Longitudinal Study of Socioeconomic Segregation Between Schools in the UK

Estudio Longitudinal de la Segregación Escolar por Nivel Socioeconómico en Reino Unido

Cynthia Martínez-Garrido [1]
Nadia Siddiqui [2]
Stephen Gorard [2]

[1] Universidad Autónoma de Madrid, Spain
[2] Durham University, United Kingdom

The aim of this study is to understand the behavior of school segregation by socioeconomic level in the UK. To do this, all data from the United Kingdom are analyzed in the PISA Assessment from 2000 to 2015 and the Gorard index, Dissimilarity index, and the Isolation index are estimated. The analysis has shown that socio-economic segregation between schools has declined somewhat in the UK from 2000 to 2015, although the clustering of the 25% poorest of students remained relatively static since 2006. England remains more highly segregated by poverty than Wales, Scotland and Northern Ireland. The segregation levels of the 10% poorest student has declined in state-maintained schools but shown a sharp increase in private schools. The level of isolation of disadvantaged students is less in state-maintained schools than private schools. The findings show that poverty segregation trends using PISA data match with segregation trends previously analysed using the national datasets using only state-maintained schools for England. This finding leads to research implications for a detailed analysis of national school segregation trends, including student data from private school.

Keywords: Socioeconomic segregation between schools; PISA; UK home countries; Clustering by poverty; Equality of opportunity.

El objetivo de este estudio es comprender el comportamiento de la segregación escolar por nivel socioeconómico. Para ello se analizan todos los datos del Reino Unido en la Evaluación PISA desde el año 2000 a 2015 y se estima el índice de Gorard, el índice de Disimilitud y el índice de Aislamiento. El análisis realizado ha demostrado que la segregación entre las escuelas ha disminuido entre 2000 y 2015, y que la segregación del 25% de los estudiantes más pobres se ha mantenido relativamente estática en el Reino Unido desde el año 2006. Las escuelas de Inglaterra están muy segregadas en comparación con Gales, Escocia e Irlanda del Norte. Los niveles de segregación del 10% de estudiantes más pobres han disminuido en las escuelas públicas, mientras hay un fuerte aumento en las privadas. El nivel de aislamiento de los estudiantes desfavorecidos es menor en las escuelas públicas que privadas. Los resultados han demostrado que la tendencia de la segregación escolar por nivel socioeconómico utilizando los datos PISA es coherente con la tendencia de segregación analizada utilizando datos nacionales de las escuelas públicas. Este hallazgo conlleva implicaciones de investigación para un análisis detallado de las tendencias nacionales de segregación escolar, incluidos los datos de estudiantes de escuelas privadas.

Palabras clave: Segregación por nivel socioeconómico entre escuelas; PISA; Países del Reino Unido; Agrupación por nivel socioeconómico; Igualdad de oportunidades.

1. Introduction

1.1. The home countries of the UK

The four home countries of the United Kingdom are England, Scotland, Wales and Northern Ireland. Since 1975, education has gradually devolved to be controlled by separate home country governments. Many of the salient features of the education systems are common, such as no tuition cost in state-maintained schools, free lunch provision for some students, and full-time compulsory education for all children until at least the age of 16. All schools are organized into year groups, so children of the same age are taught together. The state-funded school system aims to equalise the learning and development opportunities for all children, independent of factors such as gender, ethnicity, family socioeconomic status, and place of residence. Equality is the fundamental promise of the state-funded education system, and in order to achieve this promise each home country adopts education policies depending on the demography, nature of challenges and available resources.

The UK education systems diverge at various points making state-maintained schooling somewhat diverse across the four countries. But in most areas, school years are then grouped together in larger stages or phases, usually with different curriculum requirements and outcomes for each. Each country of the UK has its own curriculum. Although much of the content is similar, there are structural and pedagogical differences in the delivery of the contents. At primary level, in England and Northern Ireland, the National Curriculum applies to children in Key Stages 1 and 2. In Wales, schools follow the National Literacy and Numeracy Framework (NLF), which emphasises applying literacy and numeracy across the whole curriculum. On the other hand, the Curriculum for Excellence in Scotland includes subjects like expressive arts or health and wellbeing

Wales has a language policy of Welsh as a medium of instruction for some and compulsory Welsh language learning for the rest, in all state-maintained schools. England and Northern Ireland have state-maintained Grammar schools which select pupils on the basis of their performance at age 11. State-maintained schools in Northern Ireland are also separated on the basis of catholic or protestant religious education. Disparities across the four countries are largely related to historical changes and geo-political reforms which lead to considerable independency of the education systems. However, none of these countries have overcome the challenge of segregation by poverty in schools, establishing a state-governed system where rich and poor have equal access and opportunity of education. Recently some policy initiatives have been adopted to equalise the learning outcomes such as additional funding allocation to schools depending on the intake of children from disadvantaged families (Gorard, Siddiqui, & See, 2019). However, more evidence is required to judge if school segregation by poverty has changed as a result.

In all four UK countries, the state-maintained systems run in parallel with private fee-paying school systems. There are nearly 2,500 independent schools in the UK. These schools do not have to follow the national curriculum and the student admission policy does not have to be aligned with the state sector. This means there is selection of students on criteria such as academic ability, socioeconomic status or parental religious affiliation. The proportion of independent schools is not balanced across all four home countries. England has the highest number of independent schools (1,289) where 7.2% of the total student population in England receive private education. In Wales, less than 2% of the

Welsh student population receive private education, with around 4% in Scotland, and 2% in Northern Ireland.

