

**SCIENCE CAPITAL: A SYSTEMATIC REVIEW OF RESEARCH BETWEEN 2015-2021**

***CAPITAL DA CIÊNCIA: UMA REVISÃO SISTEMÁTICA DE PESQUISAS ENTRE 2015-2021***

***CAPITAL DE LA CIENCIA: UNA REVISIÓN SISTEMÁTICA DE LA INVESTIGACIÓN ENTRE 2015-2021***

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**ABSTRACT:** This paper presents a qualitative review of research on science capital considering 51 studies with topics related to this concept, between 2015 and 2021. In addition to the increase in research evidenced by the number of publications on the topic during this period, and the dominance of the United Kingdom in leading research in the area, we observed that topics associated to science capital vary from choosing careers in science, identifying with science and promoting a science culture, to the role of school in developing science capital and the ways to evaluate it. It is common for *science engagement*, associated to science capital, to be seen through the alignment of three important Bourdieusian concepts: capital, *habitus* and field. In this sense, due to the relevance that the topic has had in science research, we assert the importance of a systematic review that can provide an overview of current investigations involving science capital.

**KEYWORDS:** Pierre Bourdieu. Science engagement. Scientific literacy.

**RESUMO:** Este artigo apresenta uma revisão qualitativa de pesquisas sobre o capital da ciência, conceito inspirado na sociologia de Pierre Bourdieu, considerando 51 estudos com temas relacionados a esse conceito, entre 2015 e 2021. Além do aumento de pesquisas evidenciado pelo número de publicações sobre o tema nesse período, e o domínio do Reino Unido nas pesquisas de ponta na área, observamos que os temas associados ao capital da ciência variam desde a escolha de carreiras na ciência, passando pela identificação com a ciência, pela promoção de uma cultura científica, até o papel da escola no desenvolvimento do capital da ciência e as formas de avaliá-lo. É comum que o engajamento com a ciência, associado ao capital da ciência, seja percebido por meio do alinhamento de três importantes conceitos Bourdieusianos: capital, *habitus* e campo. Nesse sentido, devido à relevância que o tema tem tido na pesquisa científica, afirmamos a importância de uma revisão sistemática que possa fornecer um panorama das investigações atuais envolvendo o capital da ciência.

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**PALAVRAS-CHAVE:** *Pierre Bourdieu. Engajamento da ciência. Letramento científico.*

**RESUMEN:** Este artículo presenta una revisión cualitativa de la investigación sobre el capital de la ciencia considerando 51 estudios con temas relacionados con este concepto, entre 2015 y 2021. Además del aumento de la investigación evidenciado por el número de publicaciones sobre el tema durante este período, y el predominio de Reino Unido en investigación líder en el área, observamos que los temas asociados al capital de la ciencia varían desde la elección de carreras científicas, la identificación con la ciencia y la promoción de una cultura científica, hasta el papel de la escuela en el desarrollo del capital de la ciencia y las formas de evaluarlo. Es común que el compromiso científico, asociado al capital de la ciencia, se vea a través de la alineación de tres importantes conceptos bourdieusianos: capital, habitus y campo. En este sentido, dada la relevancia que ha tenido el tema en la investigación científica, afirmamos la importancia de una revisión sistemática que pueda brindar un panorama de las investigaciones actuales que involucran el capital de la ciencia.

**PALABRAS CLAVE:** Pierre Bourdieu. Compromiso científico. Alfabetización científica.

## Overview

Between the years 2015 and 2016, mainly starting with the publication by Archer *et al.* (2015), the concept of science capital started to spread in the scientific literature. Inspired by the concept of symbolic capital from the Frenchman Pierre Bourdieu (1972, 1975, 1976, 2003), the researchers developed an extension of it, regarding the ways in which people establish relationships with science, producing different degrees of engagement (ARCHER *et al.*, 2015). Science capital determines degrees of individual involvement/participation in science based on an analysis of historical, social and cultural factors that have defined one's path.

In the paper entitled "*Science capital*": a conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts, Archer *et al.* (2015) defines science capital according to an approach to the Bourdieusian concept of *cultural capital*. The authors assume the value added to the concept, which had been related to forms of social and cultural capital in a publication by the same group (ARCHER; DEWITT; WILLIS, 2014), in explaining and understanding motivations, to the opportunities that enable determined groups to have more or less access to science than others.

Going beyond the 2014 study, Archer *et al.* (2015) observed an unequal distribution of science capital in English students between 11 and 15 years of age. The research showed that the unequal distribution of this capital is intimately related to factors such as culture, gender and ethnicity, for example. This result also confirms the relationship the subjects establish with science after age 16 and their choices for science careers. Based on the observation of the

significant difference in answers among the individuals, divided into groups with high, medium or low science capital, the researchers establish important and current methodological-conceptual questions regarding the concept.

