

Single-sex schooling and coeducation: the continuation of the debate and the defence of science

Educación diferenciada y coeducación: continuar el debate y proteger la ciencia

Enrique G. GORDILLO. Associate Researcher. Universidad Católica San Pablo, Perú (egordillo@ucsp.edu.pe).

Abstract

In the context of the current debate regarding the best school setting (single-sex schooling v. coeducation) several advocates of coeducation have published emblematic papers that implicitly suggest that the debate should be considered as finished and that further research regarding this topic is not needed. This essay aims to refute the combined arguments of those articles using methodological and empirical facts, and show that the debate about this question and research into it should not be seen as complete, but instead should be promoted. At the same time, the essay identifies certain features in the aforementioned articles that present a risk of distorting science by moving towards arguments of an ideological nature, and it underlines the problem this represents for the debate itself and for science in general. The article does not seek to defend single-sex education, only the need for further research into it.

Keywords: Coeducation, single-sex schooling, educational research, outcomes of education, school organization.

Resumen

En el contexto del debate actual sobre la superioridad de un modo de agrupación escolar frente a otro (educación diferenciada vs. coeducación) han aparecido algunos artículos científicos emblemáticos, de parte de defensores de la educación mixta, que implícitamente han llevado a proponer que la discusión debería ser cerrada, y la investigación al respecto, concluida. El presente trabajo busca rebatir la argumentación conjunta de dichos artículos desde consideraciones metodológicas y empíricas, y demostrar que el debate y la investigación no deben darse por concluidos sino, al contrario, impulsarse. Al mismo tiempo, el ensayo identifica ciertas características en los artículos mencionados que conllevan el riesgo de desnaturalizar la ciencia al acercarla a argumentos de carácter ideológico, destacando el problema que esto representa para el debate mismo y para la ciencia en general. El artículo no busca defender la educación diferenciada; únicamente, la necesidad de más investigación al respecto.

Descriptores: Coeducación, educación diferenciada, investigación educativa, resultados educativos, organización escolar

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In recent decades the debate over whether single sex schooling or co-education is superior has gained momentum in the field of education.¹ This debate has spilled over from the areas concerning those involved in the world of education and has entered the public arena (Aréchaga, 2013; Rodríguez-Borlado, 2011), becoming highly polarised (Bigler, Hayes, & Liben, 2014). This is worrying as it is common for arguments that are ideological and subject to a number of strong opinions to reach the general public before scientific evidence does (Riordan, 2011). With regards to the topic that concerns us here, the likelihood of this happening is greater, not just because the debate is still shaped very little by science and rather more by political, religious, and other types of opinion (Mael, Alonso, Gibson, Rogers, & Smith, 2005), but also because even the academic research that does examine it has started to take on characteristics more closely linked to ideology than science, as we will see below.

In this context, the debate has seen the appearance of four academic articles that have tried to become something of a milestone that marks the proximity of its endpoint. I refer to the following ones (in order of appearance):

- The article published by Diane Halpern and her colleagues (Halpern *et al.*, 2011) called “The Pseudoscience of Single-Sex Schooling”. After a very brief literature review, the authors conclude that single-sex schooling has not been able to demonstrate positive educational effects. This text is significant as it appeared in *Science*, one of the world’s most important journals,

and because it is written by the founders and directors of the American Council for CoEducational Schooling, a non-profit organisation from the USA that supports coeducation.

- The study by Margaret Signorella and her colleagues (Signorella, Hayes, & Li, 2013), that reproduces the influential systematic review by Mael *et al.* (2005) –which concluded that there is a small advantage to single-sex schools based on a vote-counting method.² The Signorella *et al.* study not only uncovers grave errors in the Mael *et al.* investigation but also shows by using a meta-analysis that it is possible to find different results.³

- The meta-analysis by Erin Pahlke and her colleagues (Pahlke, Hyde, & Allison, 2014), that after processing information from 184 studies from all around the world, covering over 1.6 million students, concludes that single-sex schooling is shown to have “little or no advantage” over coeducation (Pahlke *et al.*, 2014, p. 1065).