1.2. What is school segregation?

According to Gorard (2000), segregation between schools is defined as the proportion of students who would have to change schools for there to be an even spread of disadvantage between schools within the area of analysis. Segregation by poverty is one of several different kinds of disadvantage used for assessing school segregation (ethnicity, religion, sex, prior performance) that can put equality of opportunity to education at risk (Murillo & Martínez-Garrido, 2018a; Taylor & Gorard, 2003). There is research evidence that shows clustering children with similar background characteristics in schools isolates them from a wider society, and this stratification is most harmful for those children who are disadvantaged (Bartholo & Da Costa, 2014; Billings, Deming, & Ross, 2016; Harris & Williams, 2012; Siddiqui, 2017; Strand & Winston, 2008). Equality of access to resources and opportunities in schools is still an issue hindered by socioeconomic segregation, which no policy so far has fully addressed.

Studies using high quality population data sets have found that school types are associated with the clustering of children on the basis of socioeconomic group, sex, language, religion and ethnicity (Gorard, 2015; Gorard et al., 2006). Where schools are given power to select students their intakes tend to be unbalanced, possibly dominated by certain other unobservable characteristics (Morris, 2015; Norwich & Black, 2015). Clustering by poverty as a common variable but can also be a proxy for associated characteristics such as ethnic group or religion, caste or tribe, less educated parents, siblings involved in labour, or even history of crime or drug abuse. Segregation on the basis of a targeted characteristic can also become a contentious issue, where for example schools supporting a religious minority would group children on the basis of their parents' religion but the scope of such education is highly contentious in a secular society (Borooah & Knox, 2015; Oldfield, Hartnett, & Bailey, 2013).

The results from international research has shown that the average of school segregation by poverty in UK is below the average of other EU countries. For example, Murillo and Martínez-Garrido (2018b) estimate the magnitude of school segregation by poverty in the 27 of the 28 countries that participate in PISA 2015 (Cyprus did not participate). The authors use the Gorard Segregation index and the Isolation index to estimate school segregation. Their results show that the average of school segregation by poverty between the different countries of the EU is 0.35 (using Gorard index) and 0.31 (using Isolation index). That means that in the EU average, 35% of poor students should change the schools to equalise the schools in terms of socioeconomic clustering of children. In the UK, those estimates are 0.33 (using Gorard index) and 0.29 (using Isolation index). According to the authors, the situation of school segregation by poverty in the UK is similar to the level of school segregation in countries like Luxemburg (0.34), Netherlands (0.33), Denmark (0.32).

There could be several underlying factors creating segregation at school level, such as independent school policy, geographical limitations, housing and residential schemes, school allocation policy, and parental choice. There is no experimental evidence of the causal nature of such clustering and its long-term impact. However, secondary data analyses on large population data sets and longitudinal studies have shown that school level segregation on the basis of disadvantaged characteristics is one of the determinants

of low academic attainment (Condron, 2011, 2013; Gorard, 2015; Knowles & Evans, 2012) and therefore of access to university education (Boliver, 2011; Cavalcanti, Guimaraes, & Sampaio, 2010).

1.3. PISA

International student assessments can be a useful addition to the evidence relevant to segregation studies and a range of other issues. The methodology, the validity and sampling techniques are all carefully constructed. The Program for International Student Assessment (PISA) is an example of these international student assessments among other like Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy (PIRLS). PISA is a near-worldwide study by the Organization for Economic Co-operation and Development (OECD) in member and non-member nations of 15-year-old school pupils' scholastic performance on Mathematics, Science, and Reading. It was first conducted in 2000, and then repeated every three years.

The UK has participated in PISA since the first version in 2000 generating a large amount of data from the UK over 15 years. The data includes of students' academic performance in literacy, numeracy, science and contextual information collected from schools, teachers and parents. The data therefore allows for the analysis of school segregation in the UK, as well as how political, economic and social changes over the last 15 years reflect any changes in patterns of school segregation by poverty. The unit of sampling in PISA is the school, and both private and state schools are included in the study. It is worth mentioning that the data from private schools are not included in the national school census and therefore the analysis based on national figures do not allow comparison between private and state schools in the UK. PISA, almost uniquely, permits such a comparison.

2. Method

The aim of this study in to understand the behavior of school segregation by socioeconomic level in the UK across the time. For this new study, we used the data PISA datasets, generated between 2000 and 2015. In each cycle of PISA, representative samples of all school types were invited to take part in student assessments and questionnaires from teachers, families and students. PISA assesses the extent to which 15-year-old students have acquired key knowledge and skills in three fundamental areas: mathematics, language and science. Additional information is also obtained on factors associated with learning that allows contextualising the academic performance of students.

1.1. Sample

The number of students assessed in PISA has increased from 2000 to 2015. To achieve the aim of this research, it is necessary that there be no missing data, so in those cases in which there was no information on the socioeconomic status of the families, they were directly eliminated. In 2003 more than a quarter of a million students took part, representing 15-year-olds enrolled in the schools of 41 participating countries. In 2015, approximately 540,000 students completed the assessment, from 72 participating countries and economies. In the UK, 9,535 students from 381 schools were assessed in PISA 2003 and, 141,57 students from 2,200 schools in PISA 2015 (table 1).

