑	↑↑↑
JobSatisfaction		
Limited_St_Not_Ready	↓↓	↓↓↓
Science_Investigation		↑↑↑
Shortage	↑↑	
Sc_Discipline		
Enter_Lit_Num_Skills	↓↓	
Level 3		
Underachievement	↓↓↓	↓↓↓
EarlyLeavers		
Employment2019	↓	
Adultlearning2016	↓↓↓	↓↓↓
Tertiary	↓↓	↓↓

Note: ↑↑↑ = statistically significant at 99%, ↑↑ = statistically significant at 95%, ↑ = statistically significant at 90%. The up arrow means the effect is positive. The down arrow means the effect is negative. No value means the effect is not statistically significant.

Table 6 gives a graphical indication of the effect of the variables on the probability of being resilient. It indicates whether the predictor variable has a positive impact (increases the probability) using ↑↑↑ if it is statistically significant at 99% ($0 \leq$ p-value $\leq .01$), ↑↑ if it is statistically significant at 95% ($.01 \leq$ p-value $\leq .05$) and ↑ if it is statistically significant at 90% ($.05 \leq$ p-value $\leq .10$). If the variable has a negative effect (reduces the probability), that is indicated by ↓↓↓ if it is significant at 99%, ↓↓ if it is significant at 95%, or ↓ if it is significant at 90%.

The resulting estimates reveal that, once immigration status and gender are discounted, the variable with the greatest predictive capacity is having carried out basic reading tasks at home before starting primary education, increasing the probability of resilience by 26.7 percentage points in mathematics and 10.4 in science; values similar to those provided by the parents' perception of the school (23.4% in mathematics and 18.7% in science). Observing the results obtained for the variables in Level Two of the analysis, we find that schools with a good educational environment increase the resilience possibilities of their students by approximately 10 percentage points in both mathematics and science. It is important to note the impact of variables that measure the emphasis on academic success and whether there are limits for teaching when students do not have a favorable academic level. In these cases, those schools that have students with educational deficiencies, but that do not emphasize academic success as their main value, are capable of obtaining a higher percentage of resilient students in both mathematics and science, with percentages between an additional 10% and 20 %. To conclude, and focusing on the three levels of analysis, those countries with the highest percentages of students at low performance levels have 5.6% fewer resilient students in mathematics and 6.3% less in science.

Discussion

This study had two objectives. Estimate the percentage of academically resilient students in the EU and identify the individual, school, and national factors which promote academic resilience.

In terms of the first objective, the average percentages of academically resilient students in mathematics and science in the participating EU countries were similar (25.67% mathematics and 24.16% science), in line with the average seen in reading competence in PIRLS 2016 (García-Crespo et al., 2019a). However, there was notable variation between countries, with a wider dispersion in the percentages between countries in science than in mathematics. Although in some countries, more than 30% of students were resilient (Latvia, Ireland, Italy, Portugal and Austria in mathematics, and Finland, Latvia, Croatia and Poland in science), in France, the percentage of academically resilient students was close to 8% in both subjects. In addition, the percentages of academically resilient students might be expected to be similar in the two subjects, and as Table 3 shows, while there are countries where that was the case, such as the Czech Republic (29.71% and 29.69%) and Latvia (37.23% and 37.43%), in other countries there were notable differences, such as Belgium (FL.) (27.16% and 10.93%) and Poland (22.52% and 31.07%). In this regard, one future line of research would be to analyze the variables that have greatest impact on being academically resilient in each subject by country and identify what led to these situations in these countries.

In terms of the second objective, the data offer a consistent picture: academic resilience is a multidimensional phenomenon that seems to be associated with sociodemographic, family, personal, school, and educational policy factors (Erberber et

al., 2015; Sandoval & Białowolski, 2016). The student demographic variables demonstrated the greatest effect. Boys were more likely to be resilient in both subjects (40 percentage points more in mathematics and 25 in science), something not observed by Sandoval & Białowolski (2016), but which was reported by Clavel et al. (2021). Nonetheless, García-Crespo et al. (2019a) found that girls were more likely to be resilient than boys in reading. These results may be due to the gender gap in STEM (Science, Technology, Engineering and Mathematics) subjects and language skills as seen in the results from boys (503 points in mathematics and 493 in science) and girls (499 points in mathematics and 489 in science) in TIMSS 2019 (Mullis et al., 2020) and in PIRLS 2016 (boys 501 points and girls 520) (Mullis et al., 2017). The data show that immigrant students demonstrate higher proportions of resilience than native students (130 percentage points more in mathematics and 82 in science), which is consistent with the conclusions from Gabrielli et al. (2021) about the variables that foster resilience in immigrant students and validate the need for specific strategies in schools to encourage the inclusion of migrants and to reduce their vulnerability. Nevertheless, it is important to consider that it is reasonable to expect a higher proportion of students who are immigrants to be resilient according to the definition used here since it is more likely that immigrant students are overrepresented in the bottom quarter of socio-economic background. The same happens for boys, who are usually overrepresented in the top quarter of STEM high performers.

Another interesting interpretation of these findings is that the effect of some of the remaining variables in the model is statistically significant even after accounting for gender and immigrant background. For instance, being able to perform literacy tasks at the beginning of primary school and positive parental perceptions of children's schools

had a positive effect on academic resilience, both in mathematics (increases of 15% and 23% respectively) and science (10% and 19%) which underscores the fact that the family environment and early stimulation are key for increasing the chances of resilience (Cordeo & Mateos-Romero, 2021; Martín-Lagos, 2018; OECD, 2018). The statistically significant affective-emotional factors included self-confidence, which predicted increases of 27% in mathematics and 4% in science, and enjoying mathematics (increase of 7%), which is consistent with the evidence reported by Jacob (2002) and Waxman et al., (1997).

Amongst the school-related factors, it is notable that schools perceived as safe environments by the teachers increased the percentage of resilience by 10 percentage points in both subjects. This was confirmed by the students' perceptions, when students did not perceive bullying, the likelihood of resilience increased by 4% in mathematics and 8% in science. This is consistent with the results reported by Erberber et al. (2015) and García-Crespo et al. (2019b). At this second level of analysis, there was a higher percentage of resilient students in schools reporting that students do not enter with literacy and numeracy skills (5 %) and classroom teaching limited by students not ready for instruction (4 %) at the same time as instruction not affected by resource shortage (4 %). This seems to indicate that, despite the initial limitations with regard to the type of student, schools where the teaching processes are not affected by scarce resources are able to increase the percentage of resilient students. Yeung & Li (2021) concluded something similar, stating that when disadvantaged students' own resources or those of their families do not help them cope with adversity or increase their chances of success, school resources are very important for their academic success. In addition with regard to teachers, Waxman et al. (2003) stated affective relationships, high expectations, and

opportunities to participate and contribute help to increase the probability of resilience. Delpit (1996) made contributions along similar lines, indicating that teachers' high expectations could structure and guide students' behaviors and challenge students beyond what they believe they are capable of. To finish off the school variables, it is important to note that, although Erberber et al. (2015) reported a positive relationship between resilience and a school's interest in students' academic success, the results from the present study are the opposite. One possible explanation, although it would be a future line of research, is that instead of schools with larger numbers of disadvantaged students focusing their interest on students' final achievement or excellence, they focus on the students achieving basic competencies, as once that is done, they will be more likely to be resilient. Another variable that suggests a new line of study is that measured by *Instructional Clarity in Mathematics Lessons* which seems to be negatively related to the condition of academic resilience in mathematics, and merits a more thorough analysis.

Finally, the country-level analysis (level 3 variables) allowed us to relate the level of achievement of the 2020 Objectives and the percentage of resilient students. The most important indicator was the percentage of low-achieving students, which was negatively related to academic resilience. The data indicate that in both subjects, the greater the percentage of underachieving students, the lower the proportion of resilient students, reaching 6 percentage points difference in both mathematics and science. The percentage of the population aged between 30 and 40 with higher education and the percentage of the adult population (aged 25-64) participating in educational or training activities exhibited significant negative effects, albeit with a very low impact (less than 2% of resilient students). This indicates that countries which have reached higher levels

of achievement in these key indicators have a marginally lower percentage of resilient students.

In short, the results from this study indicate that investing in educational policies aimed at increasing student confidence in STEM subjects would increase the rates of resilience, as would investing in policies for reducing the gender gap in science-technology. It is also important to encourage family support, fundamentally by engaging in literacy tasks when beginning primary school. In the light of the results, policy makers could benefit students by acting directly on schools, aiming to achieve safer learning environments which have the necessary resources for the teaching-learning process and in which the students feel safe and secure, reducing bullying at school as far as possible. This would very likely lead to a reduction in the percentage of low-achieving students and increase the chances of socioeconomically disadvantaged students being resilient. In addition, intervening in these contexts has shown that educational systems can compensate for the initial disadvantages of immigrant students.

In line with previous research, these findings highlight the incremental effects of individual and affective variables on academic outcomes, even after accounting for family and background characteristics (Noftle and Robins, 2007; OECD, 2021a; OECD, 2021b; Suárez-Álvarez, Fernández-Alonso and Muñiz, 2014). Ultimately, fostering resilient students and educational systems relies heavily on combining policy, research, and practice. Bridging these gaps is essential to help policy makers make informed decisions, support teachers in daily practice, and enable children and adolescents to reach their potential (Suarez-Alvarez et al., 2020)

All of the results in this study are limited by the nature of the TIMMS study, which lacks student-variables such as cognitive ability and other, non-cognitive, skills which might have an impact on resilience (Santos et al., 2018). It would also be useful to analyze whether these variables exhibit significance over time or for other sets of countries with different sociocultural characteristics. In addition, the TIMSS study lacks a proper measure of teachers' self-efficacy according to student perceptions, according to the proposal from Lera et al. (2021). Finally, defining socioeconomically disadvantaged students using home based resources may create problems of non-invariance across time as certain traditional cultural possessions, such as books, may become less indicative of socioeconomic status (Avvisati, 2020). Together with the suggestions made previously in this study, these are potentially interesting directions for future research.

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References

Agasisti, T., & Longobardi, S. (2017). Equality of educational opportunities, schools'. *Social Indicators Research, 134*(3), 917-953. https://doi.org/10.1007/s11205-016-1464-5

Agasisti, T., Avvisati, F., Borgonovi, F., & Longobardi, S. (2018). *Academic resilience. What schools and countries do to help disadvantaged students succeed in PISA.* OECD. www.oecd-ilibrary.org/docserver/e22490ac-en.pdf

Agasisti, T., Soncin, M., & Valenti, R. (2016). School factors helping disadvantaged students to succeed: Empirical evidence from four Italian cities. *Policy Studies, 37*(2), 147-177. https://doi.org/10.1080/01442872.2015.1127341

Avvisati, F (2020). Measuring socio-economic status in PISA: a review and suggested improvements. *Large-scale Assessments in Education, 8.* https://doi.org/10.1186/s40536-020-00086-x

Caprara, G. V., Barbaranelli, C., Borgogni L, L., & Steca, P. (2003). Efficacy beliefs as determinants of teachers' job satisfaction. *Journal of Educational Psychology, 95*(4), 821–832.

Clavel, J. G., García-Crespo, F. J., & Sanz San Miguel, L. (2021). Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts? *Asia Pacific Journal of Education*. https://doi.org/10.1080/02188791.2021.1886905

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences.* Routledge. https://doi.org/10.4324/9780203774441

Cordero, J. M., & Mateos-Romero, L. (2021). Exploring factors related with resilience in primary education: Evidence from European countries. *Studies In Educational Evaluation, 70*(1), 101045. https://doi.org/10.1016/j.stueduc.2021.101045

Coronado Hijón, A., & Paneque Folch, M. (2016). Resiliencia al fracaso escolar y desventaja sociocultural: un reto para la orientación y la tutoría [Resilience to school failure and socio-cultural disadvantage: a challence for guidance and tutoring]. *Trauma, contexto y exclusión. Promocionando la resiliencia [Trauma, context and exclusion. Promoting resilience]*. Grupo Editorial Universitario GEU.