- The meticulous essay by Rebecca Bigler and her colleagues (Bigler *et al.*, 2014), who review almost all of the arguments, scientific and otherwise, put forward by supporters of single-sex schooling and disprove them one by one using the empirical and theoretical evidence currently available.

Some specialists have started to interpret the appearance of these works as the end of the debate (see Trahtemberg, 2014). It is reasonable to suppose that if this is the impression of specialists, the reaction of the general public might be less ordered. This is worrying when we consider

that there are those of us who do not think that the articles mentioned are enough to signal the end of the debate; indeed, they make clear the need for more research.

The aim of this article is to demonstrate that the debate about and research into the advantages of one type of grouping over the other should not be regarded as closed, and that the reasons put forward in these works are not sufficient to put an end to the debate and research into this area. To do so, I will review what I consider the two main ideas that can be drawn from reading these articles together, and I will attempt to refute them using methodological and empirical reflections. By doing this, it will become clear that certain types of argument in some of the statements are a looming threat to the scientific world, against which I also intend to sound an alarm.

1. "Single-sex schooling has not been able to prove its advantage"

It is true that single-sex schooling has not been able to prove conclusively its potential advantage over coeducation (Mael *et al.*, 2005; Pahlke *et al.*, 2014; Riordan, 2011). However, the fact that it has not *yet* done so does not mean that it does not have such an advantage; it simply means that it has not been possible to demonstrate it at the present time. There are several reasons for this.

One of these reasons —indeed one of the main criticisms made of single-sex schooling— has to do with the lack of rationales to explain its supposed effectivity (Bigler *et al.*, 2014; Signorella *et al.*, 2013). Nonetheless, it is only partly true

that single-sex schooling lacks theoretical rationales; these do exist. As far back as 1994 Cornelius Riordan —one of the scholars who has examined this topic in most depth— proposed 8 sociological arguments to explain the advantage of single-sex schooling in certain contexts (Riordan, 1994a), a list that he would later increase to 12 (Riordan, 1998). Based on his work and the available evidence, he now proposes a list of 10 (Riordan, 2015). The ideas proposed by some regarding differing teaching strategies applied in the classroom, in other words, the teacher's work in this area, can also be seen as arguments to explain its possible advantage (James, 2014; Sax, 2014). In particular, I think that the teacher's efforts, strategies, style, and personality, might be important moderator variables in research work on this topic, and they have been neglected in the literature (Bedoya, 2006; Camps Bansell, 2015; Camps Bansell & Vidal Rodá, 2015; McNamara & Jolly, 1994).

As to the author of this paper, taking into account specific findings such as the higher level of disruptive behaviour in co-educational classrooms (Gordillo, 2013), or rationales regarding differences in adolescent self-esteem in both settings (Gordillo, Cahuana Cuentas, & Rivera, 2016), rationales based on empirical and theoretical evidence have also been proposed.

Nevertheless, there is no doubt that these rationales have not been appropriately tested using proper and specifically designed studies to evaluate theories (see Riordan, 2011). What has happened is that results from some pieces of empirical research have been taken and used to argue for or against certain theoretical

postulates, and while this does help to boost their prestige or give them a certain degree of solidity, it lacks solid probative value.

Indeed, one of the main reasons for which these theoretical arguments have not been satisfactorily proven is the methodological difficulties that a study of this nature imposes. Experts agree that to obtain high quality evidence, an experimental or quasi-experimental, longitudinal, multicentre, randomised, and blind design is necessary, or, in its absence, one that controls for extraneous variables (Estol, 2009; Halpern *et al.*, 2011; Mael *et al.*, 2005; Pahlke *et al.*, 2014; Riordan, 2011). Obviously, in the world of education this is difficult for practical, financial, and even ethical reasons, although it has occasionally taken place (Riordan, 2015).