Table 1. The number of cases in each year and home country, PISA 2000-2015

	2000	**2003**	**2006**	**2009**	**2012**	**2015**
England	2,292					5,194
Wales	-	6,812	10,708	9,548	9,714	3,451
Northern Ireland	1,586					2,410
Scotland	1,317	2,723	2,444	2,631	2.945	3,111
UK	5,195	9.535	13,152	12,179	12,659	14,517
Total number of schools	362	381	502	482	507	550
Percentage state-funded schools	95.2	94.1	95.0	96.1	80.4	91.2

Note: - Wales did not participate in PISA 2000. The data from England, Northern Ireland and Wales is reported together 2003-2012.
Source: Computed by the authors.

1.2. Coding

For analyses of the school segregation of disadvantaged students, we created a sub-group of 10% and 25% of the students with the lowest socioeconomic level of their families. Both analyses show the patterns of segregation of most disadvantaged students in state and private school type and whether the trends have changed over time.

The level of socioeconomic disadvantage has been judged according to ESCS-index of Economic, Social and Cultural Status, provided by PISA international evaluation. ESCS is 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. The ESCS variable is typified for each country.

1.3. Analysis

School Segregation has been analyzed using the Gorard Segregation index (GS) (Gorard & Fitz, 1998, 2000a, 2000b), and the Dissimilarity index (D), one of the oldest estimators of segregation (Duncan & Duncan, 1955). GS is defined as the proportion of disadvantaged students who would have to change schools for there to be an even spread of disadvantage between schools within the area of analysis. D is defined as the percentage of all students who would have to change schools so that there was no segregation between the groups. Although there have been academic disputes about the relative merits of each index, we agree with Gorard (2007) that both are measuring the same thing, and that under normal circumstances they both provide the same substantive results. We use both here for assurance.

To measure the exposure dimension of school segregation we used the isolation index (Lieberson, 1981), considered as the best for the purpose by Massey and Denton (1988). It is interpreted as the probability that a student from a minority group will be at school with another student from the same minority group. The greater the isolation of the group, the lower its exposure to the members of the other groups (Echenique & Fryer, 2007).

More precisely the formulae of segregation indexes are:

Gorard Segregation index:

$$GS = \frac{1}{2}\sum_{i=1}^{k}\left|\frac{x_{1i}}{X_1} - \frac{T_i}{T}\right|$$

Dissimilarity index:

$$D = \frac{1}{2}\sum_{i=1}^{k}\left|\frac{x_{1i}}{X_1} - \frac{x_{2i}}{X_2}\right|$$

Isolation index:

$$A = \sum_{i=1}^{k}\frac{x_{1i}}{X_1}\frac{x_{1i}}{T_i}$$

Where:

x_{1i} is the number of students of the minority group in the school i.

x_{2i} is the number of students of the majority group in the school i.

X_1 is the number of students of the minority group in the country.

X_2 is the number of students of the majority group in the country.

T_i is the number of students in the school i.

T is the number of students in the country.

The analysis has been conducted to observe segregation by poverty in both state-funded and private schools. Schools were grouped into the four countries of United Kingdom (England, Scotland, Northern Ireland, and Wales). The analysis of segregation by poverty was based on the proportion of richer and poorer children in each school. We conducted the analyses weighting each dataset through the variable weight supplied by PISA. The schools were then sorted in public and private school types and for each category GS, D and A indexes were calculated.

The analysis is presented in three sections. First, the estimation of segregation indexes for the 25% of students with the lowest socioeconomic level, looking at differences between home countries and between state-funded and private schools. Second, the same for the 10% lowest SES students. Finally, a study in more detail of the school segregation in 2015 for 25% and 10% of poorest students in the UK and each of its countries.

3. Results

3.1. How do the indices compare?

There is a vast amount of scientific literature on the use of one index or another to measure the evenness dimension of segregation. Specifically, Gorard & Taylor (2002) have come to speak of a "war of indices". The pioneer index has been the dissimilarity index developed by Duncan & Duncan (1955), more recent is the Gorard Segregation index (Gorard, 2000). Table 2 shows the correlation between both indices, in a way that shows how the use of one or the other is indifferent in terms of its results.

In fact, these correlations show yet again that GS and D are measuring the same thing, and their correlation is 1, whether looking at the segregation of the poorest 25% or the poorest 10% of students. This means that the results for GS and D are generally

interchangeable. This has been shown many times, and we hope that this puts an end to prior claims that D was somehow superior to GS (Gorard, 2007). The A index, as it is designed to, is measuring something different to either GS or D. So, it has a lower correlation with both of them.

Table 2. Correlations between the different school segregation residuals, UK, PISA 2015

	GS INDEX 25%	D INDEX 25%	A INDEX 25%	GS INDEX 10%	D INDEX 10%	A INDEX 10%
GS Index 25%	1	1.00	0.71	0.78	0.78	0.55
D Index 25%	1.00	1	0.71	0.78	0.78	0.55
A Index 25%	0.71	0.71	1	0.62	0.62	0.80
GS Index 10%	0.78	0.78	0.62	1	1.00	0.73
D Index 10%	0.78	0.78	0.62	1.00	1	0.73
A Index 10%	0.55	0.55	0.80	0.73	0.73	1

Note: Computed by the authors.

3.2. Segregation indexes for UK schools

More substantively, all three indices show that the segregation between schools of the poorest 25% of students has remained relatively static in the UK since 2006 (table 3). There was an apparent decrease in segregation from 2000 to 2003 that may be part of the bigger national picture or could be due to the sampling and methodology of PISA settling down at that early stage. Wales has relatively low segregation as far as it is possible to tell (Gorard et al., 2006), and did not take part in 2000 PISA. So, the drop could be partly due to the addition of figures for Wales in 2003.