De la Cruz, F. (2008). Modelos multinivel [Multi-level models]. *Epidemiol, 12*(3), 1-8. http://sisbib.unmsm.edu.pe/bvrevistas/epidemiologia/v12_n3/pdf/a02v12n3.pdf

Delpit, L. (1996). *The politics of teaching literate discourse.* New Press.

Edwards, M. S., & Ashkanasy, N. M. (2018). Emotions and failure in academic life: Normalising the experience and building resilience. *Journal of Management & Organization, 24*(2), 167-188. https://doi.org/10.1017/jmo.2018.20

Erberber, E., Stephens, M., Mamedova, S., Ferguson, S., & Kroeger, T. (2015). Socioeconomically disadvantaged students who are academically successful: Examining academic resilience crossnationally. *IEA'S Policy Brief Series, 5*. http://www.iea.nl/policy_briefs.html

European Comission. (2020). *Education and Training Monitor 2020*. https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/en/chapters/foreword.html#targets

Fernández-Alonso, R., & Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de las competencias básicas [Booklet designs for the evaluation of basic skills]. *Aula Abierta, 39*(2), 3-34.

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2012). Imputación de datos perdidos en la evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. *Psicothema, 24*(1), 167-175. http://www.psicothema.com/psicothema.asp?id=3995

Fishbein, B., Foy, P., & Yin, L. (2021). *TIMSS 2019 User Guide for the International Database.* Boston College, TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/international-database/

Gabrielli, G., Longobardi, S., & Strozza, S. (2021). The academic resilience of native and immigrant-origin students in selected European countries. *Journal of Ethnic and Migration Studies,* 1-22. https://doi.org/10.1080/1369183X.2021.1935657

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2019). Resilient and low performer students: Personal and family determinants in European countries. *Psicothema, 31*(4), 363-375. https://doi.org/10.7334/psicothema2019.245

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2021). Academic resilience in European countries: The role of teachers, families, and student profiles. *PLoS ONE, 16*(7).

García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. *Revista de Educación, 384,* 65-89. https://doi.org/10.4438/1988-592X-RE-2019-384-413

Gelman, A., & Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models.* Cambridge University Press.

Heckman, J. J., & Rubinstein, Y. (2001). The importance of noncognitive skills: Lessons from the GED testing program. *The American Economic Review, 91*(2), 145-149.

Iñiguez-Berrozpe, T., & Marcaletti, F. (2018). Modelos lineales multinivel en SPSS y su aplicación en investigación educativa [Linear multilevel models in SPSS and its application in educational research]. *REIRE Revista d'Innovació i Recerca en Educació, 11*(1), 26-40. https://doi.org/10.1344/reire2018.11.118984

Jacob, B. A. (2002). Where the boys aren't: non-cognitive skills, returns to school and the gender gap in higher education. *Economics of Education Review, 21*, 589-598.

Klassen, R., Wilson, E., Siu, A. Y., Hannok, W., Wong, M. W., Wongsri, N., . . . Jansem , A. (2013). Preservice teachers' work stress, self-efficacy, and occupational commitment in four countries. *European Journal of Psychology, 28*(4), 1289–1309. https://doi.org/10.1007/s10212-012-0166-x

Lera, M. J., León-Peréz, J. M., & Ruiz-Zorrilla, P. (2021). Adaptation of the Teacher Effi cacy Scale to Measure Effective Teachers' Educational Practices Through

Students' Ratings:A Multilevel Approach. *Psicothema, 33*(3), 509-517. https://doi.org/10.7334/psicothema2020.262

López-Zambrano, J., Lara Torralbo, J. A., & Romero, C. (2021). Early Prediction of Student Learning Performance Through Data Mining: A Systematic Review. *Psicothema, 33*(3), 456-465. https://doi.org/10.7334/psicothema2021.62

Martin, M. O., von Davier, M., & Mullis, I. V. (2020). *Methods and Procedures: TIMSS 2019 Technical Report.* Boston College, TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/methods

Martín-Lagos, M. D. (2018). Education and inequality: a meta-synthesis after the 50th anniversary of Coleman's report. *Revista de Educación, 380,* 186-209. https://doi.org/10.4438/1988-592X-RE-2017-380-377

Mullis, I. V., & Martin, M. O. (2017). *TIMSS 2019 Assessment Frameworks.* Boston College, TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/frameworks/

Mullis, I. V., Martin, M. O., Foy, P., Kelly, D., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science.* Boston College, TIMSS & PIRLS International Study. https://timssandpirls.bc.edu/timss2019/international-results/

Mullis, I., Martin, M., Foy, P., & Hooper, M. (2017). *PIRLS 2016 International Results in Reading.* Boston College, TIMSS & PIRLS International Study Center. http://timssandpirls.bc.edu/pirls2016/international-results/

Noftle, E. and R. Robins (2007). Personality predictors of academic outcomes: Big five correlates of GPA and SAT scores. *Journal of Personality and Social Psychology, 93-1,* pp. 116-130. https://doi.org/10.1037/0022-3514.93.1.116.

OECD. (2010). *PISA 2009 results: Overcoming social background - equity in learning opportunities.* OECD Publishing. https://doi.org/10.1787/9789264091504-en

OECD. (2011a). *Does participant in pre-primary education translate into better learning outcomes at school?. PISA in Focus nº 1.* OECD-ilibrary. http://cort.as/-M3Ms

OECD. (2011b). *How do some students overcome their socio-economic background?. PISA in Focus, nº 5.* https://www.oecd-ilibrary.org/education/how-do-some-students-overcome-their-socio-economic-background_5k9h362p77tf-en

OECD. (2016). *PISA 2015 results: Policies and practices for successful schools* (Vol. 2). OECD Publishing. https://doi.org/10.1787/9789264267510-en

OECD. (2018). *The resilience of students with an immigrant background: Factors that shape well-being, OECD Reviews of migrant education.* OECD Publishing. https://doi.org/10.1787/9789264292093-en

OECD (2021a). *21st-Century Readers: Developing Literacy Skills in a Digital World.* OECD Publishing. https://doi.org/10.1787/a83d84cb-en

OECD (2021b). *Beyond Academic Learning: First Results from the Survey of Social and Emotional Skills*. OECD Publishing. https://doi.org/10.1787/92a11084-en

Rutkowski, L., González, E., Joncas, M., & von Davier, M. (2010). International largescale assessment data: Issues in secondary analysis and reporting. *Educational Researcher, 39*(2), 142-151.

Sandoval-Hernández, A., & Białowolski, P. (2016). Factors and conditions promoting academic resilience: a TIMSS based analysis of five Asian education systems. *Asia Pacific Education Review, 17*, 511–520. https://doi.org/10.1007/s12564-016-9447-4

Santos, M. A., Ferraces, M. J., Godas, A., & Lorenzo, M. M. (2018). Do cooperative learning and family involvement improve variables linked to academic performance?. *Psicothema, 30*(2), 212-217. https://doi.org/10.7334/psicothema2017.311

Servicio de Evaluación Educativa. (2017). Éxito contra todo pronóstico: el alumnado académicamente resiliente. [Success against all odds: academically resilient students]. *Informe Evaluación, 12*, 1-8.

Snijders, T. A., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling.* Sage.

Suarez-Alvarez J, Fernández-Alonso R, Kyllonen PC, De Fruyt F, Fonseca-Pedrero E and Muñiz J (2020). Editorial: Bridging the Gap Between Research and Policy in Fostering Social and Emotional Skills. *Frontiers in Psychology, 11*-426. https://doi.org/10.3389/fpsyg.2020.00426

Suárez-Álvarez, J., R. Fernández-Alonso and J. Muñiz (2014). Self-concept, motivation, expectations, and socioeconomic level as predictors of academic performance in mathematics. *Learning and Individual Differences, 30*, pp. 118-123, https://doi.org/10.1016/j.lindif.2013.10.019.

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783–805. https://doi.org/10.1016/S0742-051X(01)00036-1

UNESCO. (2021). *UNESCO and Sustainable Development Goals*. https://en.unesco.org/sustainabledevelopmentgoals

Waxman, H. C., Gray, J. P., & Padrón, Y. N. (2003). *Review of research on educational resilience.* Center for Research on Education, Diversity & Excellence, University of California.

Waxman, H. C., Huang, S. L., & Padron, Y. N. (1997). Motivation and Learning Environment Differences between Resilient and Nonresilient Latino Middle

School Students. *Hispanic Journal of Behavioral Sciences, 19*(2), 137-155. https://doi.org/10.1177/07399863970192003

Yeung, W. J., & Li, H. (2021). Educational Resilience Among Asian Children in Challenging Family Environment. *Social Indicators Research, 153,* 675–685. https://doi.org/10.1007/s11205-019-02143-7

4. Discusión

Todas las naciones tienen como finalidad, en materia educativa, conseguir que sus jóvenes obtengan el máximo rendimiento académico del que sean capaces acompañado de su bienestar social. Un sistema educativo será más eficiente cuanto mejor rendimiento se obtenga de los recursos dispuestos a tal fin. En este sentido, los estados, a través de políticas públicas en el ámbito educativo, deben compensar las carencias de partida del alumnado desfavorecido socioeconómica y culturalmente para que la falta de recursos no suponga una merma a la hora de conseguir competencias suficientes para una transición plena a la vida activa y adulta.

Es en este punto donde surge el concepto de resiliencia académica, entendida esta como la capacidad que un estudiante tiene para sobreponerse a su situación desaventajada social, económica y culturalmente y obtener un rendimiento educativo muy por encima de lo que se esperaría por sus antecedentes. Concepto que ha ido evolucionando con el tiempo y siendo cada vez más motivo de estudio (Agasisti et al., 2018; García-Crespo et al., 2019a; OECD, 2010; OECD, 2011a; OECD, 2011b; OECD, 2018b).

La resiliencia, como la mayor parte de las habilidades no cognitivas de los estudiantes, tiene un carácter multidimendional y complejo, y depende tanto de variables individuales (personales o familiares) o como del entorno (centro educativo o profesorado).

Esta Tesis Doctoral pretende desarrollar un procedimiento que clasifique al alumnado resiliente y estimar el porcentaje de alumnado resiliente por países. Una vez conseguido esto, analizar un número suficiente de variables de contexto para encontrar

aquellas que tengan impacto significativo en la condición de resiliencia y cuantificar el mismo.

Se ha conseguido un procedimiento analítico que es capaz de diagnosticar si un estudiante desaventajado socioeconómica y culturalmente obtiene un rendimiento estimado muy por encima del que cabría esperar una vez descontado su ISEC individual (García-Crespo et al., 2019b). Aplicando este procedimiento se han estimado el porcentaje de alumnado resiliente en lectura, matemáticas y ciencias en 4º grado y en ciencias en jóvenes de 15 años (Clavel et al., 2021; García-Crespo et al., 2019b; García-Crespo et al., 2022).