Even so, there are studies that meet several of the proposed requirements and that present results that favour single-sex schooling, but they are not usually taken into consideration in the debate. Among Korean students, for example, Park and his colleagues found evidence to support single-sex schooling (Park, Behrman, & Choi, 2013). These results are significant as from 1974 to 2009 Korea allocated its middle and secondary school students randomly to various educational centres, whether public or private, single-sex or coeducational. Apart from the relevant ethical considerations, the study carried out on this population is a natural, randomised, and multicentre experiment and so its results can be regarded as reliable, particularly when comparing them with the country's performance in the PISA tests from 2006 and 2009 (as cited in Riordan, 2011). While this study was con-

sidered by Pahlke and her team in their meta-analysis, it was not considered by Halpern and her colleagues in their essay (see Park, Behrman, & Choi, 2012). Nonetheless, we should note that the study by Park and his colleagues should be compared with the one carried out by Pahlke, Hyde, and Mertz (2013), also in Korea, where they conclude that there is no difference in performance in science and mathematics of year-eight students in one type of grouping or the other.

Another study with similar characteristics is the natural experiment carried out in Switzerland by Eisenkopf and his colleagues (Eisenkopf, Hessami, Fischbacher, & Ursprung, 2015). This randomised longitudinal study found advantages for single-sex schooling regarding the performance of adolescent girls in mathematics and in their self-confidence in their own performance, albeit with a relatively small ($n = 808$) and non-representative sample. This study was also not considered, perhaps because of its novelty.⁴

We ourselves in 2008, carried out studies in Callao and Arequipa (Peru), in which we attempted to compare the levels of disruptive behaviour in class and self-esteem of secondary-school students from both types of school grouping (Gordillo, 2013; Gordillo *et al.*, 2016). The design of these studies included statistical and methodological control of extraneous variables, and they were performed in public schools, a population that is rarely studied on this topic (Riordan, 2007a). In the first of these studies, we found evidence strongly supporting single-sex schooling, although in the second we found no difference between the groups compared.

Nonetheless, the authors of the studies described as emblematic at the start of this work maintain that despite them not having an ideal number of high quality studies to obtain valid and representative conclusions, there are still enough to draw conclusions (Pahlke *et al.*, 2014, p. 1064; Signorella *et al.*, 2013), and that the first conclusion that can be obtained is that the effects supporting single-sex schooling are non-existent or excessively weak (Pahlke *et al.*, 2014; Signorella *et al.*, 2013).

That the effects of school interventions are usually limited is not news (Hattie, 2015). The Coleman Report (Coleman, 1966, as cited in as cited in Murillo Torrecilla & Román Carrasco, 2011) stated that the effects of school on academic results will always be small, especially when considering effects from covariates of origin such as the socioeconomic level of the parents or their educational level. In Latin America, for example, it has been calculated that the effects of school can explain, on average, just 19.95% of students' results (Murillo Torrecilla & Román Carrasco, 2011).

In particular, in the case of the studies that compare the effects of single-sex schooling with those of coeducation, some experts claim that the results will always give an effect size that is too close to zero –sometimes called *null*– for each type of grouping (Riordan, 2009, 2015). Riordan states that this happens for conceptual, methodological, and mathematical reasons:

1. Apparently, single-sex schooling only benefits some students, particularly those at a social disadvantage and who belong to minorities (Ferrara, 2010; Riordan, 2007b, 2011). In

a classroom, we can find students for whom this modality has a strong positive effect alongside others for whom it does not; when the effect that both groups receive is averaged, a mathematically low result will be obtained (Riordan, 2015).

2. The independent variable (school grouping) is necessarily dichotomous (coeducation v. single-sex schooling). This leads to low mathematical variability, as the standard deviation of a dichotomous variable will always be small, something that has an impact on the calculation of the effect size (Riordan, 2011).

3. When random assignment is impossible, control of extraneous variables is an appropriate method for avoiding spurious conclusion in a study that measures the impact of an intervention (Riordan, 2015). Education researchers will tend to control for all variables (socioeconomic status, previous ability, etc.) that might affect the relationship that interests them. The paradox is that the more covariates are controlled, the more the size of the resulting effect will be reduced. In addition, the challenge is to distinguish –conceptually, but above all mathematically– the variables that could potentially produce spurious results from the same outcomes of single-sex schooling that the researcher is trying to measure (Riordan, 2009).

4. Most of the research that calculates effect sizes for the different types of grouping are cross-sectional studies (i.e. not longitudinal), and so the effects they obtain will always be small (see Riordan, 1994b, 2015).

