

Between Gendered Walls: A Systematic Review on Single-Sex and Co-Educational Settings

Abstract

In this paper, we investigate the impact of educational environments characterised by single-sex and co-educational settings on students' academic performance, communication skills, and self-confidence. The analysis encompasses 677 research articles, comprising 798 effect sizes and involving a cumulative sample size of 1,179,558 participants. The existing literature presents inconclusive results regarding the effects of co-education on students' overall educational well-being. This research contributes to this ongoing debate by examining the impact of educational settings, specifically co-educational and single-sex environments, on academic achievements, communication skills, and self-confidence. Our findings indicate that the type of educational setting, whether co-educational or single-sex, does not exert a statistically significant impact on academic achievements, while students in co-educational settings demonstrate better communication skills and higher self-confidence compared to their counterparts in single-sex schools. These results challenge the prevailing notion that single-sex education enhances girls' achievement and self-confidence while providing a safer environment for self-expression. On the contrary, our data suggest that gender-segregated schools may not be the most conducive environments for girls to thrive both socially and academically, potentially due to the promotion of passive femininities within such institutions.

Key Words: coeducation, single-sex education, confidence, communication skills, academic achievement, meta-analysis.

Introduction

Girls' education and gender equality have long been major policy concerns on a global scale, prominently featured in the agendas of multilateral organisations such as the United Nations' Sustainable Development Goals, as well as international NGOs and think tanks (UNESCO, 2022). Key questions in this area include how to better embed gender equality in educational settings, how to assess girls' performance in schools, and how to mitigate intersecting gender inequalities. These concerns are primary for governments and extensively discussed in the gender and development literature (see Unterhalter, 2022; Monkman, 2021), with gender equality gaining prominence on governmental policy agendas partly due to increased advocacy and attention from the international community and UN agencies, reflecting a growing recognition of its critical importance. However, engagement with gender equality in policy varies significantly. One of the most used, but also problematic, levels of engagement is gender parity, which focuses on closing the gender gap between boys and girls in terms of access to education, participation, progression, and learning outcomes. This approach is used by the UNESCO Institute for Statistics for monitoring progress (UNESCO, 2020). However, this understanding of tangible outcomes often overlooks more critical readings of gender equality, which engage with power relations, agency, and the various structures that have historically disadvantaged women (Unterhalter et al., 2023).

A more comprehensive and intersectionality-focused conceptualisation requires examining how gender inequalities intersect with other axes of oppression that are deeply institutionalised, even within schools, which are ultimately much more challenging to measure in numeric forms (Sen and Mukherjee, 2014). Therefore, policies and governments often ignore the multifaceted nature and unmeasurability of gender in education (Unterhalter et al., 2023), resulting in educational systems continuing to play a key role in reproducing dominant sexist stereotypes and values, both through the knowledge processes offered at school and within the cultural climate fostered by the institution (Cin, 2017). Any conceptualisation of gender equality needs to be comprehensive, considering tacit power relationships, structures, and hegemonic gender orders that impact girls' schooling experiences, opportunities, and development of social and intellectual capabilities (Cin et al., 2020). In this research, we engage with such a dilemma

by examining how different forms of education—co-education and single-sex education—impact girls' academic achievement and social skills through a systematic review and meta-analysis. This focus is due to the fact that governments and policies have long positioned gender-related outcomes of education within these two discourses without necessarily engaging with the broader implications of education, such as norms, curricular frameworks, power relations, learning materials, and pedagogic approaches, while championing single-sex education as the only measure to benefit the well-being of girls. Yet, no consideration is being given how sex segregation can lead girls to develop misconceptions such as girls are weaker, need protection (Byrne and Carthy, 2022). Therefore, our aim is to explore what works for girls and boys within this limited discourse through a comprehensive meta-analysis of 677 studies, encompassing a collective sample of 1,179,558 individuals. The existing literature on single-sex schooling predominantly focuses on three central variables: (a) academic achievement, (b) self-confidence, and (c) communication skills. The primary contribution of this meta-analysis lies in its holistic examination of all three variables, thereby presenting a comprehensive and more conclusive understanding of the effects of both single-sex schooling and co-education, and providing a nuanced perspective that can inform future educational policies and practices. The findings of this research have potentially strong implications for understanding gender socialisation in single-sex and co-education environments, arguing that the advantages of single-sex education have been overstated with insufficient consideration given to performative aspect of gender.

It is also important to note that our analysis in this article is limited to the binary categorisation of biological sex as girls and boys and does not take into account the fluidity and non-binary nature of gender. This limitation stems from the ways in which the co-education/single-sex debate has taken place within rigid and binary sex interpretations. Consequently, the research comprising this meta-analysis did not accommodate any fluid gender identities. In the next section, we discuss the literature surrounding single-sex schooling and co-education.

The Gendered Dichotomy of Co-Education vs. Single-Sex Education

The question of what sort of education is conducive to students' social and academic skills and well-being has become a rather contested question to address. Several strands of this argument focus on quality education, such as equitable access to learning outcomes, learning pedagogies or social

inequalities whereas one such debate focuses on the dichotomy between co-education and single-sex education settings, exploring how single-sex and co-education affect students' performances and attitudes. In the discourse on single-sex schooling, a prevailing theoretical framework posits that inherent biological distinctions between boys and girls necessitate differentiated pedagogical strategies and learning environments (Sax, 2005) -a stance rooted in gender essentialism. This view promotes the assumption that girls excel in environments that emphasize cooperation and collaborative learning, whereas boys' benefit from contexts that foster competition (Sax, 2010) and that sexism in co-educational settings can only be mitigated by single sex schooling. Such a paradigm accentuates the redesign of educational structures distinctively for each gender in order to optimise both academic achievements and social developmental outcomes. On the other hand, this biological argument is highly contested, as it perpetuates gender inequalities and disparities within educational settings, and it resonates with neo-conservative ideologies intent on reinforcing biological essentialism (see Cin et al., 2020). Similarly, Eliot (2013), drawing from the neuroscience literature, argued that the boys and girls should be taught in separate classrooms due to their biological differences is tenuous and baseless. She emphasized that such differences are not predetermined and highlighted how this theoretical conundrum has perpetuated a burgeoning belief in "hardwired" gender differences, which subsequently propagates misleading gender stereotypes.