Table 3. Segregation 2000-2015, lowest 25% SES, all schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.29	0.25	0.27	0.27	0.27	0.26
Dissimilarity Index	0.38	0.33	0.36	0.37	0.36	0.35
Isolation Index	0.37	0.35	0.37	0.36	0.36	0.35

Note: Computed by the authors.

The same pattern appears when considering only the majority (94%) state-funded schools in the UK (table 4). Here though the levels of segregation are slightly lower, and correspondingly much higher for the small proportion of private schools (table 5). For private schools the Isolation index diverges from the other two indices because there are so few poor students in the private schools anyway, however they are clustered between private schools. In general, either private schools have become less segregated (from each other) in terms of poverty, or the private schools entering PISA have become more representative.

Table 4. Segregation 2000-2015, lowest 25% SES, state-funded schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.26	0.23	0.25	0.26	0.23	0.25
Dissimilarity Index	0.35	0.32	0.33	0.35	0.32	0.34
Isolation Index	0.37	0.35	0.36	0.36	0.37	0.35

Note: Computed by the authors.

Table 5. Segregation 2000-2015, lowest 25% SES, private schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.78	0.50	0.56	0.49	0.31	0.48
Dissimilarity Index	0.80	0.62	0.59	0.51	0.39	0.52
Isolation Index	0.13	0.09	0.20	0.06	0.33	0.21

Note: Computed by the authors.

The pattern is slightly different for the 10% poorest students in the UK. Segregation between schools for this group has declined somewhat from 2000 to 2015 in terms of GS and D measures of evenness (tables 6 to 8). For 2012 and 2000 data relating to some private schools was not recorded. There will be even fewer of the 10% poorest students in private schools (than 25% poorest), and so they would "meet" very rarely.

Table 6. Segregation 2000-2015, lowest 10% SES, all schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.40	0.34	0.38	0.40	0.37	0.35
Dissimilarity Index	0.46	0.38	0.42	0.44	0.41	0.39
Isolation Index	0.24	0.18	0.20	0.20	0.19	0.17

Note: Computed by the authors.

Table 7. Segregation 2000-2015, lowest 10% SES, state-funded schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.37	0.32	0.36	0.38	0.33	0.34
Dissimilarity Index	0.41	0.36	0.41	0.43	0.38	0.38
Isolation Index	0.24	0.18	0.20	0.20	0.20	0.17

Note: Computed by the authors.

Table 8. Segregation 2000-2015, lowest 10% SES, private schools, UK

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.75	0.80	0.79	0.42	0.78
Dissimilarity Index	-	0.76	0.80	0.80	0.46	0.79
Isolation Index	-	0.05	0.04	0.04	0.16	0.05

Note: Computed by the authors.

3.3. Segregation in each UK home country

There are no separate figures for Wales until later cycles of PISA, and for some years the results for England, Northern Ireland and Wales were reported together. These results are shown in the Appendix, along with those of Scotland. In general, the pattern of change for each home country is similar.

Table 9 compares the segregation in each home country in 2015. It shows that segregation in Scotland is markedly lower than the UK average, for both state and private sectors. The same is true for Wales to a lesser extent. The picture, overall and for state schools, is very similar in England and Northern Ireland. However, private schools in Northern Ireland are even less segregated than those in Scotland (but not Wales).

Table 9. Segregation GS index, 2015, England, Scotland, and Northern Ireland

	ENGLAND	SCOTLAND	WALES	NORTHERN IRELAND	UK
All schools 25%	0.27	0.22	0.21	0.27	0.26
All schools 10%	0.37	0.29	0.32	0.35	0.35
State schools 25%	0.26	0.20	0.21	0.27	0.25
State schools 10%	0.35	0.28	0.33	0.35	0.34
Private schools 25%	0.50	0.33	0.20	0.25	0.48
Private schools 10%	0.82	0.57	-	0.39	0.78

Note: Wales had no students in private schools among the lowest 10% SES. Computed by the authors.

The apparent level of school segregation has dropped from 2000 to 2015 in all three home countries for which there are figures. Using the GS index for the 25% lowest SES students, in England it dropped from 0.31 in 2000 to 0.27 in 2015 (table A7), and from 0.44 to 0.37 for the 10% lowest SES (table A10). This is similar to the fuller figures reported for England for all state schools, based on official figures of pupils eligible for free school meals. These were 0.33 in 2000, and 0.29 in 2015 (Gorard, Siddiqui, & See, 2019). This comparison suggests that at least some the changes and differences in the smaller sampled PISA figures are valid estimates of alterations in segregation. In NI, segregation dropped from 0.29 to 0.27 for the 25% lowest SES students, and from 0.45 to 0.35 for the 10% lowest SES students. The equivalent figures for Scotland were 0.26 to 0.22, and 0.41 to 0.29.

Figure 2 presents another way of visualizing the segregation between schools in each home country, using the GS segregation residual for each school, the equivalent figures for D residuals appear in the Appendix. Both indices can be examined in a similar way, however, it is important to remember the special property of GS index, of remaining unchanged in the face of changes in the composition of the minority group. Each graph shows a V shape, with the point at 25% on the x axis where schools have exactly their fair share of the 25% most disadvantaged students, and at 0 on the Y axis since these schools add nothing to the overall segregation figure.