Jensen and Wright (2015), in turn, provide a critique of the studies by Archer *et al.* (2015), as they considered it unnecessary to introduce the concept of science capital associated to the work of Bourdieu. Though the authors agree that there is a purpose for it, they argue that, given the concept of *cultural capital* (which developed within the sociology of the French author), a science capital, which is also symbolic in nature, could be understood as a capital related to culture, thus, being cultural.

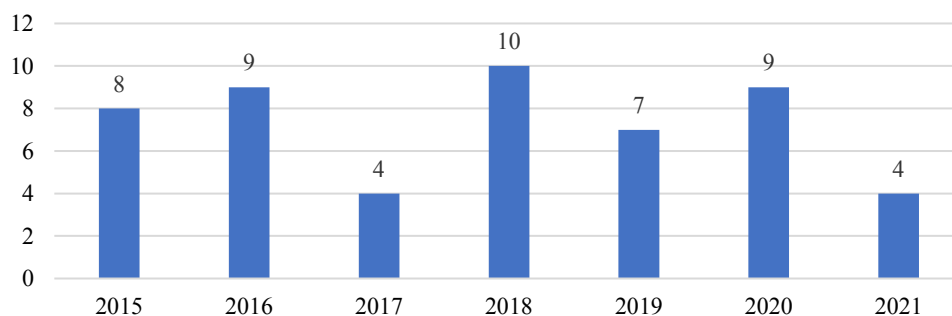
In the words of Jensen and Wright (2015), it is not a “pedantic dispute”, but an unnecessary creation of a term related to science given that the concept of cultural capital is sufficient to address the unequal socio-economic-cultural distribution patterns. As such, an analysis of the types of social difference and the reproduction of inequalities could be made from the perspective of a previously existing and functional term. The authors add that the creation of science capital could produce a kind of overlap in analyses that have been done on the concept of *cultural capital*.

However, science capital progressed, as will be discussed below. In this study, we searched for papers that use the concept of science capital from 2015 to 2021, described below.

## Methodology

From Archer *et al.* (2015) publication up to July 2021, 51 studies on the topic were selected to write the present paper (Figure 1).

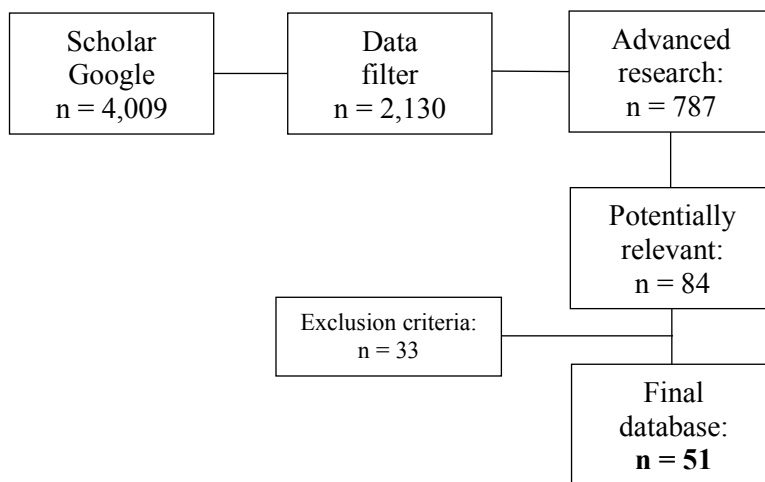
**Figure 1**–Science capital research between 2015-2021



Source: Prepared by the authors (2021)

To find these papers, we conducted a search on Scholar Google platform, searching for the term “Science Capital” and resulted in approximately 4.009 results (Figure 2). After filtering by the years 2015 and 2021, the result was 2,130 documents, but most didn’t address Archer *et al.* (2015) science capital. To find only articles that use Archer's science capital concept, we apply the advanced search to find articles ‘With all the words’: Archer; and ‘With the exact phrase’: “Science Capital”; which resulted in 787 documents. Of these, we selected documents whose title demonstrated the use of science capital conceptualization in the research, excluding those who only cited the research by Archer *et al.* (2015), resulting in 84 documents. Furthermore, in this qualitative review, we only considered papers published in scientific journals or book chapters, in English, and with open access, which result in 51 papers (Appendix 1).