Advocates of single-sex education argue that such schools leverage gender-specific learning strategies, which in turn provide some advantages such as reducing girls' anxieties and boosting their confidence. The prevalent and dominant assertion in the literature (Booth et al., 2014; Jackson, 2002; Riordan, 2015; Robinson & Smither, 1999) posits that single-sex schooling primarily benefits girls by purportedly offering them a secure environment in which they can flourish, participate in classroom discussions confidently, behave more competitively and remain free from distractions, conflicts, tensions, and pressures typically ascribed to the presence of boys. These factors are collectively argued to enhance the academic achievement of girls (Eisenkopf et al.; Booth et al., 2018), especially in STEM fields (Sadker et al., 2009), and bolster girls' self-confidence in such subjects (Shapka & Keating, 2003). More recently, there has been research suggesting that single-sex education leads to fewer arrests for boys and reduced pregnancy rates for girls (Jackson, 2021), and reduces the stress stemming from peer

relationships for girls (Kim & Kim, 2024).

On the other hand, proponents of co-education underscore the significance of socialization and communication skills that can be cultivated early on between the opposite sexes and argue that single-sex schools often reinforce gender stereotypes (see Mael et al., 2004; Campbell & Sanders, 2002), and make gender more salient through the process of gender segregation (Patterson & Bigler, 2007). Co-education, however, deconstructs such gendered divisions and improves intergroup relations, particularly the communication between boys and girls (Halpern et al., 2011). Further evidence suggests that those who have studied in single-sex schools can experience higher levels of anxiety in mixed-gender environments (Wong et al., 2018), refrain from forming close friendships with the opposite sex (Li & Wong, 2018), suffer from negative effects on their academic performance (Jackson, 2012; Strain, 2013), or experience damage to their self-perception, contributing to a belief in their powerlessness (Byrne & Carthy, 2022). Likewise, meta-analysis studies on single-sex education (SSE) and co-education (Pahlke et al., 2014; Signorella, 2013) suggest that there is scant evidence to support a distinct advantage of single-sex schooling for either girls or boys in terms of academic achievement, and single-sex schools may offer no advantage to student cognitive performance or social development.

In conclusion, extensive research has yielded inconclusive and frequently contradictory findings regarding which educational setting—single-sex or co-education—fosters superior learning and educational outcomes for students. In the next section, we focus on gender socialisation as the conceptual framework informing our analysis.

Conceptual Framework: Gender Socialisation in Schools

In this study, we draw on the concept of gender socialisation and its intertwined relation with heteronormative masculinities and femininities. Gender socialisation broadly encompasses the transmission of culturally specific gender-related identities, roles, attitudes, and practices, and signifies the learning and internalization of established societal norms, roles, and customs concerning perceived roles of women and men (Fagot, Rodgers, & Leinbach, 2012). It is deeply rooted in promoting femininities and masculinities that reinforce heteronormativity, positioning women as more passive and men as more competitive (Connell & Messerschmidt, 2005; Langer, 2010). Thus, gender socialisation operates as the societal propagation of gender-normative behaviours, facilitated by various institutions

such as families and schools. These behaviours impact how individuals engage in interpersonal relationships, make life choices, and develop their aspirations.

Schools are pivotal in this context, acting as venues where gendered patterns of socialisation, often inherited from families and larger societal constructs, are perpetuated, and disseminated through both official and informal means (Dillabough, 2003; Forouton, 2018). This is further amplified by cultural scripts governing gender behaviours. While acknowledging the nuanced spectrum of gender, indicating that it is not a rigid dichotomy and there exists a wide range of masculinities and femininities within societies (Messerschmidt, 2004), the gender composition of schools plays a critical role in perpetuating heteronormativity. This establishment of femininities and masculinities in daily school life manifests through routine practices such as gender-segregated activities (Fabes et al., 2004), interactions across different gender (Eder, 1995), and the formation of hierarchical gender status (Connell, 1995). Consequently, schools emerge as key institutions where masculine and feminine identities mutually shape each other to reproduce their own social norms. This is particularly pronounced in patriarchal societies with vertically structured cultures that champion a nearly uniform portrayal of femininity and masculinity. Within such settings, boys and girls assimilate distinct gendered perspectives based on their educational experiences, which subsequently shape their aspirations.

Gender socialisation, the process that encourages expected behaviours, career aspirations, and attitudes aligned with one's gender, is further reinforced by teacher-student interactions that position both teachers and students as active agents in this process. The gender socialisation is frequently used to explain the perceived academic underperformance of boys, who are often stereotyped as investing less effort compared to girls. Jones and Myhill (2004) and Francis (1999), for instance, link the underachievement of boys to antisocial patterns and disruptive behaviours they display. Whereas there exists a body of research, exemplified by studies like Cin (2017), illustrating the potential of schools to destabilise entrenched gender norms and pave the way for more equitable learning environments, achieving such environments often hinges on educators who are proactive in contesting gendered structures, relationships, and pedagogies. For instance, Lee et al. (1994) highlight that in single-sex education contexts, the perpetuation of gendered norms can be particularly pronounced. Within these settings, girls might find themselves in a heavily gendered environment, where the educational

environment might amplify patriarchal gender roles. Such a setting restricts both genders from gaining valuable experiences of mixed-gender interactions, inhibiting their understanding of diverse gender dynamics. Consequently, girls might transition from these educational settings into broader societal contexts, feeling less assured in mixed-gender situations.

Recent studies, highlighted by Drury et al. (2013), posit that girls in single-sex schools often feel an intensified need to conform to gender norms compared to their counterparts in co-educational environments. Conversely, for boys, there's an argument that co-education diminishes the pressure to adhere strictly to their gender-role identity (Maccoby, 1998). However, male-only settings, in contrast to mixed-gender ones, have been found to accentuate traditional masculine attitudes and behaviours (Epstein & Johnson, 1998). Specifically, environments dominated by males are associated with increased aggression and pronounced expressions of heterosexual masculinity (Jackson, 2002). So, co-education, while still perpetuating gender norms and endorsing certain modes of socialisation (often encouraging girls to be more obedient and boys to be freer), allows for diverse expressions of femininities and masculinities within the school environment and mitigate the inequalities between genders (Sara-Lafosse, 1992). This diversity creates pockets of opportunity to deemphasize gender differences in socialisation processes. Such findings underscore the notion that the gender makeup of an educational institution can both directly and indirectly cultivate or attempt to mitigate the strong gender-congruent behaviours. Although we recognise the evolving and dynamic nature of gender relations that are constantly changing, some research (e.g., Dutta et al., 2022) has found that in collectivist societies, traditional gender roles are more prominently promoted, with women often viewed as commodities in transactions for domestic services. In contrast, societies rooted in individualism, often associated with the Global North and Western communities, tend to provide greater opportunities for self-expression, freedom, have higher rates of female educational attainment, and promote active participation of women in public life. However, this does not imply that they achieve full gender equality. There are two arguments presented for the divide between individualist and collectivist societies. In the former, rights transcend beyond gender identities, leading to reduced patriarchal relations, and the individual is seen as independent. In contrast, in the latter, women are often associated with gender roles such as performing motherhood and undertaking care work, which leads them to de-emphasize their personal

goals and aspirations (Davis & Williamson, 2019). Here, the individual is interdependent and exists only within a web of social relations, networks and obligations (Gorodnichenko & Roland, 2012). While we argue that every society exhibits patriarchy to varying degrees and at different levels, gender socialisation manifests in more nuanced forms across different societies. Schools and educational systems, embedded within these societies, further reflect these distinctions. Therefore, below, we aim to investigate how the gender composition of schools influences achievement, self-confidence, and communication skills among both boys and girls. Each of these variables is significantly shaped by the processes of gender socialisation, which transpire within educational settings and extend beyond them.