When people say that research shows that the effects of single-sex schooling are of little significance or null, they are not really saying anything different from what current evidence shows regarding other interventions commonly regarded as successful (Riordan, 2009), such as reducing class size, problem-based learning, or teacher training (see Hattie, 2015). For this reason, Riordan considers that the null results of research comparing single-sex schooling with coeducation are not necessarily such; in fact, he believes that if most studies in a work like that by Mael *et al.* supported single-sex education, and there were a lot of null results, these results should be added to the number of studies that support it because of the considerations mentioned regarding the constraints that will always make the effect size of this modality low under these circumstances (Riordan, 2011, p. 10).

This phenomenon is precisely what can be seen in the systematic review by Mael and his team of the 40 studies that they managed to collect and process (Mael *et al.*, 2005). The conclusion that they reached in it can be seen in Table 1.

Table 1 should be read with certain precautions, noted by the researchers themselves: the studies included were not of sufficient quality for a meta-analysis and so the aim of performing one was abandoned; after lowering the quality standard used, the number of studies finally included (40 quantitative and 4 qualitative⁵) was quite small (Mael *et al.*, 2005). With this in mind, we can appreciate that the results show a small advantage for single-sex schooling over coeducation. If we add the null results to the “pro SS” ones—in line with Riordan’s idea described above— this support increases.

TABLE 1. Summary of the findings of Mael *et al.*, 2005.

Types of outcome ^a considered	Total outcomes	Number and percentage of outcomes							
		Pro-SS ^d		Pro-CE ^e		Null		Mixed ^f	
		N	%	N	%	N	%	N	%
Concurrent Academic Accomplishment ^b	43	15	35%	1	2%	23	53%	4	10%
Concurrent adaptation and Socio-Emotional Development ^c	49	22	45%	5	10%	19	39%	3	6%
Total	92								

^a An outcome is a specific educational result. The table should be read as follows: for the «Concurrent Academic Accomplishment» category of outcomes there were 43 results from the 40 quantitative studies included (a single study might contain more than one result, for example, if an outcome is analysed in students from different levels or if more than one outcome was analysed); of these results, 35% unambiguously supported single-sex schooling in comparison with coeducation with regards to academic performance; 2% unambiguously supported coeducational schools in comparison with single-sex ones; 53% of the results did not find significant differences between the two settings; and 10% showed results that supported both one type and the other (see note f).

^b This includes outcomes such as: results in mathematics tests, results in science tests, results in verbal tests, general average grades, results in social science tests.

- ^c This includes outcomes such as self-concept, self-esteem, locus of control, educational aspirations, attitudes towards school, etc.
- ^d SS = single-sex schooling.
- ^e CE = coeducation.
- ^f Results were classified as mixed if they partially supported single-sex schooling and partially supported coeducation (for example, a study could find that single-sex schooling supported boys' performance in mathematics, but had a negative impact on girls in the same outcome).

Source: Adapted from Riordan, 2011, using data from Mael *et al.*, 2005.

As has already been mentioned, this study was analysed by Signorella and her colleagues, who found such serious methodological errors⁶ that they ended up «drawing into question the validity of their conclusions» (Signorella *et al.*, 2013, p. 438). The researchers start from a critique of the method used by Mael and his team: for Signorella and her colleagues, a narrative interpretation of the results (such as the vote-counting method) is unreliable in itself and in comparison with a meta-analysis. For this reason, after acquiring the set of studies from the original work, correcting the methodological errors, and calculating effect sizes for the studies that required it, they carried out meta-analyses of just three of the outcomes that the original review considered, as it turned out to be impossible for them to do it with the others. The results of these meta-analyses are shown in Table 2.

TABLE 2. Result of the works processed by Signorella *et al.*, 2013.

Outcomes measured	ES ^a for SS ^b according to meta-analysis	Total of effects calculated	Number and percentage of effects					
			Pro-SS ^b		Pro-CE ^c		Null	
			N	%	N	%	N	%
Concurrent Mathematics Accomplishment	$g = 0.03^e$	24	4	17%	2	8%	18	75%
Verbal achievement	$g = 0.18^f$	13	6	46%	0	0%	7	54%
Self-esteem and self-concept ^d	$g = -0.02^h$	17	5	29%	5	29%	7	41%
Total		54	15	28%	7	13%	32	59%

- ^a ES = effect size. Positive values support single-sex schooling, negative ones support coeducation.
- ^b SS = single-sex schooling.
- ^c CE = coeducation.
- ^d Both variables were grouped into a single one by Signorella *et al.*, 2013.
- ^e 95% CI = -0.03 to 0.09, $p = 0.32$
- ^f 95% CI = 0.10 to 0.26
- ^h 95% CI = -0.12 to 0.08

Source: Adapted from Signorella *et al.*, 2013.