Each of the bubbles represented in the graphs shows the value of the residual of school segregation for each student. As can be seen, Northern Ireland has a smaller sample, followed by Scotland, Wales, and England. The four countries have a similar magnitude of school segregation showing a V shape comparable in terms of its amplitude, the difference between the country with the higher school segregation (England), and the one with the least (Wales) is 6%. However, the true difference is explained through the narrowness of the figure. The narrower the form defined by the residuals of school segregation will mean that the ratio of segregation in the schools of that country is higher and therefore it is urgent to make decisions and political measures that help alleviate it.

According to the graphs, it seems to indicate that school segregation by poverty in Northern Ireland is the highest with a narrower V-shape with higher values of school segregation ratio in comparison to the other three countries.
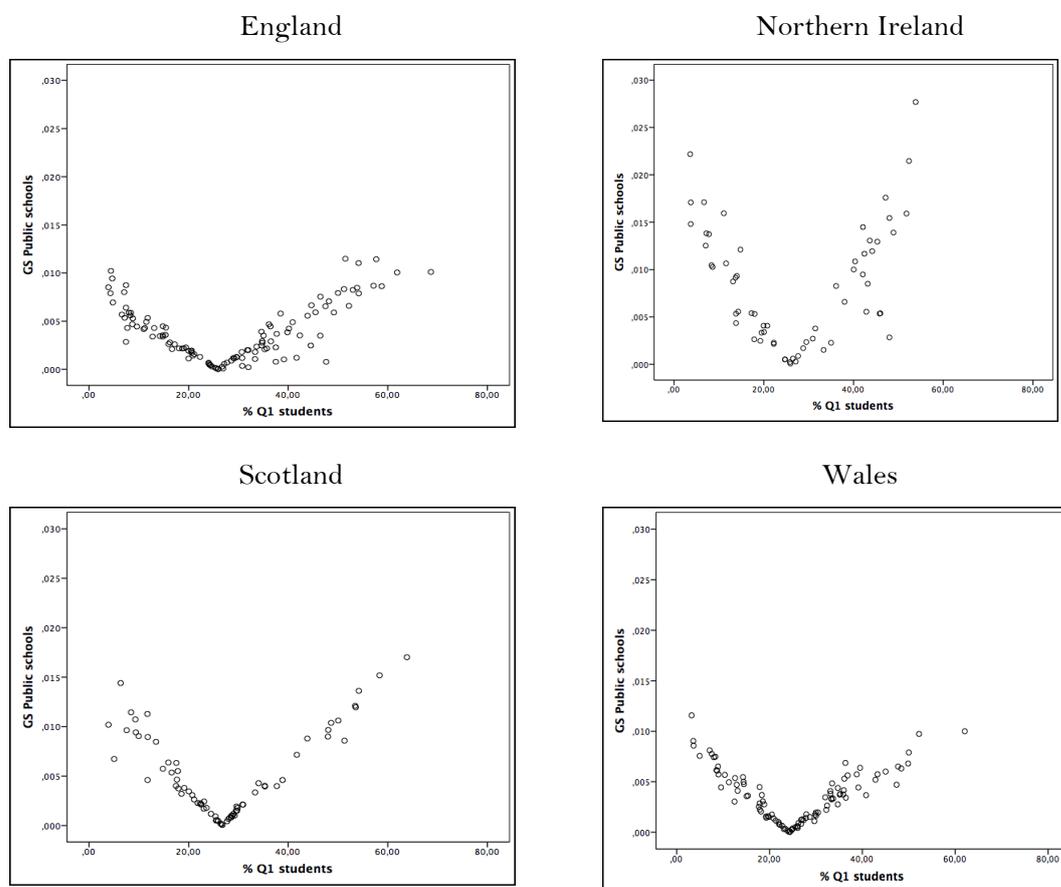
England   Northern Ireland

Scotland   Wales

Figure 2. Crossplots GS segregation residuals with % of 25% most disadvantaged students, home countries, 2015
Note: Computed by the authors.

4. Discussion

Our results highlight a similar pattern of school segregation by poverty between England, Scotland, and Wales. The levels of school segregation in all three cases have decreased over the 15 years studied. Specifically, England is the country where it has declined the most, from 0.31 in the year 2000 to 0.27 in the year 2015, measured with the GS index. On the other hand, school segregation in Northern Ireland seems to show different trends. Although segregation in Northern Ireland is less than 15 years ago, it has a very similar value (0.27 to 0.28). Previous research shows that school segregation changes over time relative to the particular economic and social characteristics of the country (Cheng & Gorard, 2010; Croxford & Raffe, 2013). In Northern Ireland, the continued existence of selection to schools by academic ability at age 11, and parental choice of faith schools for their children will tend to fix segregation and prevent further equality of access and exposure. Both religion and attainment at age 11 are linked to relative economic advantage, at an aggregated level.

Our results have implications for the UK Departments of education and for other researchers in future studies to continue exploring las implications of our findings for future research aiming to continue using PISA data to compare different countries. Our findings have shown that the private sector in the UK segregates students according to their level of poverty. Private schools have higher segregation than state schools and this has increased segregation by 17% in 3 years (from 31% in 2012 to 48% in 2015), while the situation in state-funded schools has diverged from this. This needs further investigation with recommendations that segregation analyses must include data from independent schools, where possible. Most studies on poverty segregation in England exclude independent schools considering that the independent school student intake is consistently 7% which does not contribute to the overall spread of poverty in schools, and because the National Pupil Database has only partial data on private schools. This ought to change.