The literature concerning single-sex schooling often presents inconclusive findings (see Smithers & Robinson, 2006). Recent studies (Booth et al., 2018; Park et al., 2018) that aimed to explore the causal effects of school gender composition on educational outcomes have similarly acknowledged the diverse results they unearthed. Such varied outcomes underscore the need for a more holistic approach when evaluating the impacts of co-education and single-sex schooling on students' educational well-being. Most of the discourse in this domain centers on three principal variables: academic achievement, self-confidence and efficacy, and socialisation/communication skills, emphasising their importance in gauging the effects of school gender composition. In this meta-analysis, we look into these three factors, aiming to synthesize a more coherent narrative from the existing literature. Moreover, we posit that investigations focusing on these variables often yield results that remain paradoxical and mixed. In the following section, we will briefly outline the research on self-confidence, self-efficacy, academic achievement and communication skills, particularly in the context of the debates surrounding single-sex versus co-educational schooling.

Academic achievement

Research on the effects of single-sex schooling on academic achievement significantly relies on large-scale studies that predominantly use multilevel modeling, drawing from pupil-level data and emphasizing the integration of measures of prior attainment. From this extensive body of literature, two salient trends become apparent.

The first trend suggests that the environment of single-sex schooling does not offer any advantage in terms of academic achievement for either gender. Halpern et al. (2011) argue that there is a lack of rigorously designed research indicating any positive contribution of single-sex education to students' academic outcomes and emphasize that the bulk of the evidence leans towards the assertion that segregating by sex amplifies gender stereotypes and bolsters institutional sexism, which in turn impact the performance of students. Notably, the research of Bell (1989) and Robinson and Smithers (1999) shows that single-sex educational settings did not markedly impact academic performance, and similarly, the research conducted by Daly (1996) and Harker (2000), employing multilevel analyses on pupil-level data, indicates that when variables such as prior attainment and socio-economic background are considered, the effect of single-sex education on academic achievement becomes statistically insignificant. This conclusion finds further corroboration in empirical studies from regions like the UK (Robinson & Smithers, 1999), Northern Ireland (Daly, 1996; Daly & Shuttleworth, 1997), Trinidad and Tobago (Jackson, 2012), and New Zealand (Harker, 2000), which also did not identify any significant differential in academic results between co-education and single-sex education settings.

However, studies that measure academic achievement using classroom tests, school year, and teacher ratings (Gray & Wilson, 2006; Herr & Arms, 2004; Wills, 2007; Wills et al., 2006) or through standardised assessment scores (Daley & Defty, 2004; Mulholland et al., 2004) offer less conclusive results. The second trend posits that single-sex classrooms can indeed bolster the academic outcomes of both boys and girls (Herr & Arms, 2004; Hubbard & Datnow, 2005; Malacova, 2007; Mulholland et al., 2004; Robinson & Gillibrand, 2004; Titze et al., 2011) compared to their same-sex counterparts attending co-educational schools. Notably, studies focused on mathematics or STEM performance reveal that students of both genders in single-sex educational settings tend to outpace their counterparts in co-education schools within the US context. Yet, an intriguing pattern emerges where boys from single-sex schools exceed the performance of their female peers in similar schools, while in co-education settings, girls often surpass the boys (Cherney & Campbell, 2011). Doris, O'Neill, and Sweetman (2013) find that boys in single-sex schools are more likely to show better performance than their counterparts in co-education schools with little evidence of a similar effect for girls. When socio-economic factors

are considered, Robinson and Gillibrand (2004) found that single-sex classrooms benefited affluent students academically, while Daly and Defty (2004) showed that although girls excelled on the GCSE in these settings, boys performed worse compared to those in co-educational classes.

Self-confidence and efficacy

While self-confidence and self-efficacy are distinct concepts, there is a notable trend in research on single-sex schooling that uses these terms interchangeably. This conflation seeks to explore how the gender composition of schools influences students' self-perceptions and their broader relationship with their sense of self. For instance, Lee et al. (2014) emphasized that single-sex education does not necessarily ameliorate gender disparities in academic achievement between female and male students. Several factors, such as overcrowded classrooms (Heinesen, 2010), inadequate quality of teacher training, and the inability to cater to individual student needs, may precipitate adverse outcomes for students in single-sex education. These factors can result in a range of issues, from personal and emotional to social (Blair, 2013), further damaging their self-confidence.

However, the landscape of research in this domain is also driven with incongruities. Some qualitative studies propose that girls in co-educational classrooms often hesitate to seek assistance (Booth & Nolan, 2012; Hart, 2016). In contrast, single-sex educational environments provides a space for girls to develop confidence and take leadership (Bajaj, 2009), in single-sex institutions generally demonstrate higher self-esteem than those in co-educational settings, exhibiting increased confidence and elevated levels of self-efficacy (Gist & Mitchell, 1992; Spencer et al., 1999). Interestingly, this pattern doesn't mirror for boys; their self-esteem remains largely unaffected by the type of school they attend. Furthermore, girls in single-sex schools not only display heightened intrinsic motivation compared to boys in similar settings but also surpass girls in co-educational institutions in both self-esteem and achievement motivation (Cherney & Campbell, 2011). Critics argue that co-educational schools often perpetuate traditional gender roles, particularly by reinforcing submissive roles for girls (see Jackson, 2021). In such settings, girls might find themselves overshadowed by their male peers in classroom dynamics. Conversely, girls in single-sex institutions tend to receive more attention, leading

to enhanced opportunities to bolster their confidence (Hartman, 2010). Additionally, boys in single-sex schools exhibit heightened interest and self-efficacy in science subjects compared to their counterparts in co-educational settings (Park et al., 2018). However, this premise is contested by studies such as Evans (2014), which challenge the assumption that single-sex education is inherently better for enhancing girls' self-confidence and protecting them from male violence and bullying.