La primera conclusión es que entre los estudiantes de 4º grado de la Unión Europea uno de cada cinco en lectura y uno de cada cuatro en matemáticas o ciencias es resiliente (20,53 % ± 0,29 lectura, 25,67 % ± 1,96 matemáticas y 24,16 % ± 1,87 ciencias) (García-Crespo et al., 2019b; García-Crespo et al., 2022). No obstante, existe una gran variabilidad en los porcentajes entre países. En lectura, Bélgica (francés) (5,96 % ± 0,77) es el país/región con menor porcentaje de alumnado resiliente, mientras que Polonia con 42,22 % (±2,2) es el país que mayor proporción de estudiantes resilientes presenta. En matemáticas y ciencias, Francia (8,34 % ± 1,23 y 8,07 ± 1,12) es el país que menor porcentaje de alumnado resiliente estimado tiene, mientras que en la situación opuesta se encuentran Letonia (37,23 % ± 2,50) y Finlandia (39,13 % ± 2,02) como los países que mayor proporción de alumnado resiliente estimado presentan en matemáticas y ciencias respectivamente. Estimados los porcentajes de alumnado de 15 años académicamente resiliente en ciencias en los países del sudeste asiático todos presentan porcentajes por encima del 40 % (Clavel et al., 2021).

Los resultados obtenidos en esta Tesis Doctoral corroboran el hecho de que la resiliencia académica es un fenómeno multidimensional que parece estar asociado a

factores socio-demográficos, familiares, personales, escolares y de política educativa (Day & Gu, 2013; Erberber et al., 2015; Henderson & Milstein, 2003; Henry et al., 2015; Masten & Ciccheti, 2016; Sandoval-Hernández & Bialowolski, 2016; Steward, 2014). Sin embargo, se observa una gran variabilidad por país en cuanto a las variables que son estadísticamente significativas en el modelo construido, situación que puede deberse a las diferencias culturales o bien sea resultado de los distintos sistemas educativos promovidos por los países (Kelly et al., 2020; Mullis et al., 2017; OECD, 2016a). No obstante, por un lado, sí se encuentran patrones que son comunes a la gran mayoría de los países y que se discutirán de manera conjunta, y por otro, se observan variables que son significativas en un menor conjunto de países y que se analizan en su propio contexto.

Para las evaluaciones analizadas la variable que mide la confianza en la competencia es significativa en todas ellas y además lo es en la totalidad de los países, economías y regiones estudiadas. Una alta autoconfianza en lectura puede incrementar hasta 140 puntos porcentuales la probabilidad de resiliencia (Malta) y puede disminuir hasta en 70 puntos porcentuales la probabilidad de que el alumno sea de muy bajo rendimiento (Portugal) (García-Crespo et al., 2019a). La autoconfianza, también estima incrementos del 27% en matemáticas y del 4% en ciencias en el alumnado de 4º grado de los países de la UE participantes en TIMSS 2019 (García-Crespo et al., 2022) y del 26 % en ciencias en alumnado de 15 años en Corea en PISA 2015 (Clavel et al., 2021). Resultados en la línea de lo apuntado por Jacob (2002), Martin & Marsh (2003), Vaknin-Nusbaumet al. (2018), Veaset al. (2017), o Waxmanet al. (1997), que afirmaban que el alumnado resiliente confía más en sus posibilidades y es más esforzado y perseverante en las tareas. En situación coherente con los autores anteriormente citados, el gusto por las ciencias y la motivación intrínseca ofrece resultados que hacen pensar que estas variables tienen un impacto positivo en alumnado de 15 años del sudeste asiático, pudiendo

estimarse un aumento de hasta 100 puntos porcentuales en la probabilidad de ser resiliente en países como Singapur. Farringtonet al. (2012), Heckman & Rubinstein (2001) y Humphries & Kosse (2017) estudiaron la influencia de habilidades no cognitivas sobre el rendimiento de los estudiantes. Demostrando que forman un conjunto de destrezas interconectadas que ayudan al estudiante a alcanzar sus objetivos. Si un estudiante es resiliente, también será más probable que sea persistente, autosuficiente, motivado, etc. Algunas de estas habilidades se estudiaron para esta Tesis Doctoral en el trabajo *Academic Resilience and Students' attitudes toward Science in the Asia Pacific Area* (Clavel et al., 2021) y se observó que el alumnado con mayor motivación general podría llegar a ser más resiliente (57 % más en las regiones de China: Beijing-Shanghai-Jiangsu-Guangdong o Taipei) todo lo contrario que aquellos estudiantes que muestran mayor nivel de ansiedad antes de un examen (36 puntos porcentuales menos de probabilidad en las regiones de China). Sin embargo, en lo referente a las habilidades no cognitivas, las bases de datos con las que se ha trabajado carecen de otras, tales como el perfil de personalidad, el *grit*, la inteligencia emocional o los estilos de aprendizaje, que podrían tener impacto en la resiliencia académica (Fernández-Lasarte et al., 2020; Morales-Vives et al., 2020; Santos et al., 2018).

Reforzando la idea de la OECD (2018b) al respecto del beneficio que proporciona recibir estimulación temprana fomentando los conocimientos de lectura antes de asistir a primaria y encontrar un entorno familiar favorable, propiciando un incremento de la probabilidad de resiliencia (Cordeo & Mateos-Romero, 2021; Martín-Lagos, 2018). Las variables analizadas en este trabajo que miden en qué medida el estudiante había realizado en el hogar actividades y tareas de lectura muestran ser significativas en un considerable número de países y regiones y con un impacto positivo en todas las competencias. Estimándose en 4º grado un impacto de 90 puntos porcentuales de incremento en la

probabilidad de resiliencia en lectura en el alumnado de Irlanda y un 14,6 % y 10,4 % de incremento de resiliencia en matemáticas y ciencias respectivamente en el promedio de los países de la Unión Europea. Las estimaciones también nos dicen que el alumnado que ha realizado actividades tempranas de lectura puede llegar a tener 57 puntos porcentuales menos de probabilidad de ser de muy bajo rendimiento, tal es el caso de Lituania. También en la línea de la OECD (2018b) que afirma que asistir a preescolar tiene un efecto positivo en el rendimiento académico posterior del alumnado y en la posibilidad de resiliencia, se ha analizado esta variable en la competencia lectora en primaria y se ha estimado que asistir 1 año o menos a preescolar reduce la probabilidad de resiliencia considerablemente, como mínimo 33 puntos porcentuales como ocurre en Lituania y prácticamente a 0 en el caso de Bélgica (francés). Sin embargo, multiplica por 3 la probabilidad de que sea un estudiante de muy bajo rendimiento (Dinamarca). Las estimaciones para el alumnado que asistió 2 o más años son significativas para un menor número de países, no obstante, cabe destacar que los estudiantes de Dinamarca que asistieron 2 o más años a preescolar tienen 4 veces más probabilidad de ser resilientes.

La variable sexo se ha mostrado como variable individual diferenciadora en los resultados de los estudiantes (Moffitt et al., 2001). Analizada dicha variable, las estimaciones nos dan resultados coherentes con los rendimientos que se observan en las evaluaciones internacionales, las chicas obtienen mejor rendimiento que los chicos en la competencia lectora, mientras que en matemáticas y ciencias ocurre lo contrario (Mullis, et al., 2017; Mullis et al., 2020; OECD, 2016a). Sandoval & Białowolski (2016), no observaron en sus trabajos que la condición de género resultara ser significativa respecto a la resiliencia académica. Sin embargo, en los trabajos para esta Tesis Doctoral se ha estimado que los chicos tienen mayor probabilidad de ser resilientes en matemáticas y ciencias en primaria (40 % más de posibilidades en matemáticas y 25 % en ciencias) y

también más probabilidad en ciencias en algunos países analizados de Asia-Pacífico en estudiantes de 15 años, en la línea de lo observado por Agasisti et al. (2018). En sentido contrario, se ha estimado que los chicos pueden llegar a ser casi la mitad de proclives a ser resilientes que las chicas en lectura, coherente con Jacob (2002) y Kotliarenco et al. (1997). Así pues, la respuesta no puede ser única y es probable que estos resultados se deban a la brecha de género existente entre las materias STEM (Science, Technology, Engineering and Mathematics) y las competencias lingüísticas (García-Crespo et al., 2022).

Los estimadores muestran que el alumnado inmigrante presenta mayor proporción de resiliencia en matemáticas y ciencias que el nativo (130 % y 82 % respctivamente), lo que es coherente con las conclusiones de Gabrielli et al. (2021) respecto a las variables ya analizadas que propiciaban la resiliencia en el alumnado inmigrante como son la autoeficacia y las actitudes lingüísticas en el hogar, en la misma línea de resultados de la OECD (2018b).

Las últimas variables analizadas del entorno individual y familiar son las que relacionan al estudiante y su familia con el centro educativo. En este sentido caben destacar tres que han resultado tener impacto positivo y estadísticamente significativo: sentido de pertenencia al centro, ausencia de *bullying* y percepciones de los progenitores del centro escolar de sus hijos. Al igual que resultados previos de Erberberet al. (2015), aquellos estudiantes que presentan un alto sentido de pertenencia al centro pueden llegar a tener casi un 50 % más de probabilidad de resiliencia en lectura que sus compañeros o disminuir la probabilidad de muy bajo rendimiento en la misma proporción. En la misma dirección de resultados, aunque con menor impacto, apuntan las estimaciones para las competencias matemática y científica en aquellos estudiantes que no perciben *bullying*. Percepciones positivas de los progenitores sobre el centro educativo de sus hijos tienen

un efecto positivo en la posibilidad de resiliencia en matemáticas (23 %) y en ciencias (19 %) lo que confirma la importancia de la motivación familiar y una visión favorable del entorno educativo (Cordeo & Mateos-Romero, 2021; Martín-Lagos, 2018; OECD, 2018b).

En referencia al conjunto de variables del entorno individual y familiar del estudiante y atendiendo a la probabilidad de resiliencia o de muy bajo rendimiento del alumno, se ha comprobado que cuando el efecto es estadísticamente significativo en un sentido y en una de las probabilidades (resiliencia o muy bajo rendimiento), en la otra podrá tener efecto estadísticamente significativo en sentido contrario o sin efecto (García-Crespo et al., 2019a).

En general, los resultados de las variables relativas al entorno educativo o a la actividad docente han mostrado una capacidad predictiva de la resiliencia académica menor que las relativas a los estudiantes y las características familiares. No obstante, se ha encontrado un buen número de ellas que con carácter general presentan con mayor o menor grado significatividad, se discutirán dos grupos de variables: las relativas al centro y sus docentes y las relativas a la actividad docente propiamente dicha.

En este segundo nivel de análisis las variables asociadas al centro educativo y sus docentes que mayor efecto tienen sobre la condición de resiliencia son las relacionadas con disciplina escolar de uno u otro modo. Resultados previos de Agasisti et al. (2018) o Erberber et al. (2015) afirman que un clima escolar favorable, dentro de un entorno de seguridad y convivencia en los centros favorecen la resiliencia. Las estimaciones de este trabajo ofrecen resultados en el mismo sentido, pues aquellos centros con una alta disciplina escolar pueden llegar a ser capaces de aumentar la probabilidad de resiliencia de sus estudiantes en más de 50 puntos porcentuales. En la misma proporción, aquellos profesores que dicen trabajar en un ambiente seguro también tienen más alumnado

resiliente. Respecto al tipo de alumnado de la escuela y lo que la escuela aporta, se ha estimado que aquellos centros cuyos estudiantes comienzan primaria sin habilidades básicas en lectura y matemáticas tienen más proporción de alumnado resiliente en matemáticas y ciencias si este no presenta limitaciones para la instrucción en clase (incremento de 5 %) y el centro tiene suficientes recursos para la enseñanza (incremento de 4 %), conclusión similar a la que Yeung & Li (2021) o Gaviria et al. (2004) que afirmaban que para el alumnado desfavorecido los recursos de las escuelas serían muy importantes para su éxito académico aunque con mayor relevancia en los países en vías de desarrollo que en los desarrollados. Asociado a estos resultados se encuentran las conclusiones que obtuvieron Waxman et al. (2003) y Delpit (1996), respecto de los docentes, afirmando que las relaciones afectivas, altas expectativas y oportunidades para participar aumentan las posibilidades de resiliencia de los estudiantes.