As can be seen, two of the meta-analyses (concerning performance in mathematics and self-esteem/self-concept) show null effects for both types of grouping, although the third (on verbal skills) shows a small but significant effect ($g = 0.18$) in support of single-sex schooling.

In my opinion it is questionable whether the researchers carried out meta-analyses of studies in which the original authors —despite their mistakes— concluded that it was “nearly impossible” (Mael *et al.*, 2005, p. xvii). Indeed, the mathematical complexity that the experts had to rely on in their attempt to perform them is striking, and could lead us to question, to some extent, the accuracy of their results.⁷ Therefore, I felt it was advisable —once the data had been cleaned up by the authors— to perform a new vote count for the three outcomes that they had managed to clarify. To do this, I started from the results presented by them in their Tables 1, 2, and 3 (Signorella *et al.*, 2013, pp. 432-433; 435; and 436-437 respectively) and I recorded how many of the calculated effects⁸ supported single-sex schooling, how many supported coeducation, and how many studies showed null results. These results can also be seen in Table 2, and show clear results in support of single-sex schooling in two of the three outcomes considered; in the third there is something of a draw. However, it is important to consider the caveat expressed by the authors themselves about how the correlations between the effects obtained and the covariates of origin (socioeconomic status, previous academic achievement, etc.)

were quite high in most cases (Signorella *et al.*, 2013). This precaution is even more important when dealing with uncontrolled studies.

For its part, the meta-analysis by Pahlke and her colleagues (Pahlke *et al.*, 2014) is, logically, a fairly comprehensive study. These researchers were able to process 184 studies, all of them apparently of an appropriate quality, whereas just 7 years earlier⁹ Mael and his team could find only 40, although we should recall the serious errors Mael *et al.* made, even in the selection process¹⁰ (Signorella *et al.*, 2013). The selected studies involved a sample of over 1.6 million students from all around the world.

They concluded that there were virtually no significant differences in support of single-sex schooling when the best studies are considered (those that in one way or another meet the standards described above), and that the few differences supporting this type are very small and non-significant. These results are, naturally, not surprising given what is stated above.

Their results for gender stereotypes are particularly interesting, as they contradict one of their theoretical assumptions (see Pahlke *et al.*, 2014, p. 1065), and both the samples from the USA and those from the rest of the world give results that support single-sex schooling (Pahlke *et al.*, 2014, see Table 2 on p. 1058; Table 3 on p. 1059).

In conclusion, from the proposed perspective, it is possible to conclude that

the systematic review by Mael *et al.*, which has been described by experts as one of the most comprehensive studies of the literature on single-sex v. coeducation (Bigler *et al.*, 2014), and even as the best (Riordan, 2011, p. 18; 2015, p. 36 and *passim*), continues to show —despite the criticisms, and after correcting its errors— a small advantage for single-sex schooling that should be read within the methodological and scientific context described above. Regarding the meta-analysis by Pahlke *et al.* (2014), another of the most comprehensive studies (Bigler *et al.*, 2014), it is my opinion that it could also be interpreted under the same criteria: the effects found are small and close to the null hypothesis; in line with Riordan's thesis, they also, to some extent, argue in favour of single-sex schooling. Therefore, it is not entirely true that single-sex schooling lacks supporting evidence.

2. «It is better to stick with coeducation»

This argument appears explicitly —supported by a variety of arguments— in more than one of the works identified (Bigler *et al.*, 2014; Halpern *et al.*, 2011). Nonetheless, it is important to note that, while single-sex schooling has not yet been able to prove its advantage, neither has coeducation (Riordan, 2011). As far back as 1998, Mael identified very few effects for it that were superior to those of single-sex schooling, unlike those mentioned in the opposite direction (Mael, 1998), and seven years later his systematic review (Mael *et al.*,

2005), which has also been corrected by Signorella and her colleagues (2013), did not provide many more (see Tables 1 and 2). The most recent and best available review, the meta-analysis by Pahlke *et al.*, also does not offer favourable results (2014).