Communication skills

The self-confidence notably influences students' communication and socialisation, especially in honing interpersonal skills for interactions within mixed-gender contexts, thereby preparing them for post-schooling life. Robinson & Smithers (1999) highlight that single-sex schools have adverse effects on both girls and boys, recognising that confining young individuals to single-sex environments detrimentally impacts their social skills. Sukhnandan et al. (2000), for instance, highlighted girls do not get to interact with the opposite sex and miss out on the opportunity for social learning. The study by Cin et al. (2020) supports the findings discussed earlier but highlights the specific challenges faced by girls in single-sex schools located in patriarchal societies like Turkey. According to the study, gender norms and gender-based discrimination are deeply ingrained in Turkish society, and this context can negatively impact girls' social capabilities to establish relationships with boys, express their opinions, and voice their ideas in mixed-gender environments. The study argues that attending single-sex schools in such a context can deprive girls of a schooling process that could help them recognize their potential and abilities, leading to the development of submissive gender identities. This internalisation of gender inequalities can persist in their subsequent lives, affecting their social and professional outcomes. Likewise, Willis and Kenway (1986) and Marsh et al. (1988) emphasise that single-sex education deprives students of the academic and social benefits they can get from school. The ability to communicate with the opposite sex is emphasised as the most significant of these social benefits. The studies conducted in this context (Crawford-Ferre & Wiest, 2013) reported that boys show more behaviour disorders when they are divested of communicating with the opposite sex, and they behave differently than the boys attending co-education. Such skills have vital importance, particularly for girls' education, enabling them to be fully participating members of public life and to engage in equal social relations and shared ways of life. However, opinions on communication skills include which specific

skills may differ. For example, some researchers consider communication skills as sensitivity to verbal and non-verbal messages, listening effectively and reacting effectively (Baker & Shaw, 1987; Gibson & Mitchell, 1995), whereas another study states that communication skills include verbal, vocal, physical, tactile, movement-based messages and various mixtures of these messages (Nelson-Jones, 2002). There are also various studies in the literature that put forward active listening (Nurick, 1993; Rogers & Farson, 1976), verbal communication (O'Conner, 2003) and non-verbal communication (DePaulo, 1992) among others.

Research Questions

Drawing on these inconclusive and contradictory analyses in the literature, this research analyses the studies to investigate the effect of getting co-education or single-sex education in two stages; (i) revealing the effect of getting co-education or single-sex education on students' academic achievement, self-confidence, socialisation/communication skills and (ii) identifying the moderators that may affect average effect size. The following research questions were tested in this research:

RQ₁ Is there a difference in educational achievement between students who receive single-sex education and those who receive co-education?

RQ_{1a} Does academic achievement of the students who get co-education or single-sex education differentiate according to: (i) the culture in which the research has been conducted, (ii) the course forming the base of the academic achievement, (iii) school year and (iv) gender?

RQ₂ Is there a difference in self-confidence between students who receive co-education and single-sex education?

RQ_{2a} Does self-confidence of the students who get co-education or single-sex education differentiate according to: (i) the culture in which the research has been conducted and (ii) gender?

RQ₃ "Is there a difference in communication skills between students who receive co-education and single-sex education?"

RQ_{3a} Does socialisation/communication skills of the students who get co-education

or single-sex education differentiate according to: (i) the culture in which the research has been conducted and (ii) gender?

Methods

Research Design

We examined the impact of single-sex versus co-education on students' academic achievements, socialisation/communication skills, and self-confidence. We employed a meta-analysis approach, which involves drawing conclusions by amalgamating the findings from multiple independent studies focused on a specific topic or concept (Little et al., 2008). Our research was structured in accordance with the PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) guidelines, which provide a framework for authors presenting systematic reviews and meta-analyses. In terms of search criteria, data extraction, evaluation of methodological quality, and the analysis and interpretation of results, we adhered to the "APA Style JARS (Journal Article Reporting Standards; Quantitative Meta-Analysis Article Reporting Standards Information Recommended for Inclusion in Manuscripts Reporting Quantitative Meta-Analyses)".

Search and Review Phase

We first (i) established our search strategy. This strategy involved systematic searches of both published materials, such as journal articles, and unpublished works, including master's theses and doctoral dissertations. Next, (ii) we selected online databases to retrieve relevant studies, and primarily focused on databases that have a broad scope within the social sciences and a specific emphasis on educational research. For published research, we consulted Web of Science, Science Direct, ERIC, EBSCO, Scopus, Google Scholar, JSTOR, and PsycINFO. For unpublished research, we used ProQuest Dissertations & Theses Global. In the subsequent step, (iii) we identified and curated search phrases. Our selection of these terms was guided by the SPIDER criteria (Cooke, Smith, & Booth, 2012): (S) sample, (PI) phenomenon of interest, (D) design, (E) evaluation, and (R) research type (Table 1). To account for multiple spellings and derivations of certain terms, we incorporated truncation symbols (*)

where appropriate. Additionally, to ensure a comprehensive review, we undertook a thorough reference list verification, both backward and forward.

Table 1.

Terms used in SPIDER search

SPIDER Tool	Search Terms
S	“student*” OR “pupil*” OR “learner*” OR “young*” OR “schoolgirl*” OR “schoolboy*” OR “academe*” OR “scholar*” OR “schoolie*”
P of I	“co-education” OR “co-education” OR “single-sex” OR “single-sex education” OR “single-sex school*”
D	“questionnaire*” OR “survey*” OR “scale*” OR “achievement test*” OR “test*” OR “inventory*”
E	“achievement*” OR “success*” OR “socialisation*” OR “attitude*” OR “communication*” OR “self-confidence*”
R	“quantitative” OR “mixed method*”

Exclusion and Inclusion Criteria

Initially, we included all studies identified using the SPIDER criteria, without considering their methodological quality. Our inclusion and exclusion criteria were delineated based on SPIDER, as detailed in Table 2. Notably, some single-sex education studies predominantly focus on one gender, either girls or boys, and assess differences in achievement and other metrics in comparison to their counterparts in co-educational settings. We incorporated such studies into our research.

Table 2.