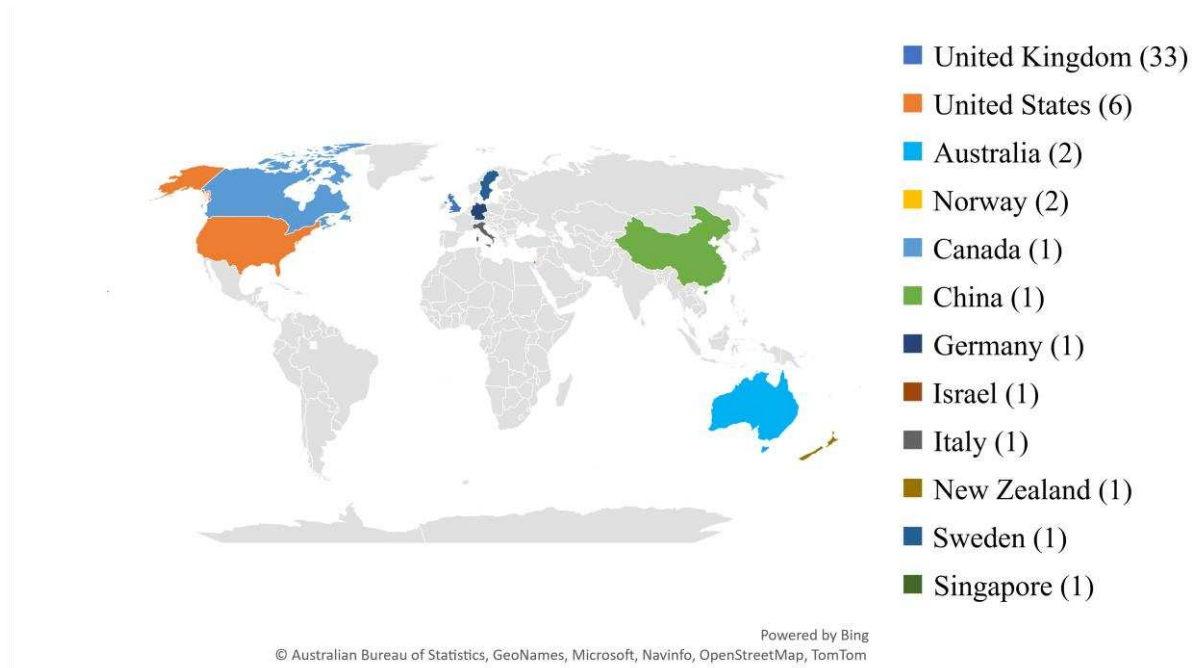
**Figure 2 – Review Process**



Source: Prepared by the authors (2021)

It is worth noting that of the 51 studies found in preparation of this review article, an analysis of the authors’ affiliation provided us with an overview of the countries and the institutions that are doing research on science capital (Figure 3).

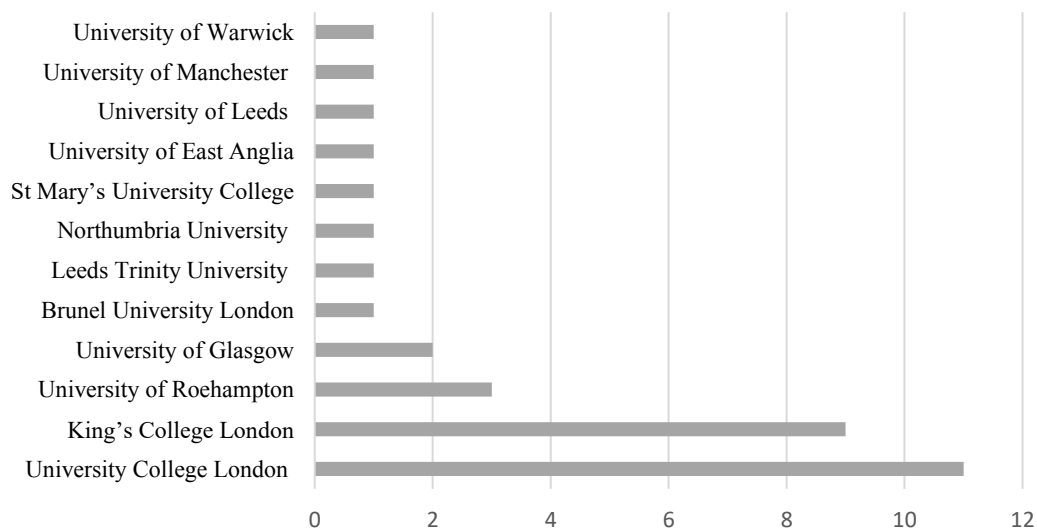
**Figure 3** – Science capitalresearch-related engagement by region between 2015-2021



Source: Prepared by the authors (2021)

Among the researcher affiliations in the United Kingdom, King’s College London and University College London stand out in the research on science capital (Figure 4). Upon analyzing the publications, we observed some joint publications, as well as researcher mobility from one institution to another.

**Figure 4** – Science capital most engaged Research Institutions between 2015-2021



Source: Prepared by the authors (2021)

The fact is that even from the critical perspective of Jensen and Wright (2015), the publication by Archer *et al.* (2015) had an important impact on the definition of a field of research related to science capital, because it stipulated some important conditions associated to this concept. Questions such as “what do you know?”, “how do you think?”, “what do you do?” and “who do you know?” are important for understanding and establishing different levels of science capital.