Despite this, coeducation seems to enjoy not just majority sympathy and support (among specialised and non-specialised audiences), but, in the view of some, it is surrounded by a sort of «protective halo» (Riordan, 2009, p. 102) that gives it uncritical legitimacy. Consequently, it has entered politically correct discourse in contemporary society in such a way that questioning its premises or consequences is felt to go against the democratic system, against advances in favour of the rights of women, and against the ideal of equality of sexes or genders (Altarejos, 2006; Ibáñez-Martín, 2007; Riordan, 2007b; Salomone, 2006). Nonetheless, the emergence and entrenchment of coeducation as something like a universal format nowadays (Riordan, 2011) is due to practical and economic reasons, and its popularity is due to sociological, political, and ideological reasons (Ibáñez-Martín, 2007); in other words, reasons that are not based on scientific and empirical observations (Bigler *et al.*, 2014; Riordan, 2011). We believe that this lack of empirical support in its origin and entrenchment legitimately justifies submitting it to an academic debate (Gordillo, 2015).

Some supporters of coeducation seem to have perceived this shortcoming, and

have abandoned the practice of defending coeducation for non-scientific reasons to —as we have seen— highlight the lack of positive effects of the other option. In this sense, some people admit the lack of proven effects of both types of grouping (Pahlke *et al.*, 2014), but they argue that it is better to remain with coeducation (the most widespread mode), again for practical reasons; it is very expensive to implement single-sex schooling in a mainly coeducational system¹¹ (Bigler *et al.*, 2014, p. 226; Pahlke *et al.*, 2014, p. 1043), as well as being difficult and disruptive¹² (Signorella *et al.*, 2013, p. 423). This way, they implicitly characterise single-sex schooling as an intervention that is not profitable in cost-benefit terms.

We believe that this line of argument has two flaws. The first is to consider that educational interventions should be evaluated in accordance with economic criteria, understanding *economic* here in a broad sense. As education deals directly with human beings, it is clear that there are interventions or policies that should be implemented even if they are expensive or unprofitable. I am not arguing that single-sex schooling is one of them, but I do uphold that instilling a mentality that does not take this fact into account could distort education itself.

Alongside this, seeing single-sex schooling as unprofitable because it is stated that its effects are *indistinguishable* from coeducation —and, consequently, are equivalent— is also a distorted approach to reality. In effect,

it is not entirely true that single-sex education and coeducation are equivalent and indistinguishable in their effects, as the literature has found negative effects for the latter. For example, as a result of their own study, Pahlke *et al.* find an average weighted effect ($g_w = -0.57$) that has a negative impact on girls in coeducational schools in terms of gender stereotypes: the probability of maintaining gender stereotypes is higher in female students from coeducational schools than in those from single-sex schools. They found this result after processing the best studies from their meta-analysis (controlling for confounding variables and weighting them); however, they warn that it is necessary to be cautious with the figure, as the unweighted effect size is, paradoxically, non-significant, even though it supports coeducation (Pahlke *et al.*, 2014). Another study performed using a quite large sample ($n = 3450$) finds a positive correlation between the number of classmates of the student's own gender and various academic and non-academic outcomes for a student, as well as a negative correlation between the number of classmates of the opposite sex and these outcomes (Martin, 2009, as cited in Riordan, 2011). While it is true that this finding is not a result of specific research into coeducational v. single-sex schooling, it is reasonable to suppose that the mixed grouping could be the right atmosphere for the second correlation to appear. Halpern and her colleagues presented evidence to the contrary: according to some studies, boys who spend time with other boys tend to behave more aggressively and have

more behavioural problems, while girls who spend time with other girls tend to fit into gender stereotypes more (Martin & Fabes, 2001; Fabes, 1997, as cited in Halpern *et al.*, 2011). Nonetheless, some experts have stated that these pieces of research were carried out with small samples, and so are not representative (Park *et al.*, 2012).