Inclusion and Exclusion Criteria

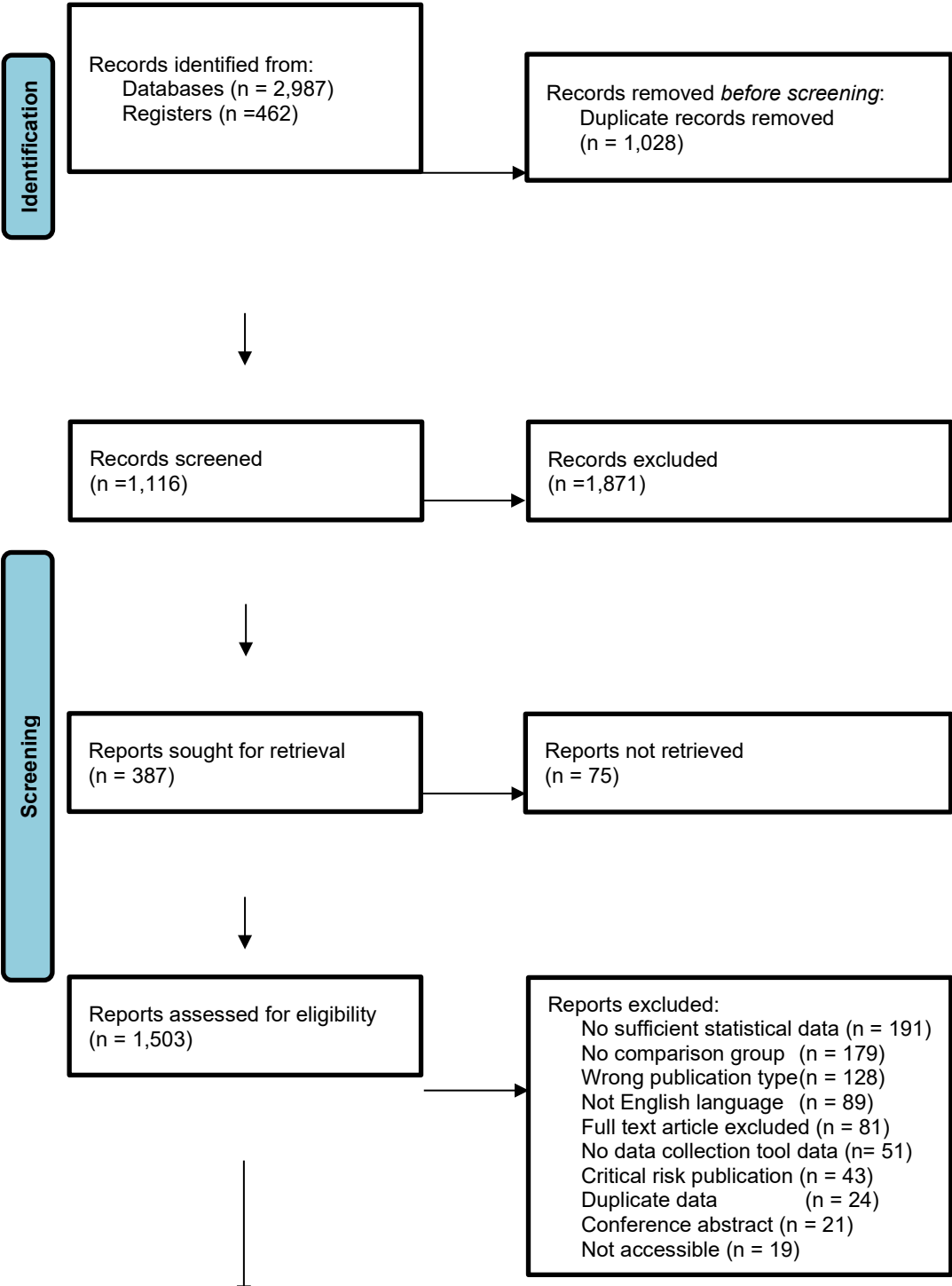
SPIDER Tool	Inclusion Criteria	Exclusion Criteria
Sample	The sample consists of K-12 students (elementary, middle, and high school)	The sample consists of university students, short-course participants, special education students, or

		vulnerable individuals, etc.
Phenomenon of Interest	The focus has been on the achievement, socialization/communication skills, or self-confidence of students in single-sex education/schools.	The focus is on co-education students.
Design	The data has been obtained through questionnaires, scales, and achievement tests.	The data has been obtained through interviews, observations, and document analysis.
Evaluation	To determine the effect size, adequate statistical data must be available: N ; mean and standard deviation or standard error; F , t , r and p values; Cohen's d ; Eta-Squared (η^2).	-
Research type	Studies designed using quantitative or mixed-methods research and published in English	Studies designed using qualitative, case analysis, systematic review, and meta-analysis

Study Selection and Data Extraction

During this phase, we focused on the title, keyword, and abstracts using specified search strategies across various databases. We performed two comprehensives forward and backward citation searches on all included studies. The initial search coincided with the date the study draft was drafted (15 February 2022), and a subsequent search was conducted in August 2023. Our search ended up with 3,449 studies. To organise our findings, we imported the studies from various databases into the EndNote program, and identified and removed duplicates studies, resulting in 2,421 unique studies. The first two authors meticulously reviewed the full texts of 2,421 selected studies. A data summarisation form, tailored to our inclusion criteria, was independently filled out by two researchers. During this screening process, we excluded any unrelated study to our core subject. In case of disagreements between the researchers, we referred to the original inclusion criteria, ensuring consensus was achieved.

As we intentionally kept our literature search broad, we realised that the majority of the studies were not related to the topic. For example, we excluded theoretical studies that did not report empirical data, studies containing qualitative data, and those merely mentioning “achievement,” “communication skills,” or “self-confidence” but not having them as study variables. Therefore, we further refined the studies to 1,503. However, only 677 of these studies met the inclusion criteria specified in Table 2. From the 677 study (see Additional Material) that met the inclusion criteria, a total of 789 effect sizes were determined (Figure 1. PRISMA flow chart).



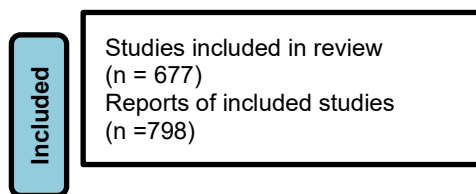


Figure 1. *PRISMA flow diagram*

Primary Study Quality (PSQ) Assessment

The quality assessment of individual studies highlighted in meta-research articles is a fundamental step to underpin the evidence synthesized by the meta-research (Dreirer, 2013). Several quality assessment tools, models, and criteria are available in the literature, such as CONSERT, NOS, STROBE, and RoB2. Given that the studies we incorporated into our meta-analysis are cross-sectional, we used the PSQ based on the STROBE guidelines. Our assessment considered the following components: study title/abstract (one item), introduction (two items), methods (nine items), results (five items), and discussion (four items) (von Elm et al., 2008). For the PSQ evaluation, we allocated a risk of bias rating—low, moderate, serious, or critical—to each component of the studies. Upon examining the distribution of all the included studies based on the risk of bias rating for each component, only 6% of the studies were found to have a “critical” risk of bias (Figure 2). We excluded studies with a critical rating ($n = 43$) from our final analyses. In studies with identified risks, essential details like the setting, locations, relevant dates, data collection methods, data sources/measurement, study size, and statistical methods were insufficiently described.