Based on these questions, the authors establish eight important aspects to be considered. They are: (a) *science literacy*, (b) *science-related attitudes and values*, (c) *knowledge about the transferability of science*, (d) *consumption of science-related media*, (e) *participation in activities in and out of school*, (f) *family science skills, knowledges and qualifications*, (g) *knowing people in a related science job/role* and (h) *talking to others about science* (ARCHER *et al.*, 2015).

Most of the publications selected discuss the engagement of groups considered “minorities” in science. Topics such as participating in science, choosing careers related to science, identifying with science, promoting a science culture, the role of school in developing science capital, and the topic of inclusion/exclusion in science, are recurrent in these publications, as well as ways to evaluate science capital. Next, we will analyze each work.

## Results and discussion

The underrepresentation of certain groups and the distribution pattern of inequality can be explained by Bourdieu (1979) and his concept of cultural capital. In the case of science capital, we can analyze the situation regarding access to and participation in science. Archer and DeWitt (2015) discuss the lack of mandatory science in school and discuss the aspirations that children and adolescents between ages 10 and 14 have in relation to science careers. The researchers observed that children who have this aspiration in primary school and continue to have it in secondary school, a result of positive interactions with scientific content, are much more likely to choose a career in science. However, the authors did not confirm the relation between positive attitudes towards science in school and in the family as definitive and decisive in choosing a career in science.

Archer, DeWitt and Osborne (2015) emphasize the concerns of policies that aim to decrease gender, racial and ethnic stratification observed when analyzing individual participation in science, considering mathematics and engineering. The authors analyzed a

sample of black students from Africa and the Caribbean and showed that, in this population, choosing science is less “conceivable” for them.

Considering the importance of school in promoting actions related to fostering science capital, King *et al.* (2015) report on the findings of a one-year pilot program aimed at the professional development of secondary school teachers. Over the course of the program, the educators discussed ways to develop science capital and to implement practices related to it in their classrooms. According to the researchers, the concept of “science capital” seemed “convincing” to them and is compatible with their prior experiences and intuitive understanding of science. The authors even claim to have observed differences in the way in which teachers operationalize practices related to science capital.

In a study with children and adolescents from 10 to 14 years old, Archer and DeWitt (2015) associated gender with choosing a career in science. The researchers determined that the type of femininity expressed by the girls is decisive in whether they decide to choose a career in science or not. Moreover, they observed that the association between intelligence and masculinity is one of the factors that makes it difficult to create femininities capable of accepting science for themselves.

Salehjee and Watts (2015) followed 12 scientists in relation to their careers *towards* or *away from* science. They also observed three different types of transitions by these professionals. The first is a smooth transition where those interviewed always knew what they were doing and were aware of their choices. Here, we highlight the role of the family and peers of these professionals and their shared tastes and hobbies relating, or not, to science.

Besides the smooth transition, there may have been a wavering transition. This refers to there being some ambivalence at the time of choosing, which may be the result of a shaping event, though not necessarily the only or decisive one. Here, the subjects may have chosen any area - into or out of science - but due to influence, indecision or a lack of commitment, they ended up choosing one of them. Contrary to the wavering transition, a transformative transition is about events that determined a subject’s decision, choice for, or against, science, showing that from this point forward, they became resolute with respect to their choices.

Henriksen, Dillon and Pellegrini (2016) write about choosing a profession in STEM (*Science, Technology, Engineering and Mathematics*) areas. They consider the structure of academic curricula to be a crucial factor for this choice, in addition to observing that it is often not only about what people want to do, but who they want to be. The authors also focus on an important issue: keeping students in STEM areas is as important as recruiting new ones.



This means that not only the school, but also the higher education curriculum, should offer an important and significant experience to students.

In an attempt to refine the concept of science capital, DeWitt, Archer and Mau (2016) analyzed a sample of students in England, in schools located in areas considered disadvantaged. The researchers found a difference in association between cultural capital and science capital with respect to observing student aspirations for science careers. They observed that, between the two, science capital was more decisive in choosing, or not choosing, a career in science. Moreover, the aspects established by Archer *et al.* (2015), such as *scientific literacy, perceived transferability and usefulness of science*, as well as family influence, were shown to be the most important for engagement with science.

Padwick *et al.* (2016) indicate the considerable cost of interventions related to promoting diversity in STEM areas. Nonetheless, authors claim that, in the United Kingdom, less than 10% of engineers are women. By claiming the importance of developing science capital as a way to capture individuals in science, the authors present a possible approach for evaluating it in children from 7 to 11 years of age. The children in this age range identified scientists mostly as hard-working, kind, and creative; in an intermediate age range, as smart, funny and sensitive; and less as strange, friendly and cool. This perception was true regardless of gender, though sex, age and science capital influenced children to identify themselves with the figure of a scientist. The authors claim that decreasing this gap may be associated to future engagement in science.