Although each year of the PISA assessment the four countries have been expanding their sample, which undoubtedly improves the reliability of the data. However, it must continue to be recognized that little data remains available. The ideal would be to have data from the entire population and this is undoubtedly one of the limitations of using the PISA database. Other limitation for the figures of the segregation index is that the data from England, Northern Ireland and Wales is reported together 2003-2012. Also, the PISA dataset does not provide information that allows us to know more about the characteristics of these private schools in order to explain why segregation seems to have increased over time, geographical location of schools and type of school (faith school, grammar school, and so on). It would be interesting if the UK government would allow researchers to have access to know which schools participated in the PISA study. This would enable researchers to use information from the National Pupil Database which contain a more detailed information on each of the schools. The combination of both databases would give us the opportunity to develop quality empirical research that can clarify the drivers of segregation in each country and sector.

References

Bartholo, T. & Costa, M. (2014). Turnos e segregação escolar: Discutindo as desigualdades intraescolares. *Cadernos de Pesquisa, 44*(153), 670-692. https://doi.org/10.1590/198053142771

Billings, S., Deming, D., & Ross, S. (2016). *Returns to education: The causal effects of education on earnings, health and smoking*. Economics Research Center-University of Chicago.

Boliver, V. (2011). Expansion, differentiation, and the persistence of social class inequalities in British higher education. *Higher Education, 61*(3), 229-242. https://doi.org/10.1007/s10734-010-9374-y

Borooah, V. & Knox, C. (2015). Segregation, inequality, and educational performance in Northern Ireland: Problems and solutions. *International Journal of Educational Development, 40,* 196-206. https://doi.org/10.1016/j.ijedudev.2014.09.002

Cavalcanti, T., Guimaraes, J., & Sampaio, B. (2010). Barriers to skill acquisition in Brazil: Public and private school student's performance in a public university entrance exam. *The Quarterly Review of Economics and Finance,50*(4), 395-407. https://doi.org/10.1016/j.qref.2010.08.001

Cheng, S. C. & Gorard, S. (2010). Segregation by poverty in secondary schools in England 2006–2009: A research note. *Journal of Education Policy, 25*(3), 415-418. https://doi.org/10.1080/02680931003699542

Condron, D. (2011). Egalitarianism and educational excellence compatible goals for affluent societies? *Educational Researcher, 40*, 47-55. https://doi.org/10.3102/0013189X11401021

Condron, D. J. (2013). Affluence, inequality, and educational achievement: A structural analysis of 97 jurisdictions across the globe. *Sociological Spectrum, 33*(1), 73-97. https://doi.org/10.1080/02732173.2013.732866

Croxford, L. & Raffe, D. (2013). Differentiation and social segregation of UK higher education, 1996-2010. *Oxford Review of Education, 39*(2), 172-192. https://doi.org/10.1080/03054985.2013.784193

Duncan, O. & Duncan, B. (1955). A methodological analysis of segregation indexes. *American Sociological Review, 20*, 210-217. https://doi.org/10.2307/2088328

Echenique, F. & Fryer, J. (2007). A measure of segregation based on social interactions. *The Quarterly Journal of Economics, CXXII*(2), 441-485. https://doi.org/10.1162/qjec.122.2.441

Gorard, S. (2000). Underachievement is still an ugly word: Reconsidering the relative effectiveness of schools in England and Wales. *Journal of Education Policy, 15*(5), 559-573. https://doi.org/10.1080/026809300750001694

Gorard, S. (2007). What *does* an index of school segregation measure? A commentary on Allen and Vignoles, *Oxford Review of Education, 33*, 5, 669-677. https://doi.org/10.1080/03054980701451140

Gorard, S. (2015). The complex determinants of school intake characteristics, England 1989 to 2014, *Cambridge Journal of Education, 46*, 1, 131-146. https://doi.org/10.1080/0142569980190306

Gorard, S. & Fitz, J. (1998). The more things change... The missing impact of marketisation? *British Journal of Sociology of Education, 19*(3), 365-376. https://doi.org/10.1080/026715200402452

Gorard, S. & Fitz, J. (2000a). Investigating the determinants of segregation between schools. *Research Papers in Education, 15*(2), 115-132. https://doi.org/10.1177/0895904800014003004

Gorard, S. & Fitz, J. (2000b). Markets and stratification: A view from England and Wales. *Educational Policy,14*(3), 405-428. https://doi.org/10.1177/0895904800014003004

Gorard, S., Smith, E., May, H., Thomas, L., Adnett, N., & Slack, K. (2006). *Review of widening participation research: Addressing the barriers to participation in higher education.* https://vtechworks.lib.vt.edu/bitstream/handle/10919/97805/BarriersHigEducEngland.pdf?sequence=1

Gorard, S., Siddiqui, N., & See, B. H. (2019). The difficulties of judging what difference the pupil premium has made to school intakes and outcomes in England. *Research Papers in Education,* https://doi.org/10.1080/02671522.2019.1677759

Harris, D. & Williams, J. (2012). The Association of classroom interactions, year group and social class. *British Educational Research Journal, 38*(3), 373-397. https://doi.org/10.1080/01411926.2010.548547

Knowles, E. & Evans, H. (2012). *PISA 2009: How does the social attainment gap in England compare with countries internationally?*

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/198957/DFE-RB206.pdf

Lieberson, S. (1981). An asymmetrical approach to segregation. In C. Peach (Ed.), *Ethnic segregation in cities* (pp. 61-83). Croom-Helm.