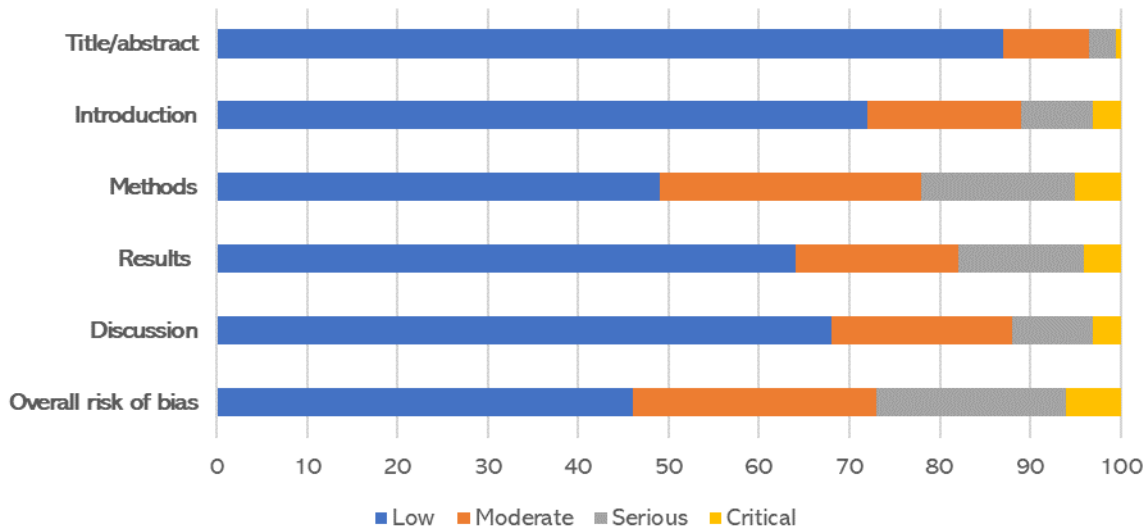


Figure 2. *Bias risk*

Data Analysis

Prior to the analyses, we formulated both a general coding system that could encompass all studies and a more specific system to capture the unique characteristics of each individual study. Two coders, the first two authors of this study, independently coded all the studies. The data extracted encompassed statistical information such as sample sizes, means, standard deviations or errors, f or t values, and p values. Additionally, we gathered information related to potential moderators. In instances of disagreement during coding, the coders collaboratively reviewed each study until a consensus was achieved. The inter-coder reliability, as measured by *Cohen's Kappa*, was determined to be .97. Given the diverse methods used to measure trust across studies and the anticipated heterogeneity, we employed a random effects model for our data analysis (Hunter & Schmidt, 2004). The standardized mean difference (Cohen's d) and 95% CIs were used as the effect size (ES) measure. Co-education (CE) was considered as the reference group in our analyses. Therefore, the positive d coefficient indicates that the difference between group averages (Co-education – (minus) Single-sex Education) is in favor of the co-education group, and the negative d coefficient shows that the difference is in favor of single-sex education.

We carried out subgroup analyses to examine the potential effects of variables like the cultural context of the study, the type of achievement (course), school level, and the gender characteristics. To assess publication bias, we visually examined the Funnel Plot and performed a Trim and Fill analysis.

For the analysis procedures, we used Excel and the Comprehensive Meta-Analysis (CMA, version 2) software, with a significance level set at 0.05.

Findings

Search Results

From our comprehensive scan of databases, coupled with forward and backward citation searches, we identified 3,449 studies. After removing duplicate studies, we had 2,421 potentially appropriate articles. At the full-text review stage, 1,503 of these were examined in detail, out of which 826 were excluded for not meeting the inclusion criteria. Consequently, out of the 677 studies left, 443 were incorporated into the quantitative synthesis for academic achievement, 196 for socialisation/communication skills, and 159 for self-confidence (see Figure 1).

Characteristics of the Reviewed Studies

The review encompassed a total of 1,179,558 participants. From this number, 659,549 participants were considered in meta-analytic computations for academic achievement, 250,699 for socialisation/communication skills, and 269,310 for self-confidence. Specifically:

- For academic achievement, the meta-analysis consisted of 400,043 participants from co-education groups and 259,506 from single-sex education groups.
- For communication skills, the meta-analysis incorporated 147,043 participants from co-education groups and 103,656 from single-sex education groups.
- For self-confidence, the meta-analysis took into account 126,929 participants from co-education groups and 142,381 from single-sex education groups.

The gender distribution of participants in the meta-analysis showed that girls constituted between 39% and 62% of the sample. Geographically, the studies analysed were from North America, Europe, Asia, and Africa.

Publication Bias

We initially assessed the presence of publication bias using the funnel plot method. As depicted in Figure 3, we did not identify any evidence that suggests publication bias among the studies in our meta-analysis. A notable asymmetry in the funnel plot is typically indicative of publication bias. Specifically, a clustering of studies, particularly on the right side of the average effect size line situated at the funnel's base, may signify potential publication bias (Çoğaltay & Karadağ, 2015).



Figure 3. Effect size funnel pertaining to publication bias

Subsequent to the funnel plot analysis, we used Duval and Tweedie's trim and fill test to ascertain the magnitude of potential bias affecting the effect size derived from our meta-analysis. The results showed no significant discrepancy between the real effect size and a hypothetically adjusted effect size designed to account for bias originating from unpublished studies (Table 3).

Table 3.

Results of Duval and Tweedie's trim and fill test

		Excluding	CI			Q
		Study	d	Lower Limit	Upper Limit	
<i>Achievement</i>						
Observed values			.026	.007	.045	5,701.47
Adjustment values		0	.026	.007	.045	5,701.47
<i>Self-Confidence</i>						
Observed values			.537	.497	.578	4,129.76
Adjustment values		0	.537	.497	.578	4,129.76
<i>Communication Skills</i>						
Observed values			.219	.187	.252	2,922.63

Adjustment values	0	.219	.187	.252	2,922.63
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The Effect of Receiving Co-education vs. Single-Sex Education on Students' Academic Achievement

The results of the meta-analysis detailing the impact of receiving co-education versus single-sex education on students' academic achievement are presented in Table 4. The findings suggest that the type of education, whether co-education or single-sex, does not influence students' academic achievement. The Standardised Average Effect Size was determined to be .027 according to the random effects model (d), and it is not statistically significant. This finding indicates that *the academic achievement of students who receive co-education is similar to those who receive single-sex education*

The studies were sorted out as (i) Vertical-Collective Culture (Eastern Culture) and (ii) Horizontal-Individualistic Culture (Western Culture) according to the culture in which the research has been conducted (Triandis, 1995). As a result of the conducted moderator analysis, the academic achievement of the students who get single-sex education in vertical-collective culture is relatively higher than those who get co-education, but this difference is not statistically significant. According to this finding, *neither co-education nor single-sex education impacts students' academic achievement in either Western or Eastern cultures.*

According to moderator analysis, academic achievement, school year, and research sample do not influence the students' academic outcomes based on whether they receive co-education or single-sex education. The overall achievement, mathematics performance, science performance, social science performance, and language/literature performance of students attending schools that offer either co-education or single-sex education are comparable.