Black and Hernandez-Martinez (2016) investigated the role of “capital” and “identity” in student involvement in programs in which mathematical requirements were highlighted. Therefore, they researched what led students to choose programs in which the curricula presented a demanding mathematical requirement. Upon observing that they justify this choice in different ways, the authors suggest revising the concept of science capital, considering that some students can accumulate it, having it as an exchange value, while others recognize its importance in use, which produces different ways of engaging in science.

Wong (2016a) conducted an exploratory study based on 46 interviews and 22 hours of classroom observation with British students between ages 11 and 14 with Black, Bengali, Pakistani, Indian and Chinese ethnicities. The research demonstrated that students from minority ethnicities participate in science in different ways. As such, they establish different engagements with science, which demonstrates - contrary to common sense in scientific literature - that when they are analyzed, these groups are not homogeneous. This is evidence that even for these groups, different and specific policies should be considered.

In another study, Wong (2016b) associates the concept of *habitus*, by Pierre Bourdieu (1979), to minority groups in science. Therefore, the author attempts to address the concept of science capital, questioning how it is internalized in these groups. Based on this, the author examines the level of this capital in these communities, if their access is structured by ethnicity, gender and social class, highlighting studies that indicate the importance of science capital in continuing scientific studies in the post-obligatory stage, that is, when studying science becomes optional.

Wong (2016c) writes further about youth participation in science. Based on a sample of 460 British young people between 14 and 18 years of age who were interviewed, 57% had visited at least one informal learning environment. Therefore, outside of school, there are other possible types of student engagement in science: at home or in Informal Science Learning Environments (ISLEs).

Upon observing three times more men than women employed in STEM-related industries in Northern Ireland, Conlan (2016) decided to investigate gender and science engagement. She observed that a small number of women take courses in these areas and, subsequently, studied successful strategies developed in a primary school, promoting them as a professional development resource. The author believes that increasing the number of women in jobs in STEM-related industries can positively impact the economy of the country.

Considering an intercultural perspective, Banner (2016) claims it is important that people from different cultures are not simply assimilated but are seen and heard in determined communities. For the author, this makes learning opportunities more significant in these social groups, while encouraging students from minority ethnic groups to engage in science. Consequently, once they are seen and perceived by the school, a range of practices can be designed to bring science culture closer to their realities, since it softens the barrier between science and its cultural expression.

Archer *et al.* (2016) addresses the importance of expanding participation in science. They associate this importance to ISLEs, though they recognize that their use is still limited. During the study, 10 parents and 10 children from urban schools visited a large museum, where their statements revealed experiences that were “fun”, “disorientating” and/or “meaningful” based on pre- and post-visit interviews. Therefore, they aimed to understand the experiences of disadvantaged families in relation to these spaces that the authors believe promote equity and inclusion.

Nomikou, Archer and King (2017) investigated building science capital in the classroom. In this study, the researchers worked with secondary teachers in England to

explore the concept of science capital in practice, based on the topic of “social justice”. This decision was meant to engage a greater number of students from diverse backgrounds in the discussion. The authors emphasize the importance of eliciting, valuing and linking students’ own experiences to an improved reflection on science capital.

In this study, DeWitt and Archer (2017) value informal learning spaces as a valuable opportunity to learn science, highlighting them as an integral part of a STEM ecosystem. Therefore, in a study involving 6,000 children between the ages of 11 and 16, the researchers analyzed how often they visited these spaces. Clearly, students from more privileged social groups participate more, while also finding more gender and race patterns in these spaces. Moreover, the authors indicated that certain everyday practices have more potential to be assimilated and understood, from the perspective of science, in this type of environment than in school, thus doing more to reduce inequalities in science capital.

Mendick, Berge and Danielsson (2017) critique the models that regulate Western policies of science education. The authors indicate flaws in the correlation between gender, ethnicity, social class, and nationality with the pipeline model, structured to create these policies. The study analyzed the discourse of two young Swedish women in interviews on identity work and production.

Archer *et al.* (2017) observed in the United Kingdom what is called Triple Science, a path to three separate GCSEs (*General Certificate of Secondary Education*). The data were obtained from a sample of 13,000 students aged 15 to 16 years and from interviews with 70 students aged 10 and 16. Based on the concept of *pedagogic action* in Bourdieu (BOURDIEU; PASSERON, 1990), the authors observe how certain practices related to science are chosen or naturalized, which suggest correct decision-making. Therefore, they see how *Triple Science* practices channel students towards certain choices, thus perpetuating certain mistaken beliefs, as well as social inequalities. The study also indicates potentially more equitable ways to reflect on *science engagement* in students after age 16.

Godec *et al.* (2018) addressed science capital through the Bourdieusian concept of field. Over the course of one year, they observed classrooms of secondary teachers in London. By proposing this analysis, their focus led to a connection between three concepts by the French sociologist: the students’ *habitus* and capital, with the field. They observed an association between the concept of field, the rules of the game and student recognition. The field is a space where students with different science capitals experienced different relationships with science, implying the importance of the Bourdieusian

*habitus/capital/campus* relation for understanding different behavioral patterns of social groups in relation to science.