Massey, D. S. & Denton, N. A. (1988). The dimensions of residential segregation. *Social Forces, 67*(2), 281-315. https://doi.org/10.2307/2579183

Morris, R. (2015). Free schools and disadvantaged intakes. *British Educational Research Journal, 41*(4), 535-552. https://doi.org/10.1002/berj.3168

Murillo, F. J. & Martínez-Garrido, C. (2018a). Impact of the economic crisis on school segregation in Spain. *Revista de Educación, 381*, 67-93. https://doi.org/10.4438/1988-592X-RE-2017-381-381

Murillo, F. J. & Martínez-Garrido, C. (2018b). Magnitud de la segregación escolar por nivel socioeconómico en España y sus comunidades autónomas y comparación con los países de la Unión Europea [Magnitude of school segregation by socioeconomic level in Spain and its Autonomous Communities and comparison with the countries of the European Union]. *RASE. Revista de Sociología de la Educación, 11*(1), 37-58. https://doi.org/10.7203/RASE.11.1.10129

Norwich, B. & Black, A. (2015). The placement of secondary school students with statements of special educational needs in the more diversified system of English secondary schooling. *British Journal of Special Education, 42*(2), 128-151. https://doi.org/10.1111/1467-8578.12097

Oldfield, E., Hartnett, L., & Bailey, E. (2013). *More than an educated guess: Assessing the evidence on faith schools.* Theos.

Siddiqui, N. (2017). Socio-economic segregation of disadvantaged children between schools in Pakistan: Comparing the state and private sector. *Educational Studies, 43*(4), 391-409. https://doi.org/10.1080/03055698.2016.1277139

Strand, S. & Winston, J. (2008). Educational aspirations in inner city schools. *Educational Studies 34*(4), 249-267. https://doi.org/10.1080/03055690802034021

Taylor, C. & Gorard, S. (2003). *Secondary school admissions in London.* Institute for Public Policy Research.

Appendix

England

Northern Ireland

Scotland

Wales

Figure A1: D index segregation residuals, UK, PISA 2015
Note: Computed by the authors.

Table A1. England, Wales, NI 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	–	0.26	0.27	0.28	0.27	0.27
Dissimilarity Index	–	0.34	0.36	0.37	0.37	0.36
Isolation Index	–	0.36	0.36	0.36	0.37	0.36

Note: Computed by the authors.

Table A2. England, Wales, NI 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	–	0.24	0.25	0.26	0.24	0.25
Dissimilarity Index	–	0.32	0.33	0.35	0.33	0.34
Isolation Index	–	0.36	0.36	0.36	0.37	0.35

Note: Computed by the authors.

Table A3. England, Wales, NI 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.62	0.56	0.51	0.31	0.48
Dissimilarity Index	-	0.64	0.58	0.52	0.39	0.52
Isolation Index	-	0.09	0.20	0.06	0.34	0.22

Note: Computed by the authors.

Table A4. England, Wales, NI 10% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.35	0.38	0.40	0.37	0.36
Dissimilarity Index	-	0.384	0.42	0.44	0.407	0.40
Isolation Index	-	0.18	0.20	0.20	0.19	0.18

Note: Computed by the authors.

Table A5. England, Wales, NI 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.33	0.37	0.39	0.34	0.35
Dissimilarity Index	-	0.37	0.41	0.43	0.38	0.39
Isolation Index	-	0.18	0.20	0.20	0.20	0.18

Note: Computed by the authors.

Table A6. England, Wales, NI 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.79	0.80	0.79	0.41	0.80
Dissimilarity Index	-	0.80	0.81	0.80	0.45	0.81
Isolation Index	-	0.07	0.04	0.04	0.17	0.04

Note: Computed by the authors.

Table A7. England 25% lowest all schools

	2000	2015
Gorard Segregation Index	0.31	0.27
Dissimilarity Index	0.42	0.36
Isolation Index	0.41	0.36

Note: Computed by the authors.

Table A8. England 25% lowest state schools

	2000	2015
Gorard Segregation Index	0.28	0.26
Dissimilarity Index	0.38	0.35
Isolation Index	0.41	0.36

Note: Computed by the authors.

Table A9. England 25% lowest private schools

	2000	2015
Gorard Segregation Index	0.78	0.50
Dissimilarity Index	0.79	0.54
Isolation Index	0.07	0.22

Table A10. England 10% lowest all schools

	2000	2015
Gorard Segregation Index	0.44	0.37
Dissimilarity Index	0.49	0.41
Isolation Index	0.26	0.18

Note: Computed by the authors.

Table A11. England 10% lowest state schools

	2000	2015
Gorard Segregation Index	0.41	0.35
Dissimilarity Index	0.45	0.39
Isolation Index	0.26	0.18

Note: Computed by the authors.

Table A12. England 10% lowest private schools

	2000	2015
Gorard Segregation Index	0.93	0.82
Dissimilarity Index	0.93	0.82
Isolation Index	0.07	0.04

Note: Computed by the authors.

Table A13. Northern Ireland 25% lowest all schools

	2000	2015
Gorard Segregation Index	0.29	0.27
Dissimilarity Index	0.38	0.36
Isolation Index	0.37	0.35

Note: Computed by the authors.

Table A14. Northern Ireland 25% lowest state schools

	2000	2015
Gorard Segregation Index	0.28	0.27
Dissimilarity Index	0.37	0.36
Isolation Index	0.37	0.35

Note: Computed by the authors.

Table A15. Northern Ireland 25% lowest private schools

	2000	2015
Gorard Segregation Index	0.19	0.25
Dissimilarity Index	0.33	0.29
Isolation Index	0.55	0.16

Note: Computed by the authors.

Table A16. Northern Ireland 10% lowest all schools

	2000	2015
Gorard Segregation Index	0.45	0.35
Dissimilarity Index	0.49	0.39
Isolation Index	0.22	0.17

Note: Computed by the authors.