The outcomes of the last moderator analysis show that the differences of standardized means of the samples (girls & boys), in which the research has been conducted, are statistically significant ($p < .05$). According to the finding of the analysis, *girls show better academic achievement in co-education schools compared to all-girls schools.* This trend is not observed for boys.

Table 4.

The effect of receiving co-education or single-sex education on students' academic achievement: The

results of the meta-analysis

Concepts	k	N _{CoE}	N _{S-SE}	d	CI		Q	Q _b
					LL	UL		
Co-education/Single-sex Education	443	400,043	259,506	.027	.008	.046	5,701.47	
Moderator [Culture]								2.28
Vertical-Collective Culture	243	195,235	114,338	.001	-.016	.044		
Horizontal-Individualistic Culture	300	204,808	145,168	.043	.021	.065		
Moderator [Courses]								7.52
Math	128	105,272	76,984	.037	.063	.083		
Science	99	87,776	54,638	-.035	-.030	-.040		
Social Science	30	30,902	14,577	.041	.021	.062		
Language	88	89,794	52,561	.097	.086	.108		
Moderator [The level of education at the school]								.062
Elementary	194	183,169	110,363	.030	.002	.057		
High School	249	216,874	149,143	.025	-.002	.051		
Moderator [Gender]								73.422*
Female	85	87,128	54,328	.119	.107	.131		
Male	107	65,587	72,823	-.034	-.088	.020		

* $p < .01$; CoE = Co-education; S-SE= Single-sex Education; LL= Lower Limit; UL= Upper Limit

The Effect of Receiving Co-education vs. Single-Sex Education on Students' Self-Confidence

The results of the meta-analysis, which explore the impact of receiving co-education or single-sex education on students' self-confidence, are presented in Table 5. The findings suggest that the type of education, be it co-education or single-sex, does influence students' self-confidence. The standardized average effect size for self-confidence, calculated according to the random effects model, is $d = .530$.

This value indicates a moderate-to-high and statistically significant level of self-confidence, suggesting that *students receiving co-education exhibit higher self-confidence*.

Concerning the moderator analysis, in both Western and Eastern cultures, students who receive co-education exhibit higher self-confidence compared to their counterparts in single-sex education. Another moderator analysis reveals statistically significant differences in the standardized means of the samples (girls & boys) where the research was conducted ($p < .05$). From this, it can be inferred that co-education has a greater impact on the self-confidence of girls than on boys.

Table 5.

The effect of receiving co-education or single-sex education on students' self-confidence: The results of the meta-analysis

Concepts	k	N _{CoE}	N _{S-SE}	d	CI		Q	Q _b
					LL	UL		
Co-education/Single-sex Education	159	126,929	142,381	.530	0.497	.579	4,129.76*	
Moderator [Culture]								1.237
Vertical-Collective Culture	108	83,143	96,618	.522	.473	.570		
Horizontal-Individualistic Culture	51	43,777	45,763	.572	.498	.645		
Moderator [Gender]								92.691*
Female	75	61,867	61,236	.723	.661	.785		
Male	47	34,597	37,802	.373	.324	.422		

* $p < .01$; CoE = Co-education; S-SE= Single-sex Education; LL= Lower Limit; UL= Upper Limit

The Effect of Receiving Co-education vs. Single-Sex Education on Students' Communication Skills

The results of the meta-analysis, examining the impact of receiving co-education or single-sex education on students' communication skills, are presented in Table 3. The findings suggest that the type of education, whether co-education or single-sex, influences students' communication skills. The

standardised average effect size, calculated according to the random effects model, is $d=.210$. This value denotes a moderate and statistically significant effect. Consequently, this indicates that *students who receive co-education demonstrate better communication skills compared to their counterparts in single-sex education.*

The moderator analysis reveals that in both Western and Eastern cultures, students who receive co-education display superior communication skills compared to their counterparts in single-sex education. Another moderator analysis indicates statistically significant differences in the standardized means of the samples (girls & boys) ($p<.05$). Accordingly, the difference in communication skills between SS and CE schools is higher for girls than for boys.

Table 6.

The effect of receiving co-education or single-sex education on students' communication skills: The results of the meta-analysis

Concepts	k	N _{CoE}	N _{S-SE}	d	CI		Q	Q _b
					LL	UL		
Co-education/Single-sex Educatio	196	147,043	103,656	.210	.202	.219	2,922.63*	
Moderator [Culture]								3.064
				.24				
Vertical-Collective Culture	104	77,126	61,118	.08	.200	.296		
Horizontal-Individualistic Culture				.18				
Culture	92	69,917	42,538	.08	.145	.230		
Moderator [Gender]								63.443*
				.35				
Female	45	32,961	28,345	.08	.324	.391		
				.15				
Male	79	57,353	40,866	.03	.113	.192		

* $p<.01$; CoE = Co-education; S-SE= Single-sex Education; LL= Lower Limit; UL= Upper Limit

Discussion

In this research, we aimed to explore the effect of getting co-education or single-sex education on students' academic achievement, self-confidence, and communication skills and covered 677 studies (798 effect size) and 1,179,558 samples, taking (a) the culture in which, the research has been conducted, (b) subject of academic achievement, (c) school year and (d) gender as moderator variables.

The primary finding from this meta-analysis indicates that both co-education and single-sex education (SS) exhibit a neutral impact on academic achievement. This result aligns with the findings of studies (Chouinard et al., 2008; Daly & Defty, 2004; Kessels & Hannover, 2008) that highlight that there is no statistical significance between how single-sex and co-education schooling affect achievement. Despite the dominant assumption that single-sex education benefits both boys and girls in terms of increasing their academic performance, the findings of several other research echo our findings. For instance, Halpern et al. (2011) argue that empirical evidence that claims students perform better in single sex (SS) schools does not provide strong empirical evidence on the organisation of these schools and is driven by sampling bias. Likewise, the research of Harker (2000) and Robinson and Smither (1999), which draw on large-scale data sets, show no difference in the academic outcomes of children in SS and co-education schools. Furthermore, a meta-analysis of 184 studies that included approximately 1.6 million students in K–12 from 21 nations did not support the view that single-sex schooling provided benefits compared with co-ed schooling (Pahlke et al., 2014). Malacova (2007), in her research, challenged the assumption that single-sex schools perform better, showcasing that single-sex schools recruit pupils with higher initial academic achievement and from higher social-economic backgrounds compared to co-education schools and highlighting the importance of prior attainment as an important variable. Hubbard and Datnow (2005) conclude that single-sex schools' success can be attributed to schools' organisational characteristics, positive student-teacher relationships, and ample resources" than to the fact that they were single-sex (p. 115). Similarly, James' (2010) ethnographic case study on African American boys highlights the advancement of both social and academic excellence and posits that it remains uncertain whether these achievements are solely attainable within a single-sex setting. Instead, these subjects and skills appear to be essential components that ought to be imparted in all educational institutions and are indeed prevalent in well-resourced and efficiently-managed co-

education schools.