Considering that the pedagogy of science capital is supported by the notion of social justice, King and Nomikou (2018) observe the importance of different approaches to building science capital in the classroom, highlighting the importance of the role of teachers. Therefore, teacher agency should be considered in association to important elements, such as the development of autonomy and reflexivity, not only as characteristics of the teachers themselves, but as elements to be developed in students, which can thus contribute to *science engagement* by promoting science capital.

Wilson-Lopez *et al.* (2018) studied science capital mobilized in high school students who developed engineering projects. The research participants self-identified as Hispanic or Latino, with some having had classes in English as a Second Language. Their parents or guardians had migrated to the United States and were members of the working class. The research included monthly interviews and bi-monthly meetings to follow the developments of the groups' projects. Science capital was mobilized based on formal scientific knowledge, literacy practices and experiences with solving everyday problems; on social capital in the form of connections with authorities, experts and colleagues; on objectified capital in the form of information and communication technologies (ICTs) and measuring tools; and on institutional capital in the form of awards and titles.

Cerrato *et al.* (2018) developed a study with students between the ages of 12 and 19 who had interrupted their studies. The research was carried out in the *International School for Advanced Studies* (SISSA), a higher education institution focused on physics, mathematics and neurosciences, in Italy. The activities aimed at science engagement were focused on the production of video games. During these activities, the students responded positively in a context of the socialization of knowledge, where they were valued and respected.

Mujtaba, Sheldrake, Reiss and Simon (2018) investigated a sample of 4,780 English students from 11 to 13 years of age with a considerable proportion of them considered disadvantaged. The researchers observed that a student's choice to study science or specifically, chemistry, after compulsory education was related to their intrinsic motivation. Therefore, the perceived usefulness of science, together with extracurricular interest in these topics, are an important factor for greater *science engagement*. The authors also observe that family influence had less, but still an important, impact on this case.

Curtis (2018a, 2018b) studied *citizen science*, which is produced online by indicating characteristics that enable the production of this subject of knowledge. The author emphasizes

the importance of online science content facilitating engagement for many participants who became active in science, highlighting mobile technology and inquiry-based learning. However, despite this perspective of citizen science being associated to the democratization of science knowledge, the majority of subjects in online science are men who have a certain level of education and interest in science, which presumes a certain science capital. Moreover, she emphasizes the importance of developing strategies that enable more inclusion of people in science.

Teo *et al.* (2018) conducted a study in Singapore correlating science capital and the ability of students to make inferences, an essential activity in the realm of science. 1397 students from regular schools, 637 from technical schools, and 37 from public schools in the country participated. There was a difference between groups, wherein the science capital of students in regular schools, regarding their perceptions on learning and the nature of science, was a significant predictor of their scientific inference competencies.

Based on ethnographic fieldwork, Dawson (2018) conducted 5 focus groups and 32 interviews with participants from low-income, minority ethnic groups. Her study showed that in the scope of scientific communication, social differences marked by structural inequalities are reproduced. The author observes that social reproduction in the scope of science contributes to the construction of a limited public, which also reproduces the perception of dominant classes in this context. The study has contributed significantly to the debate on inclusion and exclusion mechanisms in science.

Thompson and Jensen-Ryan (2018) observe that professors underrecognize their students as future scientists. The field of study was in a multi-institutional biology research network. The authors argue that there is a kind of mismatch between the capital that students have and display and what the professors expect to see. The need for professors to broaden their scope of recognition in order to affirm the science identities of their students can contribute to their being more well-guided, thus having a better understanding of the rules of the science field.

Inspired by Judith Butler's concepts such as *intelligibility* and *identity*, Archer *et al.* (2019) aimed to study the understanding of students from subaltern groups in science. Upon observing the classroom as a place of competition and power relations, the researchers investigated a perception of science imposed by some classes of students who limited the opportunities of other classmates to appear intelligible, or not, in science classes. Observations in London schools lasted for a period of 9 months, with participants totaling 9 teachers and 200 students, aged 11 to 15. Subsequently, the researchers organized 13

discussion groups with 59 of the 200 students who participated in the observation phase. In the groups, they observed performances such as competing, dominating and controlling the discourse on science in class and policing the science conversation of other colleagues. These attitudes were perceived ambiguously by the teachers and negatively by the students.

Jones and Spicer (2019) questioned how the science capital of a teacher without a background in sciences who works in a primary school can make them feel more or less confident to work with science content. The study was developed with PGCE (Postgraduation Certificate in Education) trainees where differences were observed in science capital according to gender, but also related to their experience with science in school, which influences the attitudes and confidence of these teachers in training.