Por otra parte, en el segundo nivel de análisis hay un conjunto de variables de carácter instructivo que presentan efectos positivos en una proporción relevante de países respecto a la resiliencia académica en lectura, destacando algunas características de las prácticas de enseñanza. En ese sentido, aquellos docentes que llevan a sus aulas con mayor frecuencia técnicas de lectura compresivas y reflexivas consiguen mayores probabilidades estimadas de resiliencia que aquellas prácticas de enseñanza de la lectura basadas en procedimientos rutinarios, sistemáticos y repetitivos, con incrementos de entre 20 y 60 puntos porcentuales (García-Crespo et al., 2021). Estos resultados están en línea con la evidencia previa que señala la importancia de las prácticas docentes en el rendimiento escolar (Creemers & Kyriakides, 2008; Hattie, 2009; Isac et al. , 2015; Kunter et al., 2013; Lavy, 2016; Lera et al., 2021; Nilsen & Gustafsson, 2016; Rjosk et al., 2014). Algunos trabajos determinan la relevancia de la formación continua del profesorado para la mejora de los resultados académicos de los estudiantes (Barber &

Mourshed, 2007; Darling-Hammond et al., 2017; OECD, 2019). En este sentido, se ha estimado que la participación del profesorado en actividades de formación complementaria en ámbitos tales como la teoría de la lectura, le lectura correctiva, o métodos de evaluación de la lectura, tiene un impacto significativo y positivo en al menos uno de cada cuatro de los países analizados. Además, los alumnos cuyos docentes han recibido formación complementaria durante su educación llegan a incrementar 40 puntos de probabilidad adicional de resiliencia.

Finalmente, en el nivel 3 de análisis, aquel que hace referencia al grado de consecución de los Objetivos ET2020. El indicador de mayor relevancia es el porcentaje de alumnado con bajo rendimiendo, que se relaciona negativamente con la resiliencia académica. Las estimaciones apuntan que tanto en matemáticas como en ciencias a mayor porcentaje de alumnado con bajo rendimiento en primaria, menor tasa de alumnado resiliente, alcanzándose 6 puntos porcentuales de diferencia en ambas competencias. Por otra parte, el porcentaje de población de entre 30 y 34 años con educación superior y el porcentaje de población adulta (25-64 años) que participa en actividades de formación presentan efectos significativos y negativos, aunque con muy bajo impacto (menos del 2% de alumnado resiliente). Ello indica que los países que han alcanzado mejor grado de consecución en estos indicadores clave poseen menor porcertanje de alumnado resiliente, aunque mínimamente.

Los resultados presentados tienen importantes implicaciones para orientar las políticas públicas educativas y van enfocados en primer término a aumentar la autoconfianza del estudiante, promover las actividades y tareas lectoras previas al ingreso en primaria para incrementar la resiliencia. En segundo término, poner en valor los centros educativos, convirtiéndolos en espacios seguros, climas favorables y disciplinados para que las familias perciban que el entorno de aprendizaje de sus hijos es

idóneo y propicie su participación en la vida escolar del centro. También se ha observado que la implicación docente es importante y que la formación continua, orientada a actividades innovadoras repercute favorablemente en la condición de resiliencia del estudiante. Además, los resultados parecen indicar que deberían potenciarse políticas educativas enfocadas a conseguir el objetivo ET2020 de reducir el porcentaje de alumnado con bajo rendimiento.

5. Conclusiones

A continuación, se enumeran las principales conclusiones obtenidas a partir del conjunto de publicaciones incluidas en esta Tesis Doctoral:

- Tomando como referencia las evaluaciones educativas a gran escala, se ha propuesto una definición de alumnado resiliente, con el rendimiento académico asignado en dichas evaluaciones y el Índice Social, Económico y Cultural obtenido de los cuestionarios de contexto de las mismas como indicadores necesarios.
- Se ha propuesto un procedimiento analítico robusto para clasificar al alumnado resiliente según la definición dada a tal fin.
- Aplicando del procedimiento propuesto, se ha estimado el porcentaje de alumnado resiliente en 4º grado en las competencias lectora, matemática y científica en los países la Unión Europea y de 15 años en la competencia científica de los países Asia-Pacífico.
- Se ha diagnosticado una batería de variables individuales del estudiante, de la familia, del contexto escolar, de la práctica docente y de Objetivos ET2020 y se han seleccionado aquellas que presentan significatividad estadística con respecto a la resiliencia académica.
- Para las variables que se han mostrado significativas se ha cuantificado el impacto que tienen.

Referencias

Agasisti, T., Avvisati, F., Borgonovi, F., & Longobardi, S. (2018). *Academic resilience. What schools and countries do to help disadvantaged students succeed in PISA.* OECD. Retrieved from www.oecd-ilibrary.org/docserver/e22490ac-en.pdf

Agasisti, T., Soncin, M., & Valenti, R. (2016). School factors helping disadvantaged students to succeed: Empirical evidence from four Italian cities. *Policy Studies, 37*(2), 147-177. doi:10.1080/01442872.2015.1127341

Aldridge, J. M., Fraser, B. J., Fozdar, A., Ala'i, K., Earnest, J., & Afari, E. (2015). Students' perceptions of school climate as determinants of wellbeing, resilience and identity. *Improving Schools, 19*(1), 5-26. doi:10.1177/1365480215612616

Barber, M., & Mourshed, M. (2007). *How the world's best-performing school systems come out on top.* Retrieved from https://www.mckinsey.com/industries/social-sector/our-insights/how-the-worlds-best-performing-school-systems-come-out-on-top

Barber, M., & Mourshed, M. (2009). Shaping the Future: How Good Education Systems Can Become Great in the Decade Ahead. In *Report on the International Education Roundtable.* Singapur: McKinsey & Company, London.

Barca, A., Mascarenhas, S. A., Brenlla, J. C., & Morán, H. (2012). Contextos de aprendizaje, determinantes familiares y rendimiento escolar en el alumnado de Educación Secundaria de Galicia [Learning contexts, family determiners and school performance in students of secondary education in Galicia]. *Revsita Amazónica, 9*(2), 370-412.

Barragán, A. B., Pérez-Fuentes, M. C., Martos, A., Simón, M. M., Molero, M. M., Martínez-Sánchez, A., . . . Gázquez, J. J. (2016). Intervención y variables del personal docente y el centro escolar que modulan el rendimiento académico del alumno [Intervention and variables in the teaching staff and the school which modulate student academic performance]. *European Journal of Child Development, Education and Psychopathology, 4*(2), 89-97. doi:10.1989/ejpad.v4i2.37

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., . . . Tsai, Y.-M. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal, 47*(1), 133-180. doi:10.3102/0002831209345157

Bryk, A., & Raudenbush, S. W. (1992). *Hierarchical LinearModels for Social and Behavioral Research: Applications and Data Analysis Methods.* Newbury Park: Sage.

Caprara, G., Barbaranelli, C., Borgogni, L., & Steca, P. (2003). Efficacy beliefs as determinants of teachers' job satisfaction. *Journal of Educational Psychology, 95*(4), 821-832. doi:http://dx.doi.org/10.1037/0022-0663.95.4.821

Cheung, K., Sit, P., Soh, K., Leong, M., & Mak, S. (2014). Predicting Academic Resilience with Reading Engagement and Demographic Variables: Comparing Shanghai, Hong Kong, Korea, and Singapore from the PISA Perspective. *The Asia-Pacific Education Researcher, 23*(4), 895–909.

Choi, A., & Calero, J. (2013). Determinantes del riesgo de fracaso escolar en España en PISA-2009 y propuestas de reforma [Determinants of the risk of school failure in Spain in PISA-2009 and proposals for reform]. *Revista de Educación, 362*, 562-593. doi:10.4438/1988-592X-RE-2013-362-242

Clavel, J. G., García-Crespo, F. J., & Sanz San Miguel, L. (2021). Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts? *Asia Pacific Journal of Education*. doi:10.1080/02188791.2021.1886905

Coburn, J., & Nelson, S. (1989). Teachers do make a difference: whar indian graduates say about their school experience. In *Northswest Regional Educational Laboratory.* Retrieved from eric.ed.gov/?id=ED306071

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences.* New York: Routledge.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, A. M., Weinfeld, F. D., & York, R. L. (1966). *Equality of Educational Opportunity.* Washington: Government Printing Office.

Cordeo, J. M., & Mateos-Romero, L. (2021). Exploring factors related with resilience in primary education: Evidence from European countries. *Studies In Educational Evaluation, 70*(1), 101045. doi:10.1016/j.stueduc.2021.101045

Cordero, J. M., & Manchón, C. (2014). Factores explicativos del rendimiento en educación primaria: un análisis a partir de TIMSS 2011. [Explanatory Factors for Achievement in Primary Education: An Analysis Using TIMSS 2011]. *Estudios sobre evaluación, 27*, 9-35. doi:10.15581/004.27.9-35

Creemers, B., & Kyriakides, L. (2008). *The Dynamics of Educational Effectiveness: A Contribution to Policy, Practice and Theory in Contemporary Schools.* Routledge, Abingdon. Retrieved from https://lib.ugent.be/nl/catalog/rug01:001240853

Darling-Hammond, L., Burns, D., Campbell, C., Goodwin, A., Hammerness, K., Low, E.-L., . . . Zeichner, K. (2017). *Empowered Educators: How High-Performing Systems Shape Teaching Quality Around the World.* Jossey-Bass, San Francisco.

Day, C., & Gu, Q. (2013). *Resilient teachers, resilient schools: Building and sustaining quality in testing times.* London: Routledge. doi:10.4324/9780203578490

De la Cruz, F. (2008). Modelos multinivel [Multi-level models]. *Epidemiol, 12*(3), 1-8. Retrieved from http://sisbib.unmsm.edu.pe/bvrevistas/epidemiologia/v12_n3/pdf/a02v12n3.pdf

Delpit, L. (1996). *The politics of teaching literate discourse.* New York: New Press.

Doll, B. (2013). Enhancing Resilience in Classrooms. In *Handbook of Resilience in Children* (pp. 399-409). Boston,MA: Springer US. doi:10.1007/978-1-4614-3661-4_23

Enríquez, M., Insuasty, M., & Sarasty, M. (2018). Escuela para Familias: Un escenario de socialización entre la familia y la escuela [School for Families: a scenario of socialization between the family and the school]. *Revista Katharsis, 25*, 94-107. Retrieved from revistas.iue.edu.co/index.php/katharsis/article/view/978

Erberber, E., Stephens, M., Mamedova, S., Ferguson, S., & Kroeger, T. (2015). Socioeconomically disadvantaged students who are academically successful: Examining academic resilience crossnationally. *IEA'S Policy Brief Series, 5*. Retrieved from http://www.iea.nl/policy_briefs.html

European Comission. (2020). *Education and Training Monitor 2020*. Retrieved from https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/en/chapters/foreword.html#targets

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2012). *Teaching adolescents to become learners: The role of noncognitive factors in shaping school performance–A critical literature reviwew.* Chicago: Consortium on Chicago School Research.

Fauth, B., Decristan, J., Rieser, S., Klieme, E., & Büttner, G. (2014). Student ratings of teaching quality in primary school: Dimensions and prediction of student outcomes. *Learning and Instruction, 29*, 1-9. doi:10.1016/j.learninstruc.2013.07.001

Feinstein, L., & Symons, J. (1999). Attainment in secondary education. *Oxford Economic Papers, 51*(2), 300-321. doi:10.1093/oep/51.2.300

Fernández-Alonso, R., & Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de las competencias básicas [Booklet designs for the evaluation of basic skills]. *Aula Abierta, 39*(2), 3-34.