Table A17. Northern Ireland 10% lowest state schools

	2000	2015
Gorard Segregation Index	0.43	0.35
Dissimilarity Index	0.48	0.38
Isolation Index	0.22	0.17

Note: Computed by the authors.

Table A18. Northern Ireland 10% lowest private schools

	2000	2015
Gorard Segregation Index	-	0.39
Dissimilarity Index	-	0.40
Isolation Index	-	0.06

Note: Computed by the authors.

Table A19. Scotland 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.26	0.21	0.24	0.24	0.22	0.22
Dissimilarity Index	-	0.34	0.36	0.37	0.37	0.36
Isolation Index	-	0.36	0.36	0.36	0.37	0.36

Note: Computed by the authors.

Table A20. Scotland 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.24	0.20	0.21	0.23	0.20	0.20
Dissimilarity Index	0.33	0.27	0.29	0.31	0.27	0.27
Isolation Index	0.36	0.32	0.31	0.35	0.34	0.34

Note: Computed by the authors.

Table A21. Scotland 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.32	0.31	0.47	0.31	0.33
Dissimilarity Index	-	0.33	0.32	0.48	0.32	0.34
Isolation Index	-	0.06	0.05	0.06	0.06	0.05

Note: Computed by the authors.

Table A22. Scotland 10% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.41	0.31	0.35	0.36	0.31	0.29
Dissimilarity Index	0.46	0.34	0.38	0.39	0.34	0.32
Isolation Index	0.20	0.16	0.19	0.18	0.16	0.15

Note: Computed by the authors.

Table A23. Scotland 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	0.39	0.29	0.32	0.33	0.28	0.28
Dissimilarity Index	0.44	0.33	0.36	0.37	0.31	0.32
Isolation Index	0.20	0.17	0.18	0.18	0.16	0.15

Note: Computed by the authors.

Table A24. Scotland 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard Segregation Index	-	0.28	0.77	-	0.82	0.57
Dissimilarity Index	-	0.29	0.77	-	0.82	0.59
Isolation Index	-	0.03	0.02	-	0.03	0.06

Note: Computed by the authors.

Table A25. Wales 2015

	ALL SCHOOLS 25%	ALL SCHOOLS 10%	STATE SCHOOLS 25%	STATE SCHOOLS 10%	PRIVATE SCHOOLS 25%	PRIVATE SCHOOLS 10%
Gorard Segregation Index	0.21	0.32	0.21	0.33	0.20	-
Dissimilarity Index	0.28	0.36	0.28	0.37	0.21	-
Isolation Index	0.32	0.17	0.31	0.17	0.07	-

Note: Computed by the authors.

Brief CV of the authors

Cynthia Martínez-Garrido

Assistant Professor Doctor in Research Methods and Diagnosis in Education at the Autonomous University of Madrid (Spain). Extraordinary Doctorate Award from the Autonomous University of Madrid. Award for the best Doctoral Thesis in 2015 by the Interuniversity Association for Pedagogical Research (AIDIPE). Researcher of the UNESCO Chair on Education for Social Justice from the Autonomous University of Madrid. Member of the research group "Educational Change for Social Justice" (GICE). Technical Coordinator of the Ibero-American Network for Research on School Change and Effectiveness (RINACE). She has completed her postdoctorate at the University of Durham (United Kingdom) and the University of Granada (Spain) under the Juan de la Cierva contract of the Spanish Ministry of Science, Innovation and Universities. In addition, she has done research stays abroad at UCLA-University of California (Los Angeles, USA) and at Uppsala University (Sweden). She is the Editor of REICE. Ibero-American Journal on Quality, Effectiveness and Change in Education, the International

Journal of Education for Social Justice, and the Latin American Journal of Inclusive Education. Her research lines are School Segregation, Effective Teaching, Educational Leadership, and Education for Social Justice. ORCID ID: https://orcid.org/0000-0001-7586-0628. Email: cynthia.martinez@uam.es

Nadia Siddiqui

She has academic expertise in education research and equity in education. She has led important education research projects contributing evidence for education policy in England. Her research interests are to explore the stubborn patterns of poverty and inequalities through population data sets and large scale surveys such as National Pupil Database (NPD, England), Higher Education Statistics (HESA), Annual Survey of Education Report data (ASER, Pakistan), Longitudinal Survey of Young People in England (LSYPE). By using these secondary data resources, she investigates the indicators of disadvantage that determine children's academic attainment, well-being and happiness, and access to pathways for successful life. ORCID ID: https://orcid.org/0000-0003-4381-033X. Email: nadia.siddiqui@durham.ac.uk

Stephen Gorard

He is Professor of Education and Public Policy, and Director of the Evidence Centre for Education, Durham University (https://www.dur.ac.uk/). He is a Fellow of the Academy of Social Sciences, member of the British Academy grants panel, the ESRC Commissioning Panel for the Research Methods Program, and Lead Editor for Review of Education. He is a member of the Cabinet Office Trials Advice Panel as part of the Prime Minister's Implementation Unit. His work concerns the robust evaluation of education as a lifelong process, focused on issues of equity, especially regarding school intakes. He is author of around 30 books and over 1,000 other publications. He is currently funded by Nesta to evaluate their EdTech Testbed, and by the British Academy to look at the impact of schooling in India and Pakistan. ORCID ID: https://orcid.org/0000-0002-9381-5991. Email: s.a.c.gorard@durham.ac.uk