Du and Wong (2019) carried out a study on the correlation between career aspirations and science capital in China and in the United Kingdom. Using items from PISA (Programme for International Student Assessment) for the year 2015, the authors use the evaluation as a kind of proxy to operationalize the construction of science capital to explore career aspirations and achievements in a sample of 23,998 students at age 15. The relation between science capital and science career aspirations was more decisive among British students.

Moote *et al.* (2019) analyzed a sample of 7,013 English students from 17 to 18 years of age. The researchers observed that in this age range, levels of science capital remain patterned by gender, ethnicity, cultural capital and a specific view of science that constitutes a kind of *science set*. Moreover, they showed that, when compared with groups from younger age ranges, the number of students considered to have a high science capital remained stable, while the number of those who had a lower level increased.

Stahl *et al.* (2019) explore local geographies and family relationships in the development of science capital, as well as in the construction of science identities in Australia. 45 year eight students in secondary school participated in the research. For the authors, local characteristics, as well as cultural aspects, may explain the different patterns among young people in relation to science capital.

The topic of building science identities, as well as the relation between science capital and science career aspirations was also studied by Rüschenpöhler and Markic (2020) in Germany. In the study in question, developed in 2019, the researchers analyzed the mobilization of science capital in the field of chemistry, in an attempt to define *chemistry capital*. Upon interviewing 48 German students in secondary school, they observed an uneven distribution of *chemistry capital* in the home environment. Moreover, in most of the families, this capital is reduced to that of the individual students. The authors also condemn the



German school structure in the sense that they perpetuate inequalities, and they determined that few students are able to acquire significant *chemistry capital* independently from their families developing a chemistry identity, mostly based on interactions with media online.

Livesey and Hoath (2019) investigate the relation between homework and the development of science capital. The authors show how the promotion of science capital may also be grounded in the homework that teachers assign.

DeWitt, Nomikou and Godec (2019) propose a study on student engagement in science museums from a sociological approach. By exploring qualitative data, the researchers evaluated student participation in visits to science museums to explore the possibilities, reasons for their motivation and the types of engagement carried out. The participants formed a group of underrepresented ethnic and cultural communities. It was shown that engagement took place according to an alignment between *habitus*, *capital* and the field. In the sample in question, engagement occurred more with the sociocultural aspects related to these three concepts, rather than with the scientific content of the museum exhibits.

After the study in 2019, Moote *et al.* (2020) have continued to investigate the relation between science capital aspirations among young people aged 17/18 but focus on whether science capital can be extended to related disciplines including engineering, math and technology. From the 7,013 students survey, they found that science capital aspirations are strongly related to engineering and physical but less related to the pursuit of either math or technology postsecondary study. Those findings suggest that science, engineering and math attitudes are more related to science capital than attitudes relating to technology, suggesting a better focus on “TEM” (technology, engineering and math) not just science, as a way of exploring these trends and possibilities further.

Cooper and Berry (2020) investigate students' access to cultural, social and scientific capital, considering that participation rates in science are falling in Australia. They aimed to examine how demographic factors predict student participation after 16 years in STEM, conducting a survey with 4,300 students, including participants from low socioeconomic status, indigeneity and gender backgrounds. They demonstrate that demographic factors are capable of predicted students' chances of participation in different STEM domains, showing a negative predictor of participation in biology, physics and chemistry for indigenous peoples, better predictors in biology and physics by gender and prediction in low socioeconomic level participants.

To understand the influence of the oil industry and fossil fuel corporations in schools, Tannock (2020) carried out a study about the ‘petro-pedagogy’ that promotes a neoliberal

model of STEM education based on pro-petroleum and anti-science propaganda. The argument of the author is that the “science capital” group are funded by one of those companies, that benefits from the concept of scientific capital in some ways, as providing a clear appeal for schools to work closely with business, including those pro-petroleum and anti-science agencies; by adopting a business framework, in order to improve the ‘national economic competitiveness’ by the ‘enterprising’ science; and promoting the neoliberal STEM model of education, which tends not to look critically at the wider ‘field’ of science capital in capitalist industrial production.

Jones *et al.* (2020) worked with the development and validation of a measure of science capital and future science interest with a survey with 889 youth in grades 6–8 because of the low interest in STEM career by the young. They develop the *The NextGen Scientist Survey* that shown four correlated factors that had influence in youth career aspirations: Science Expectancy Value, Science Experiences, Future Science Task Value, and Family Science Achievement Values. In the next year, Jones *et al.* (2021) examined the factors that shown to predict middle school students' task values, discussing that science capital are key in shaping the interest in science. They found that youth who don't experience science at home, don't live with people who work in science or don't have the materials to engage in science are less likely to feel confident in their ability to do science and are less likely to follow a scientific career.

Aiming to understand the impact of science capital on self-concept in science, Turnbull *et al.* (2020) developed a research with 693 university students in New Zealand. The main result is that the social relationships with teachers and peers in science are the most important factor to develop the science self-concept. Besides that, parents' value of science doesn't influence that much, but the number of university generations in the family did have a positive association.