Fernández-Alonso, R., Álvarez-Díaz, M., Woitschach, P., Suárez-Álvarez, P., & Cuesta, M. (2017). Parental involvement and academic performance: Less control and more communication. *Psicothema, 29*(4), 453-461. doi:10.7334/psicothema2017.181

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2012). Imputación de datos perdidos en la evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. *Psicothema, 24*(1), 167-175. Retrieved from http://www.psicothema.com/psicothema.asp?id=3995

Fernández-Lasarte, O., Ramos-Díaz, E., Goñi-Palacios, E., & Rodríguez-Fernández, A. (2020). The role of social support in school adjustment during Secondary Education. *Psicothema, 32*(1), 100-107. doi:10.7334/psicothema2019.125

Fishbein, B., Foy, P., & Yin, L. (2021). *TIMSS 2019 User Guide for the International Database.* Boston College, TIMSS & PIRLS International Study Center. Retrieved from timssandpirls.bc.edu/timss2019/international-database/

Gabrielli, G., Longobardi, S., & Strozza, S. (2021). The academic resilience of native and immigrant-origin students in selected European countries. *Journal of Ethnic and Migration Studies*, 1-22. doi:10.1080/1369183X.2021.1935657

Ganzeboom, H. B., & Treiman, D. J. (2003). Three internationally standardised measures for comparative research on occupational status. In *Advances in Cross-National Comparison, A European Working Book for* (pp. 159-193). New York: Kluwer Academic Press,.

García Sanz, M. (2003). *La evaluación de programas en la intervención socioeducativa. [The evaluation of programs in socio-educational intervention].* Murcia: DM. Retrieved from http://www.redined.mec.es/oai/indexg.php?registro=018200420021

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2019a). Resilient and low performer students: Personal and family determinants in European countries. *Psicothema, 31*(4), 363-375. doi:10.7334/psicothema2019.245

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2021). Academic resilience in European countries: The role of teachers, families, and student profiles. *PLoS ONE, 16*(7).

García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019b). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. *Revista de Educación, 384*, 65-89. doi:10.4438/1988-592X-RE-2019-384-413

García-Crespo, F. J., Suárez-Álvarez, J., & Fernández-Alonso, R. (2022). Resiliencia Académica en Matemáticas y Ciencias: Datos de Europa TIMSS-2019 [Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data]. *Psicothema*.

Garner, C., & Raudenbush, S. (1991). Neighborhood effects on educational attainment: A multi-level analysis of the influence of pupil ability, family, school, and neighborhood. *Sociology of Education, 64*(4), 251-262.

Gaviria, J., Martínez-Arias, R., & Castro, M. (2004). Un Estudio Multinivel Sobre los Factores de Eficacia Escolar en Países en Desarrollo: El Caso de los Recursos en Brasil [A Multilevel Study on School Effectiveness Factors in Developing Countries: The Case of Resources in Brazil]. *Education Policy Analysis Archives, 12*(20). Retrieved from epaa.asu.edu/epaa/v12n20/

Gelman, A., & Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models.* Cambridge: Cambridge University Press.

Grotberg, E. (1995). *A guide to promoting resilience in children:.* La Haya: Bernard van Leer Foundation.

Hambleton, R. K. (2002). Adapting achievement tests into multiple languages for international assessments. In *Methodological advances in cross-national surveys of educational achievement* (pp. 58-79). National Academies Press.

Hattie, J. (2009). *Visible Learning: A Synthesis of over 800 Meta-Analyses Relating to Achievement.* Routledge, London.

Heckman, J. J., & Rubinstein, Y. (2001). The importance of noncognitive skills: Lessons from the GED testing program. *The American Economic Review, 91*(2), 145-149.

Henderson, N., & Milstein, M. M. (2003). *Resiliency in schools: Making it happen for students and educators.* Corwin Press. Retrieved from au.sagepub.com/en-gb/oce/resiliency-inschools/

Henry, C. S., Morris, A. S., & Harrist, A. W. (2015). Family resilience: Moving into the. *Family Relations, 64*(1), 22-43. doi:10.1111/fare.12106

Howard, S., & Johnson, B. (2000). What Makes the Difference? Children and teachers talk about resilient outcomes for children 'at risk. *Educational Studies, 26*(3), 321-337. doi:10.1080/03055690050137132

Humphries, J., & Kosse, F. (2017). On the interpretation of non-cognitive skills – What is being measured and. *Journal of Economic Behavior & Organization, 136*, 174-185.

Iñiguez-Berrozpe, T., & Marcaletti, F. (2018). Modelos lineales multinivel en SPSS y su aplicación en investigación educativa [Linear multilevel models in SPSS and its application in educational research]. *REIRE Revista d'Innovació i Recerca en Educació, 11*(1), 26-40. doi:10.1344/reire2018.11.118984

Isac, M., Dinis da Costa, P., Araujo, L., Soto Calvo, E., & Albergaria-Almeida, P. (2015). *Teaching Practices in Primary and Secondary Schools in Europe: Insights from Large-Scale Assessments in Education - JRC Science and Policy Report.* Publications Office of the European Union, Luxembourg. doi:10.2788/383588

Jacob, B. A. (2002). Where the boys aren't: Noncognitive skills, returns to school and the gender gap in higher education. *Economics of Education Review, 21*(6), 589-598.

Kane, T., & Cantrell, S. (2010). *Learning about Teaching: Initial Findings from the Measures of Effective Teaching Project About the Measures of Effective Teaching Project.* Bill & Melinda Gates Foundation, Seattle, WA. Retrieved from https://docs.gatesfoundation.org/Documents/preliminary-findings-research-paper.pdf

Kelly, D. L., Centurino, V. S., Martin, M. O., & Mulis, I. S. (2020). *TIMSS 2019 Encyclopedia: Education Policy and Curriculum in Mathematics and Science.* Retrieved from timssandpirls.bc.edu/timss2019/encyclopedia/

Kirjavainen, T., & Loikkanen, H. A. (1998). Efficiency differences of Finnish senior secondary schools: an application of DEA and Tobit analysis. *Economics of Education Review, 17*(4), 377-394. doi:10.1016/S0272-7757(97)00048-4

Klassen, R., Wilson, E., Siu, A., Hannok, W., Wong, M., Wongsri, N., . . . Jansem, A. (2013). Preservice teachers' work stress, self-efficacy, and occupational commitment in four countries. *European Journal of Psychology of Education, 28*(4), 1289-1309. doi:10.1007/s10212-012-0166-x

Kleinbaum, D. G., & Klein, M. (2010). *Logistic Regression.* Springer.

Kobasa, S. C., Maddi, S. R., & Kahn, S. (1982). Hardiness and health: A prospective study. *Journal of Personality and Social Psychology, 42*(1), 168-177. doi:10.1037/0022-3514.42.1.168

Kotliarenco, M. A., Cáceres, I., & Fontecilla, M. (1997). *Estado del arte en resiliencia [State of the art in resilience].* Organización Panamericana de la Salud. Retrieved from www1.paho.org/hq/dmdocuments/

Kunter, M., & Voss, T. (2013). The model of instructional quality in COACTIV: A multicriteria analysis. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers* (pp. 97-124). Springer, New York, NY. doi:10.1007/978-1-4614-5149-5_6

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology, 105*(3), 805-820. doi:10.1037/a0032583

Lavy, V. (2016). What Makes an Effective Teacher? Quasi-Experimental Evidence. *CESifo Economic Studies, 62*(1), 88-125. doi:10.1093/cesifo/ifv001

Lera, M. J., León-Peréz, J. M., & Ruiz-Zorrilla, P. (2021). Adaptation of the Teacher Efficacy Scale to Measure Effective Teachers' Educational Practices Through Students' Ratings:A Multilevel Approach. *Psicothema, 33*(3), 509-517. doi: 10.7334/psicothema2020.262

Li, H. (2017). The 'Secrets' of Chinese Students' Academic Success: Academic Resilience among Students from Highly Competitive Academic Environments. *Educational Psychology, 37*(8), 1001–1014. doi:10.1080/01443410.2017.1322179

Martin, A. (2002). Motivation and academic resilience: Developing a model for studentenhancement. *Australian Journal of Education, 46*(1), 34-49. doi:10.1177/000494410204600104

Martin, A. J., & Marsh, H. W. (2003). Academic resilience and the four Cs: Confidence, control, composure, and commitment. *Joint AARE/NZARE Conference.* Auckland, New Zeland.

Martin, M. O., Mullis, I., & Hooper, M. (2017). *Methods and Procedures in PIRLS 2016.* Boston College, TIMSS & PIRLS International Study Center. Retrieved from https://timssandpirls.bc.edu/publications/pirls/2016-methods.html

Martin, M. O., von Davier, M., & Mullis, I. V. (2020). *Methods and Procedures: TIMSS 2019 Technical Report.* Boston College, TIMSS & PIRLS International Study Center. Retrieved from https://timssandpirls.bc.edu/timss2019/methods

Martín-Lagos, M. D. (2018). Education and inequality: a meta-synthesis after the 50th anniversary of Coleman's report. *Revista de Educación, 380*, 186-209. doi:10.4438/1988-592X-RE-2017-380-377

Masten, A. S., & Ciccheti, D. (2016). Resilience in development: Progress and transformation. In V. 4. Developmental psychopathology. doi:10.1002/9781119125556.devpsy406

Matin, A. (2002). Motivation and Academic Resilience: Developing a Model for Student Enhancement. *Australian Journal of Education, 46*(1), 34-49. doi:10.1177/000494410204600104

McTigue, E., Washburn, E., & Liew, J. (2009). Academic Resilience and Reading: Building Successful Readers. *The Reading Teacher, 62*(5), 422-432. doi:10.1598/rt.62.5.5

MECD. (2016). *PISA 2015. Programa para la Evaluación Internacional de los Alumnos. Informe español [PISA 2015. Program for International Student Assessment. Spanish report].* Madrid. Retrieved from sede.educacion.gob.es/publiventa/descarga.action?f_codigo_agc=18204

Merino Noé, J. (2017). La potencialidad de la Regresión Logística Multinivel. Una propuesta de aplicación en el análisis del estado de salud percibido [The potential of Multilevel Logistic Regression. A proposal for implementation in self-perceibed-health]. *Revista de Metodología de Ciencias Sociales, 36*, 177-211. doi:empiria.36.2017.17865

Moffitt, T., Caspi, A., Rutter, M., & Silva, P. (2001). *Sex Differences in Antisocial Behaviour: Conduct Disorder, Delinquency, and Violence in the Dunedin Longitudinal Study.* Cambridge: Cambridge University Press. doi:10.1017/CBO9780511490057

Morales-Vives, F., Camps, E., & Dueñas, J. M. (2020). Predicting academic achievement in adolescents: The role of maturity. *Psicothema, 32*(1), 84-91. doi:10.7334/psicothema2019.262

Mullis, I. S., Martin, M. O., Goh, S., & Prendergast, C. (2017). *PIRLS 2016 Encyclopedia: Education Policy and Curriculum in Reading.* Retrieved from timssandpirls.bc.edu/pirls2016/encyclopedia/

Mullis, I. V., & Martin, M. O. (2017). *TIMSS 2019 Assessment Frameworks.* Boston College, TIMSS & PIRLS International Study Center. Retrieved from timssandpirls.bc.edu/timss2019/frameworks/