On the other hand, when examining the effect of gender as a moderator, we found that girls who receive co-education outperform their counterparts in single-sex education. This aligns with other meta-analysis research on academic achievement across different school types in the US. Notably, Pahlke et al. (2014) highlight that gendered schools don't offer any advantages in terms of attainment when compared to co-educational institutions. This may be related to the passive forms of femininities being promoted in gendered schools where girls are socialised into behaviours homogenising gender roles (Bhana & Pillay, 2011), affecting not only their academic achievement and aspirations but also their social skills and confidence as we will discuss below. There is, however, no such difference for boys.

The second finding challenges the popular view and assumption that single-sex schooling provides safe spaces and environments where girls can freely participate in school and classroom discussions, speak up, be free from sexual violence and, bullying and oppressive behaviours of boys, with the expectation that this may lead to better academic achievement and build self-confidence. Our analysis shows that boys and girls in co-education have more self-confidence than those in single-sex schools.

One of the most important findings of our analysis is that especially girls in co-education have significantly higher self-confidence than their female peers in SS education. Pahlke et al. (2014) concluded that the difference in self-concept between SS and co-education schools is low. However, it was reported that moderator analyses were not possible for female students in SS and co-education schools in the study. Our analysis draws attention to the differences between SS and co-education schools in terms of self-confidence, especially for girls. The reason for this situation is intriguing as some studies have concluded that there may be a correlation between self-concept and self-confidence (For example, Morony et al., 2012). However, it is also argued that these concepts do not predict structural differences and success to the same extent. Morony et al., (2012) put forward that the main difference between these two concepts is that whereas trust is related to tasks that have just been completed, the self-concept involves comparison with other people, and stated that there is no visible relationship between these two concepts, which explains the difference between Pahlke et al.'s (2014) and our study. Besides, there are no outliers in our analysis regarding the difference in self-confidence

among female students in co-education and SS. Also, when the studies included in the analysis are examined, it is clear that the factors that may affect the effect size (such as class size, public/private school, teacher characteristics) are similar and there is no quality difference between primary study and ours.

The research (Evans, 2014) on single sex education and girls supports this conclusion and argue that co-education provides a more gender-equal setting where both sexes are treated on equal footing and girls are no less confident than boys when gendered structures are mitigated by their environment (Fitzsimmons et al., 2021). In collectivist societies, traditional gender roles are often less deconstructed and go unquestioned. This leads to heightened levels of perceived pressure to conform to gender norms, especially in single-sex schools (Dury et al., 2013). What we observe is that co-education acts as a mitigating factor. In collectivist societies, students attending co-educational institutions have considerably higher self-confidence than those attending single-sex schools. As a result, such schools potentially disrupt, if not neutralise, prevailing patriarchal attitudes that may underlie the social and gendered norms and obligations.

The last finding is that those who get co-education have higher communication skills than their peers who get single-sex education, and as far as girls' education is concerned, co-education positively affects the communication skills of girls more than male students. One of the frequently highlighted weaknesses of SSE in the literature is the lack of social experience and communication skills one may develop with the other sex (Crawford-Ferre & Wiest, 2013). This is also followed by the negative behaviors both boys and girls may develop in single-sex education environments, such as bullying or intimidation. Despite studies suggesting that single-sex education can reduce girls' anxiety and create a conducive space for them, this benefit is realised only with gender-specific learning strategies and not merely through physical single-sex schooling structures (Hart, 2016). Further research (Hubbard & Datnow, 2005) also focused on how single-sex education settings were able to reduce some distractions and harassment from the other sex, whereas an increasing number of research (Crawford-Ferre & Wiest, 2013; Spielhagen & Milczarski, 2013) showcase how boys became more aggressive in single-sex classes compared to mixed classes. Recent studies suggest little social and psychological benefit of single-sex education; on the contrary they talk about the potential gendered stereotypes reinforced by these schools

(Fabes et al., 2013; Glasser, 2012). As Halpern et al. (2011) have argued, single-sex education does not provide neither the youth nor the educators with a conducive environment to develop and sustain healthy friendships and relationships with members of the other sex. In both collectivist and individualist societies, we observe that students in co-educational settings develop better communication skills compared to their peers in single-sex schools. Additionally, co-education has a more pronounced influence on girls' communication skills, leading us to conclude that co-educational institutions help mitigate the effects of gendered effects of single-sex schools.

Conclusion

This paper presents findings from a comprehensive meta-analysis of single-sex and co-education schooling to provide more conclusive results of the burgeoning literature over the last two decades. Separating students by sex may reify the problematic beliefs about gender differences. Given that girls develop more self-confidence in co-education schooling, the argument that single-sex schools will reduce tensions between boys and girls and the stereotypical belief about girls do not seem convincing. Similarly, academic achievement cannot be explained with co-or-single sex education and de-validates the assumptions that girls will be much more successful because they will be studying in gendered schools where hegemonic and toxic masculinities will not impede their educational well-being. Our findings also highlight the political nature of these debates by showcasing that academic achievement is often used as a justification for promoting single-sex schools on the grounds that they provide spaces free from gender and stereotypical constructs and sexual tensions.

Nevertheless, as argued above, it is often underestimated that these schools indeed endorse the differences between sexes and deepen the gender constructs creating highly binary categories (see Gallagher, 2012) to the extent that this impacts their socialisation patterns, skills and position themselves in relation to the other sex. This research shows that single-sex and co-education schooling has much more profound implications for students' communicative skills and capabilities, such as being more confident, having self-confidence, and developing healthy social relations with the opposite sex. Particularly, the girls enhance their self-confidence and ability to make friends and establish meaningful relations. In conclusion, this study suggests that gendered types of schools and environments do not

provide much benefit to girls and mixed-gender schools are likely to increase girls' ability to communicate effectively and self-confidence.

Co-education plays a crucial role in enhancing and sustaining girls' social skills, communication skills, and, most importantly, self-confidence. On the other hand, the dominance of single-sex education might influence girls' experiences, potentially hindering their expression and decision-making processes. Consequently, this might exacerbate gender inequalities in society, potentially diminishing transformative progress where women are not considered on equal terms with men.

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