The second problem with the argument presented is the ideological nature of the debate: coeducation was implemented in the Western world for non-scientific reasons (Gordillo, 2015), and it appears that nowadays people are attempting to defend it for the same reasons. This failure to use empirical evidence to support the benefits of a system is characteristic of beliefs that are not scientific in nature and are more typical of the phenomenon of ideology (Doig, 1991).

We fear that these approaches have entered the debate, and will strip it of the scientific nature which several people have complained it lacks (Mael *et al.*, 2005), and that has required so much effort to give to it. In this sense, not only is the somewhat offensive title of the article by Halpern *et al.* worrying (it describes single-sex schooling or its premises as *pseudoscience*), but so are some of its arguments, such as where it states that combating sexism through gender segregation is akin to using racial segregation to combat racism —ergo, in some way identifying the evil of racism with single-sex schooling, as one observer notes (Ford, 2012)— or like when a commentator notes that the claims of the authors

about how it is impossible to judge the effectiveness of single-sex schooling without randomised, blind studies (Halpern *et al.*, 2011, p. 1706) are similar to those used by tobacco companies, which for years claimed that without causal studies it was impossible to prove the belief that smoking cigarettes is bad for one's health (Kalkus, 2012). Halpern, and all of the signatories of the article in *Science*, conclude by calling on the government of the USA to rescind the new regulations for «Title IX» of 1972 (Nondiscrimination on the Basis of Sex in Education Programs or Activities Receiving Federal Financial Assistance [NBSE], 2006). This would lead to public funding for single-sex schooling again being prohibited in the United States (see appendix). In countries like the USA, it is common for academic research to be closely linked with political decision making. Nonetheless, attitudes such as those identified are still surprising, and they are worrying in a context where they could prejudice not only single-sex schooling but also science in general.

3. Conclusion

I hope that I have been able to show that there are insufficient grounds —among those proposed by certain influential academic works— to claim that the academic debate surrounding the advantage of one or other type of school grouping and research into it is finished. It is not true that there is a lack of empirical and theoretical evidence supporting single-sex schooling. Neither is it true that coeducation has proven its superiority

or that it should be the canonical model for education in the Western world for non-scientific reasons.

Finally, I would like to make it clear that in no way am I trying to claim that single-sex schooling is superior to co-education. Indeed, as I believe has been sufficiently set out, a consistent volume of literature has found significantly null results or ones very close to zero when comparing its effects with those of co-education (Bigler *et al.*, 2014; Gordillo *et al.*, 2016; Gordillo, Rivera, & Gamero, 2014; Pahlke *et al.*, 2014; Riordan, 2011; Signorella *et al.*, 2013). My only intention with this work is to provide methodological and empirical arguments that contradict many people's assumption that the debate is finished or is no longer necessary; on the contrary, I agree with the leading experts in that we still know very little about this topic, and that research into it is still in its infancy (Riordan, 2011).

Appendix. Single-sex public education in the USA and the impact of the systematic literature review by Mael *et al.*, 2005

Until before the first decade of the 21st century, there were virtually no single-sex public schools in the USA (Dee, 2006). The reason for this is related to Title IX of the Education Amendments of 1972, which prohibited discrimination against people based on their gender in participation in any educational program that received federal funding (Title IX of the Education Amendments, 1972). The document's apparent objective was to combat discrim-

ination against female staff in teaching positions in higher education (Sandler, 2000). The standard interpretation of the document was, for several decades, based on the regulations issued in 1975 by the then Department of Health, Education, and Welfare that prohibited single-sex public education.

This interpretation lasted until January 2002, when President George W. Bush passed a new education act (No Child Left Behind, 2002), Chapter V of which (drawn up by the senators Hillary Clinton, Democrat, and Kay Bailey Hutchinson, Republican) proposed releasing federal funding for single-sex schools or classes (Cable & Spradlin, 2008). This innovation compared with the previous position created enthusiasm in a section of public opinion, to the extent that in May of that year, the Office for Civil Rights, of the Department of Education, found itself obliged to draw up guidelines for this possibility in the public sector (Single-Sex Classes and Schools: Guidelines on Title IX Requirements, 2002), at the same time as holding a national public consultation about the features these regulations should have in a «complex and sensitive» topic (Nondiscrimination on the Basis of Sex in Education Programs or Activities Receiving Federal Financial Assistance; Proposed Rule [Notice of Intent to Regulate], 2002, p. 31 098). This led to the appearance of some experiments with public single-sex schooling, as well as a fierce debate.