Mullis, I. V., Martin, M. O., Foy, P., Kelly, D., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science.* Boston College, TIMSS & PIRLS International Study. Retrieved from timssandpirls.bc.edu/timss2019/international-results/

Mullis, I., & Martin, M. O. (2015). *PIRLS 2016 Assessment Framework (2nd ed.).* Boston College, TIMSS & PIRLS International Study Center. Retrieved from http://timssandpirls.bc.edu/pirls2016/framework.html

Mullis, I., Martin, M., Foy, P., & Hooper, M. (2017). *PIRLS 2016 International Results in Reading.* Boston College, TIMSS & PIRLS International Study Center. Retrieved from http://timssandpirls.bc.edu/pirls2016/international-results/

Muñoz-Izquierdo, C., & Guzmán, J. T. (2010). Una exploración de los factores determinantes del rendimiento escolar en la educación primaria [An exploration of the determinants of school performance in primary education]. *Latinoamericana de Estudios Educativos, XL*(2), 167-191. Retrieved from www.redalyc.org/pdf/270/27018884008.pdf

Nilsen, T., & Gustafsson, J.-E. (Eds.). (2016). *Teacher Quality, Instructional Quality and Student Outcomes. Relationships Across Countries, Cohorts and Time.* IEA Research for Education. doi:10.1007/978-3-319-41252-8

O'Dwyer, L., Wang, Y., & Shields, K. (2015). Teaching for conceptual understanding: A cross-national comparison of the relationship between teachers' instructional practices and student achievement in mathematics. *Large-scale Assessments in Education, 3*(1), 3-30. doi:10.1186/s40536-014-0011-6

OECD. (2005). *Teachers matter: attracting, developing and retaining effective teachers.* Organisation for Economic Co-operation and Development. Retrieved 12 07, 2017, from http://www.oecd.org/edu/school/attractingdevelopingandretainingeffectiveteachers-finalreportteachersmatter.htm

OECD. (2010). *PISA 2009 results: Overcoming social background - equity in learning opportunities.* OECD. doi:doi.org/10.1787/9789264091504-en

OECD. (2011a). *Does participant in pre-primary education translate into better learning outcomes at school?. PISA in Focus nº 1.* Paris: OECD-ilibrary. Retrieved from http://cort.as/-M3Ms

OECD. (2011b). *How do some students overcome their socio-economic background?. PISA in Focus, No. 5.* Retrieved from https://www.oecd-ilibrary.org/education/how-do-some-students-overcome-their-socio-economic-background_5k9h362p77tf-en

OECD. (2016a). *PISA 2015 Results (Volume I): Excellence and Equity in Education, PISA.* París: OECD Publishing. doi:10.1787/9789264266490-en

OECD. (2016b). *PISA 2015 results: Policies and practices for successful schools* (Vol. 2). doi:10.1787/9789264267510-en

OECD. (2017a). *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving.* París: OECD Publishing. doi:10.1787/9789264281820-en

OECD. (2017b). *PISA 2015 Technical Report.* Retrieved from www.oecd.org/pisa/data/2015-technical-report/

OECD. (2018a). *Effective Teacher Policies: Insights from PISA.* París: OECD Publishing. doi:10.1787/9789264301603-en

OECD. (2018b). *The resilience of students with an immigrant background: Factors that shape well-being, OECD Reviews of migrant education.* Paris: OECD Publishing. doi:10.1787/9789264292093-en

OECD. (2019). *More than the sum of their parts: Human resource policies for effective schools.* OECD Reviews of School Resources, Paris.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical Linear Models: Applications and data analysis methods.* Thousand Oaks: Sage Publications, Inc.

Rjosk, C., Richter, D., Hochweber, J., Lüdtke, O., Klieme, E., & Stanat, P. (2014). Socioeconomic and language minority classroom composition and individual reading achievement: The mediating role of instructional quality. *Learning and Instruction, 32*, 63-72. doi:10.1016/j.learninstruc.2014.01.007

Rutkowski, L., González, E., Joncas, M., & von Davier, M. (2010). International largescale assessment data: Issues in secondary analysis and reporting. *Educational Researcher,, 39*(2), 142-151.

Rutter, M. (1979). Protective factors in children's responses to stress and disadvantage. In *Primary Prevention of Psychopathology Volume III: Social Competence in Children* (pp. 49-74). Hanover: University Press of New England.

Sandoval-Hernández, A., & Bialowolski, P. (2016). Factors and Conditions Promoting Academic Resilience: A TIMSS-Based Analysis of Five Asian Education Systems. *Asia Pacific Education Review, 17*(3), 511-520.

Santos, M. A., Ferraces, M. J., Godas, A., & Lorenzo, M. M. (2018). Do cooperative learning and family involvement improve variables linked to academic performance? *Psicothema, 30*(2), 212-217. doi:10.7334/psicothema2017.311

Snijders, T. A., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling.* London: Sage.

Southwick, S. M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., & Yehuda, R. (2014). Resilience definitions, theory, and challenges: Interdisciplinary perspectives. *European, 5*(1), Article: 25338. doi:10.3402/ejpt.v5.25338

Steward, D., Sun, J., Patterson, C., Lemerle, K., & Hardie, M. (2004). Promoting and Building Resilience in PrimarySchool Communities: Evidence from a Comprehensive 'Health Promoting School' Approach. *International Journal of Mental Health Promotion, 6*(3), 26-33. doi:10.1080/14623730.2004.9721936

Steward, J. (2014). Sustaining emotional resilience for school leadership. *School Leadership & Management, 34*(1), 52-68. doi:10.1080/13632434.2013.849686

Suárez-Alvarez, J., Pedrosa, I., Lozano, L. M., García-Cueto, E., Cuesta, M., & Muñiz, J. (2018). Using reversed items in Likert scales: A questionable practice. *Psicothema, 30*, 149-158. doi:10.7334/psicothema2018.33

Tschannen-Moran, M., & Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783-805. doi:https://doi.org/10.1016/S0742-051X(01)00036-1

UNESCO. (2021). *UNESCO and Sustainable Development Goals*. Retrieved from https://en.unesco.org/sustainabledevelopmentgoals

Vaknin-Nusbaum, V., Nevo, E., Brande, S., & Gambrell, L. (2018). Developmental aspects of reading motivation and reading achievement among second grade low achievers and typical readers. *Journal of Resarch in Reading, 41*(3), 438-454.

Veas, A., López-López, J. A., Gilar, R., Miñano, P., & Castejón, J. L. (2017). Differences in cognitive, motivational and contextual variables between under-achieving, normally-achieving, and over-achieving students: A mixed-effects analysis. *Psicothema, 29*(4), 533-538. doi:10.7334/psicothema2016.283

Villegas, G., González-García, N., Sánchez-García, A., Sánchez-Barba, M., & Galindo-Villardón, M. P. (2018). Seven methods to determine the dimensionality of tests: application to the General Self-Efficacy Scale in twenty-six countries. *Psicothema, 30*, 442-448. doi:10.7334/psicothema2018.113

von Davier, M., Gonzalez, E., & Mislevy, R. J. (2009). What are plausible values and why are they useful? In *IERI Monograph Series. Issues and Methodologies in Large-Scale Assessments, volume 2* (pp. 9-36). Retrieved from http://www.ierinstitute.org/fileadmin/Documents/IERI_Monograph/IERI_Monograph_Volume_02.pdf

Wagner, W., Göllner, R., Helmke, A., Trautwein, U., & Lüdtke, O. (2013). Construct validity of student perceptions of instructional quality is high, but not perfect: Dimensionality and generalizability of domain-independent assessments. *Learning and Instruction, 28*, 1-11. doi:10.1016/j.learninstruc.2013.03.003

Waxman, H. C., Gray, J. P., & Padrón, Y. N. (2003). *Review of research on educational resilience.* Santa Cruz: Center for Research on Education, Diversity & Excellence, University of California.

Waxman, H. C., Huang, S. L., & Padron, Y. N. (1997). Motivation and Learning Environment Differences between Resilient and Nonresilient Latino Middle School Students. *19*(2), 137-155. doi:10.1177/07399863970192003

Yeager, D., & Dweck, C. (2012). Mindsets That Promote Resilience: When Students Believe That Personal Characteristics Can Be Developed. *Educational Psychologist, 47*(4), 302-314. doi:10.1080/00461520.2012.722805

Yeung, W. J., & Li, H. (2021). Educational Resilience Among Asian Children in Challenging Family Environment. *Social Indicators Research, 153*, 675–685. doi:10.1007/s11205-019-02143-7

Universidad de Oviedo
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FORMULARIO RESUMEN DE TESIS POR COMPENDIO

1.- Datos personales solicitante	
Apellidos: García Crespo	Nombre: Francisco Javier

Curso de inicio de los estudios de doctorado	2018/19

	SI	NO
Acompaña acreditación por el Director de la Tesis de la aportación significativa del doctorando	X	
Acompaña memoria que incluye		
Introducción justificativa de la unidad temática y objetivos	X	
Copia completa de los trabajos *	X	
Resultados/discusión y conclusiones	X	
Informe con el factor de impacto de la publicaciones	X	
Se acompaña aceptación de todos y cada uno de los coautores a presentar el trabajo como tesis por compendio (Art. 32.4.b)	X	
Se acompaña renuncia de todos y cada uno de los coautores no doctores a presentar el trabajo como parte de otra tesis de compendio (Art. 32.4.c)		

* Ha de constar el nombre y adscripción del autor y de todos los coautores asi como la referencia completa de la revista o editorial en la que los trabajos hayan sido publicados o aceptados en cuyo caso se aportará justificante de la aceptación por parte de la revista o editorial

FOR-MAT-VOA-033

Artículos, Capítulos, Trabajos

Trabajo, Artículo 1

Titulo (o título abreviado)	Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe
Fecha de publicación	Abril/2019
Fecha de aceptación	11/02/2019
Inclusión en Science Citation Index o bases relacionadas por la CNEAI (indíquese)	JCR
Factor de impacto	1,057

Coautor2 X Doctor □ No doctor . Indique nombre y apellidos	Begoña Galián Nicolás
Coautor3 X Doctor □ No doctor . Indique nombre y apellidos	Rubén Fernández Alonso
Coautor4 X Doctor □ No doctor . Indique nombre y apellidos	José Muñiz Fernández

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Trabajo, Artículo 2

Titulo (o título abreviado)	Resilient and low performer students: Personal and family determinants in European countries
Fecha de publicación	Diciembre/2019
Fecha de aceptación	16/09/2019
Inclusión en Science Citation Index o bases relacionadas por la CNEAI (indíquese)	JCR
Factor de impacto	3.890

Coautor2 X Doctor □ No doctor . Indique nombre y apellidos	Rubén Fernández Alonso
Coautor3 X Doctor □ No doctor . Indique nombre y apellidos	José Muñiz Fernández

Trabajo, Artículo 3

Titulo (o título abreviado)	Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts?
Fecha de publicación	27/02/2021
Fecha de aceptación	31/01/2021
Inclusión en Science Citation Index o bases relacionadas por la CNEAI (indíquese)	JCR
Factor de impacto	1.057

Coautor2 X Doctor □ No doctor . Indique nombre y apellidos	José Joaquín García Clavel
Coautor3 X Doctor □ No doctor . Indique nombre y apellidos	Luis Sanz San Miguel

Trabajo, Artículo 4

Titulo (o título abreviado)	Academic resilience in European countries: The role of teachers, families, and student profiles
Fecha de publicación	02/07/2021
Fecha de aceptación	05/06/2021
Inclusión en Science Citation Index o bases relacionadas por la CNEAI (indíquese)	JCR
Factor de impacto	3.240

Coautor2 X Doctor □ No doctor . Indique nombre y apellidos	Rubén Fernández Alonso
Coautor3 X Doctor □ No doctor . Indique nombre y apellidos	José Muñiz Fernández

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Trabajo, Artículo 5

Titulo (o título abreviado)	Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data
Fecha de publicación	Febrero/2022
Fecha de aceptación	22/11/2021
Inclusión en Science Citation Index o bases relacionadas por la CNEAI (indíquese)	JCR
Factor de impacto	3.890

Coautor2 X Doctor □ No doctor . Indique nombre y apellidos	Javier Suárez Álvarez
Coautor3 X Doctor □ No doctor . Indique nombre y apellidos	Rubén Fernández Alonso

En caso de compendio de un número de artículos superior a seis, se incorporarán hojas suplementarias conforme a este modelo

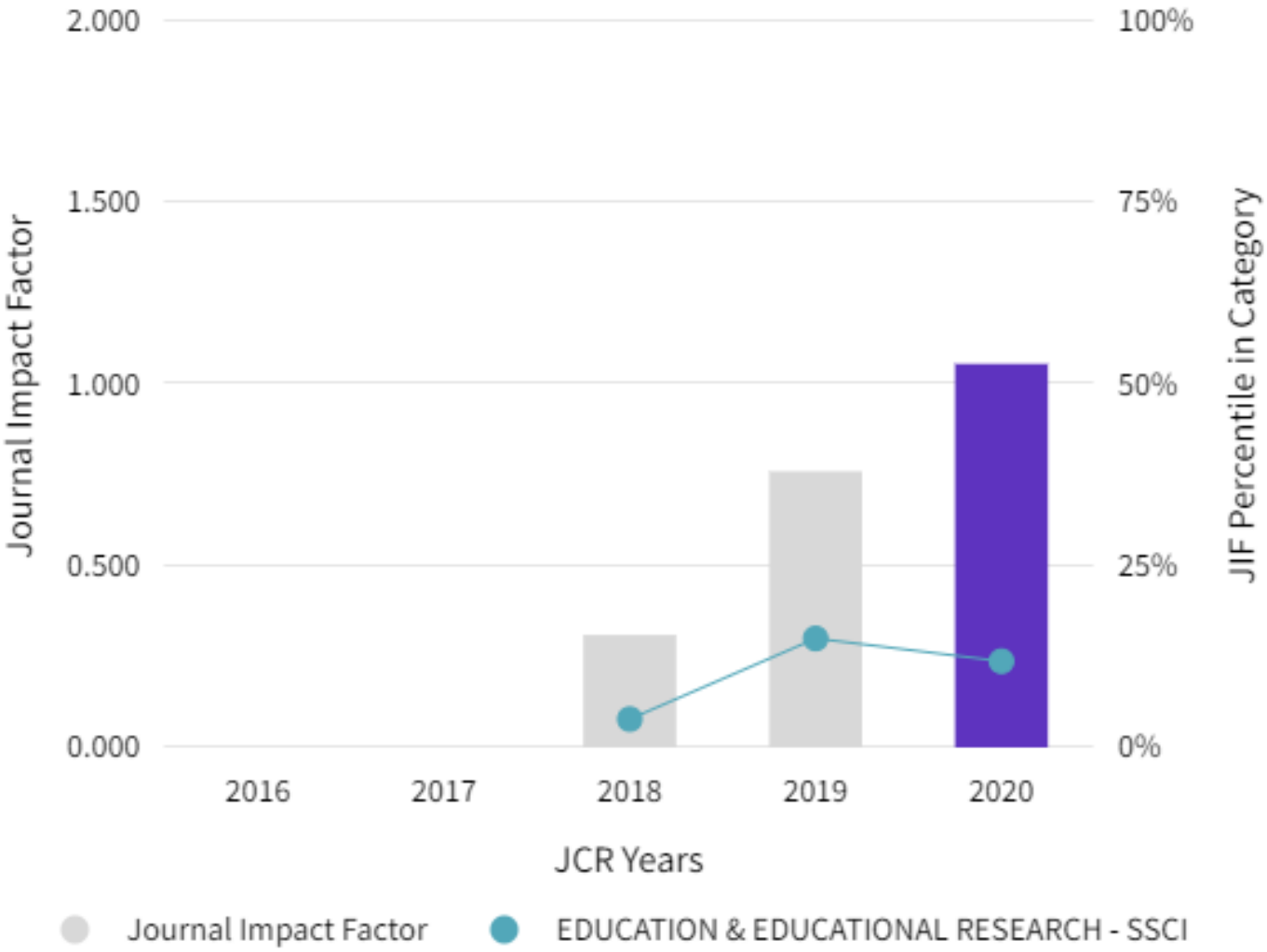
Revista de Educacion

2020 JOURNAL IMPACT FACTOR & PERCENTILE RANK IN CATEGORY

The Journal Impact Factor (JIF) is a journal-level metric calculated from data indexed in the Web of Science Core Collection. It should be used with careful attention to the many factors that influence citation rates, such as the volume of publication and citations characteristics of the subject area and type of journal. The Journal Impact Factor can complement expert opinion and informed peer review. In the case of academic evaluation for tenure, it is inappropriate to use a journal-level metric as a proxy measure for individual researchers, institutions, or articles.

1.057

2020 Journal Impact Factor



PSICOTHEMA

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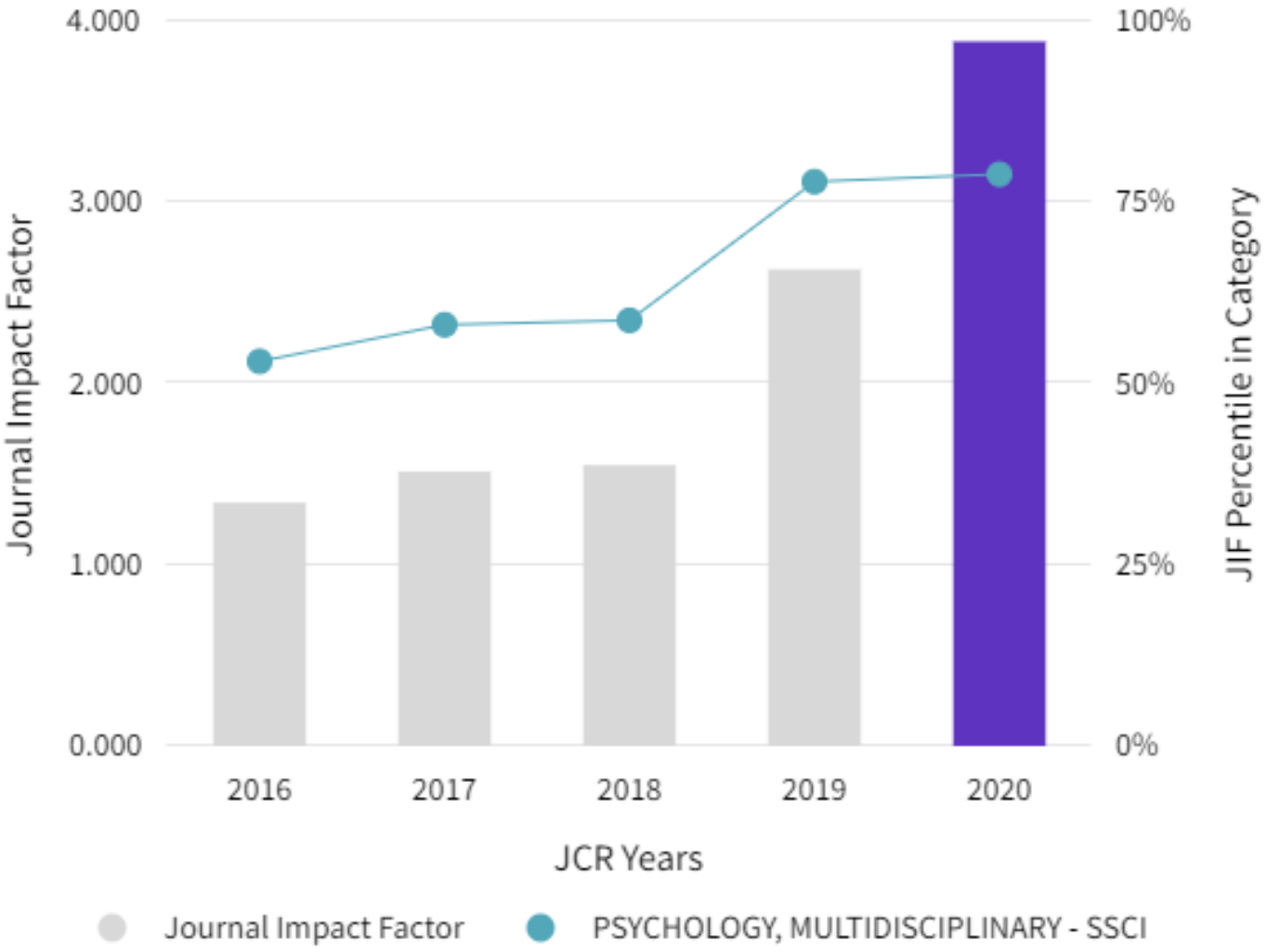
3.890