The following year, the US Government, through the Department of

Education, requested, according to Arms (2007), a descriptive study of the new experiments in public single-sex schooling that had recently appeared (a study that finally saw the light of day in the work by Riordan *et al.*, 2008), and (as the authors of the work itself note) a meta-analysis of the comparative studies on single-sex and coeducation (that would finally become the study by Mael *et al.*, 2005). Apparently, these works were to act as input for drawing up the new regulations for the aforementioned «Title IX».

Mael and his colleagues could not produce a meta-analysis because of the lack of quality research (Mael *et al.*, 2005, p. xvii). Instead, they opted for a vote-counting method with the collected studies, from which they concluded that there was a slight advantage for single-sex schooling in some of the educational outcomes examined. Even so, given the context in which this research appeared —significant national interest in the matter with numerous articles and books published and over 5000 comments collected in the public consultation (Arms, 2007)— it became of great importance and was extensively cited by supporters of single-sex schooling.

The following year, the Office for Civil Rights published the new regulations for «Title IX», this time containing an interpretation that was favourable to public funding for single-sex programmes under certain conditions (NBSE, 2006). As a result of this, a so-called «boom» in this type of schooling has occurred (Pahlke *et al.*, 2014, p. 3).

Eight years later, Signorella, Hayes, & Li (2013) reproduced this emblematic work using the same set of studies, and they attempted the meta-analysis that the earlier piece had been unable to perform. The impact of this new study is not only because their meta-analysis led the authors to reject the conclusions of the original work, but also because they demonstrated the numerous and serious errors in it, casting significant doubts on its validity.

Notes

- ¹ In this piece we treat the terms *coeducation* and *mixed education* as synonyms, even though some specialists believe there are differences between them (see Bartolomé, 1980; Breuse, 1972).
- ² The vote-counting method consists of counting how many studies supporting or opposing a particular intervention are found in a selected corpus of pieces of research.
- ³ See the appendix for a description of the social and political context in which the review by Mael *et al.* appeared, to understand better its importance, as well as that of the work on which we are commenting.
- ⁴ The article was published in July 2015, although it was available online in some databases, as a document in press, from August 2014.
- ⁵ Table 1 only shows the results of the quantitative studies.
- ⁶ These flaws included inadvertently processing repeated studies, using the same data set —and therefore the same sample— in studies that were considered different but that measured the same outcomes, errors of judgement when interpreting the nature of the pieces of research processed (i.e. they classified a piece of research as a comparison of single-sex schooling v. coeducation when it was not one), unjustified exclusion of some studies that met the required standards, etc. (Signorella *et al.*, 2013).
- ⁷ In any case, Signorella and her team do not state the reasons for which they thought that this was advisable and possible.

- ⁸ These are effects of uncontrolled studies; Signorella and her team make it clear that, owing to the circumstances, they preferred to work with these instead of controlled ones (Signorella *et al.*, 2013, p. 431). A single study could produce various effects; for example, if it gave results independently for boys and girls, there would be two effects. I did not take into consideration mixed results, as was done in the original study by Mael *et al.*, because individual effects were calculated and not studies (that could include various effects), and because Signorella and her colleagues did not do so either.
- ⁹ Mael *et al.* searched for pieces of research that covered from 1988 “to the present” (Mael *et al.*, 2005, p. 3) (we should take into account that their systematic review was published in 2005); meanwhile, Pahlke *et al.* searched for studies up to 2012, including those by Mael and his team (Pahlke *et al.*, 2014, p. 4).
- ¹⁰ This is reasonably possible given that, with the described explosion in single-sex schools, a wide variety of studies into this also appeared (see Pahlke *et al.*, 2014).
- ¹¹ This is perhaps only the case in some countries such as the USA. In others, such as Peru, for example, single-sex schooling is relatively common, even in public schooling (see Gordillo, 2013; Gordillo *et al.*, 2016).

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