2020 Journal Impact Factor



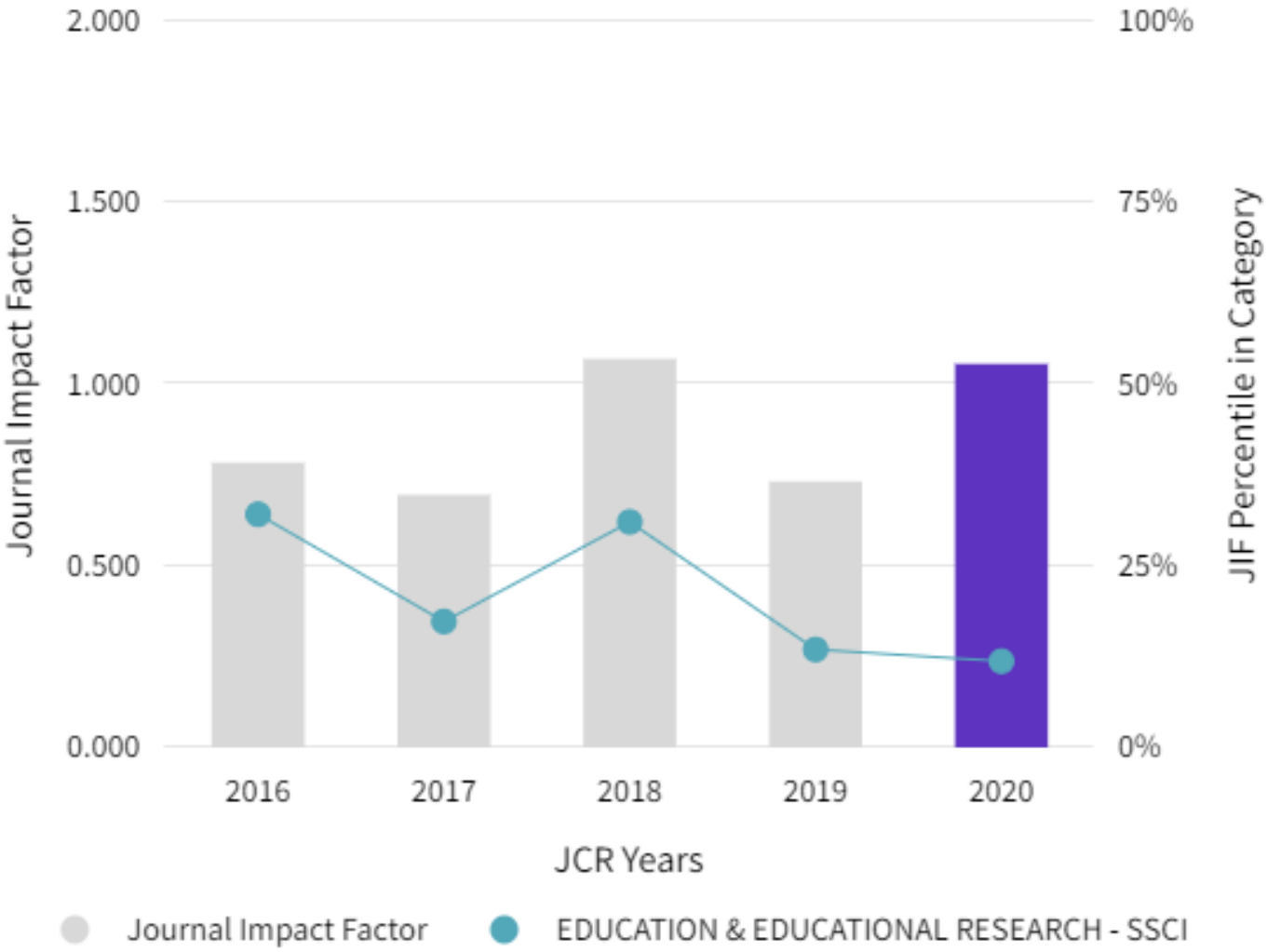
Asia Pacific Journal of Education

2020 JOURNAL IMPACT FACTOR & PERCENTILE RANK IN CATEGORY

The Journal Impact Factor (JIF) is a journal-level metric calculated from data indexed in the Web of Science Core Collection. It should be used with careful attention to the many factors that influence citation rates, such as the volume of publication and citations characteristics of the subject area and type of journal. The Journal Impact Factor can complement expert opinion and informed peer review. In the case of academic evaluation for tenure, it is inappropriate to use a journal-level metric as a proxy measure for individual researchers, institutions, or articles.

1.057

2020 Journal Impact Factor



PLoS One

2020 JOURNAL IMPACT FACTOR & PERCENTILE RANK IN CATEGORY

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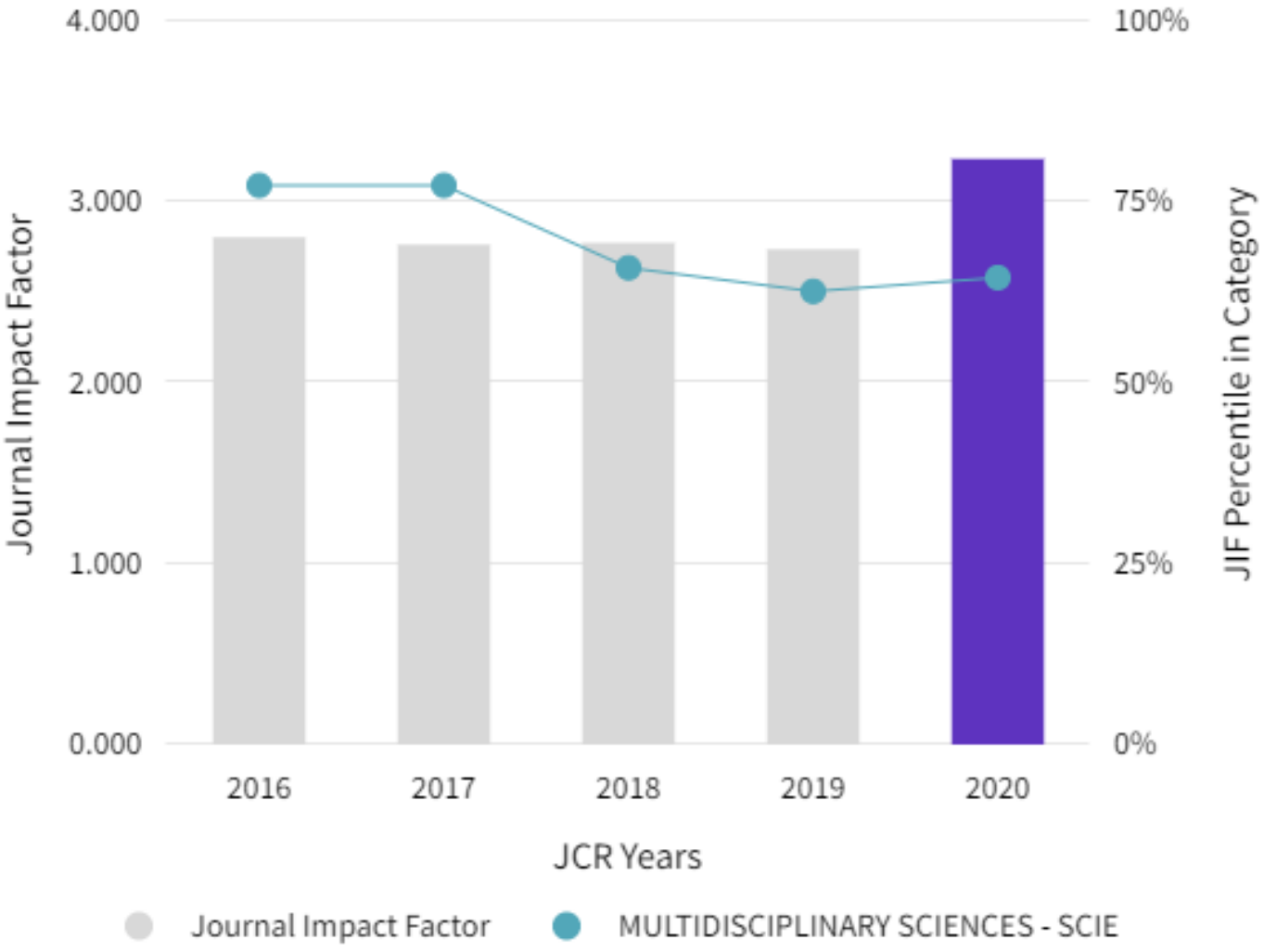
3.240

2020 Journal Impact Factor



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INFORME PARA LA PRESENTACIÓN DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

Año Académico: 2021/2022

1.- Datos personales del autor de la Tesis		
Apellidos: García Crespo	Nombre: Francisco Javier	
DNI/Pasaporte/NIE: 50081695T	Teléfono: 696393118	Correo electrónico: uo273985@uniovi.es

2.- Datos académicos	
Programa de Doctorado cursado: Psicología y Educación	
Órgano responsable: Universidad de Oviedo (Centro Internacional de Posgrado)	
Departamento en el que presenta la Tesis Doctoral: Ciencias de la Educación	
Título definitivo de la Tesis	
Español: Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS y PISA	Inglés: Academic Resilience in the PIRLS, TIMSS and PISA International Assessments
Rama de conocimiento: Ciencias Sociales	

3.- Director/es de la Tesis	
D: Rubén Fernández Alonso	DNI/Pasaporte/NIE: 32873889N
Departamento: Ciencias de la Educación	
D: José Muñiz Fernández	DNI/Pasaporte/NIE: 10529899Q
Departamento/Instituto/Institución: Psicología/Universidad de Nebrija	

4.- Informe
La resiliencia educativa es una habilidad que se está mostrando de gran interés en el entorno investigador. Las referencias más actuales se encuentran en mayor medida en las publicaciones en revistas de divulgación científica, pues se analiza la misma desde muy distintas vertientes. Con esta Tesis Doctoral se pretende profundizar en algunas de esas líneas de trabajo, motivo por el cual se considera conveniente la presentación como compendio de publicaciones. El doctorando D. Francisco Javier García Crespo ha sido responsable principal de los procesos de revisión bibliográfica, investigación, análisis de las bases de datos y redacción de las publicaciones presentadas en esta Tesis Doctoral, se ha mostrado autónomo y ha cumplido con los plazos que se le marcaron desde la dirección de la Tesis.

Madrid, 23 de noviembre de 2021

Director/es de la Tesis Doctoral

Rubén Fernández Alonso

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García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. Revista de Educación, 384, 65-89. doi:10.4438/1988-592X-RE-2019-384-413

ACEPTACIÓN:

Acepto que las publicaciones anteriores formen parte de la tesis doctoral titulada

Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS Y PISA

Y elaborada por D. Francisco Javier García Crespo

Murcia, 23/11/2021

Firma

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ACEPTACIÓN COAUTORES PRESENTACIÓN TRABAJOS FORMANDO PARTE DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

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García-Crespo, F. J., Suárez-Álvarez, J., & Fernández-Alonso, R. (2022). Resiliencia Académica en Matemáticas y Ciencias: Datos de Europa TIMSS-2019 [Academic Resilience in Mathematics and Science: Europe TIMSS-2019 Data]. Psicothema.

ACEPTACIÓN:

Acepto que las publicaciones anteriores formen parte de la tesis doctoral titulada

Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS Y PISA

Y elaborada por D. **Francisco Javier García Crespo**

Madrid, 23/11/2021

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ACEPTACIÓN COAUTORES PRESENTACIÓN TRABAJOS FORMANDO PARTE DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

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2.- Publicaciones que formarán parte de la tesis y de las que es coautor

Clavel, J. G., García-Crespo, F. J., & Sanz San Miguel, L. (2021). Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts? Asia Pacific Journal of. doi:10.1080/02188791.2021.1886905

ACEPTACIÓN:

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Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS Y PISA

Y elaborada por D. **Francisco Javier García Crespo**

Madrid, 23/11/2021

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ACEPTACIÓN COAUTORES PRESENTACIÓN TRABAJOS FORMANDO PARTE DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

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2.- Publicaciones que formarán parte de la tesis y de las que es coautor

García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019b). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. Revista de Educación, 384, 65-89. doi:10.4438/1988-592X-RE-2019-384-413

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2019a). Resilient and low performer students: Personal and family determinants in European countries. Psicothema, 31(4), 363-375. doi:10.7334/psicothema2019.245

García-Crespo, F. J., Fernández-Alonso, R., & Muñiz, J. (2021). Academic resilience in European countries: The role of teachers, families, and student profiles. PLoS ONE, 16(7)

ACEPTACIÓN:

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Resiliencia Académica en las Evaluaciones Internacionales PIRLS, TIMSS Y PISA

Y elaborada por D. Francisco Javier García Crespo

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Oviedo, 23/11/2021

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ACEPTACIÓN COAUTORES PRESENTACIÓN TRABAJOS FORMANDO PARTE DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

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2.- Publicaciones que formarán parte de la tesis y de las que es coautor

Clavel, J. G., García-Crespo, F. J., & Sanz San Miguel, L. (2021). Rising above their circumstances: what makes some disadvantaged East and South-East Asian students perform far better in science than their background predicts? Asia Pacific Journal of. doi:10.1080/02188791.2021.1886905

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Y elaborada por D. **Francisco Javier García Crespo**

Madrid, 23/11/2021

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University of Oviedo

ACEPTACIÓN COAUTORES PRESENTACIÓN TRABAJOS FORMANDO PARTE DE TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

1.- Datos personales del coautor		
Apellidos: Fernández Alonso	Nombre: Rubén	
DNI/Pasaporte/NIE 32873889N	Teléfono 665013630	Correo electrónico fernandezaruben@uniovi.es

2.- Publicaciones que formarán parte de la tesis y de las que es coautor

García-Crespo, F. J., Galián, B., Fernández-Alonso, R., & Muñiz, J. (2019b). Educational resilience in reading comprehension: Deteminant factors in PIRLS-Europe. Revista de Educación, 384, 65-89. doi:10.4438/1988-592X-RE-2019-384-413

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Firma

Oviedo, 23/11/2021

Rubén Fernández Alonso

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