Quinlan (2020) explores the need to include the science capital and cultural capital of African Americans in science teaching in the K–12 science curriculum. In the article, she identified that science textbooks are one of the primary modes of transmission of privilege and power in the science classroom and most of the authors of any textbook are phenotypically white. The author concludes the importance of African Americans in STEM to promote diversity and social inclusion.

From Jerusalem, Diamond (2020) is an author that studies patterns of social reproduction of science education outcomes for high school students in Israel, by examining the relationship between one aspect of science capital and the family socioeconomic status.



The study was done with 380 high school students aged 14 to 18, comparing Jewish and Arab-Palestinian. The study demonstrated that higher socioeconomic status and the presence of a scientist in the family have a positive impact on university aspirations for Jewish students (majority), but with no noticeable effect for minority students.

Considering minorities in science, Ceglie (2020) studies the underrepresentation patterns in women in STEM field and the growing number that are completing degrees. He believes that this growing is result of the support to underrepresented students that STEM college faculty offers. This support occurs as counseling, mentoring and networking; through the importance of a warm and inviting environment and targeted support programs as the salient factor. The author identified two aspects of science capital that emerged from this study: the science-related behaviors and science-related social capital.

Gonsalves *et al.* (2021) argue that “anyone can do science if they are brave enough” by investigating the experiences and resources that make science thinkable to science graduates as they engage in post-secondary scientific contexts. The authors suggest that these experiences and resources contribute to the capital of science, which accumulates over time along identity trajectories. Interestingly, they cite Ceglie (2020) and Cooper and Berry (2020) as researchers who assume the concept of science capital in secondary and post-secondary contexts and corroborate the theoretical implications of this study.

Christidou, Papavlasopoulou and Giannakos (2021) wrote about the use of science capital lens to capture and explore children’s attitudes toward science in the Norway context. To understand why young people don’t choose to study science after the age of 16, they tried to identify the factors that shape students’ attitudes of science learning. Their findings are that children who are more exposed to science-related activities and contexts in school or in out-of-school can enhance their self-efficacy in STEM domain. Also, they identified the need for creative teaching methods and active learning arose to promote the interest in STEM activities.

To continue their research about science capital, Godec, Archer and Dawson (2021) had mapping young people’s participation in informal STEM education through an equity lens. They draw a survey with 1,624 young people aged 11–14 to examine the ways in which science dispositions, demographic characteristics, ‘consumption’ of cultural practices and exclusion interact to produce unequal forms of STEM participation. In previous research, they found that Informal STEM education participation was highest among the most privileged young people with socioeconomically advantaged. With this work, they shown that the reason of young people to don’t participate in informal STEM educations isn’t the lack of interest in

STEM, as assumption before, but the lower levels of dominant forms of science and cultural capital, highlighting the intersection of inequalities. To conclude, they found the key to diversify participation in STEM isn't focus on trying to change young people, but directly changing the ISLE systems, institutions, and practices.

## Conclusion

The concept of science capital and the research on this topic are important markers of individual relationships with science. With this concept, we have a perspective on patterns of interaction based on the distribution of behaviors and actions by subjects who can be categorized in several ways, according to the studies used for this review article.

We have shown over the course of this paper, which revisits research in this area, that there is a significant relation between *science engagement* and minority groups due to their underrepresentation, including in science. Therefore, research on science capital makes us see social reproduction in specific microcosms of the scientific field, where the reproduction of structural inequalities seems to be maintained by the logic of dominant discourses in science.

It is also striking how the sociology of Pierre Bourdieu (1979) and his concepts, such as symbolic capital, *habitus* and *campus*, have enabled analyses that have been extrapolated so successfully within the hard core of the scientific field. From this perspective, Bourdieusian thinking seems to be in line with the discussion observed and presented by the authors of the present systematic review.

With important effects on (re)considering the ways in which we have engaged with science, science capital opens up possibilities to creating future policies that will also reflect on science education. Consequently, we are compelled to consider educational possibilities, not only for students, but also for teachers.

Therefore, in addition to inciting and strongly promoting scientific literacy, we see that the discussion on science capital is a transversal topic, contributing broadly to a greater effectiveness of *science engagement*.

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## Appendix

## Appendix 1 - Final database of the systematic review

Year	Title	Type	University/Local	Citation
2015	Science aspirations and gender identity: Lessons from the ASPIRES project	BC	King's College London / UK	Archer & Dewitt (2015)
	"Science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts	P	King's College London / UK	Archer <i>et al.</i> (2015)
	Is science for us? Black students' and parents' views of science and science careers.	P	King's College London / UK	Archer, DeWitt & Osborne (2015)
	Who aspires to a science career? A comparison of survey responses from primary and secondary school students	P	King's College London / UK	DeWitt & Archer (2015)
	Improving participation in science and technology higher education: ways forward	BC	University of Oslo / NO	Henriksen, Dillon & Pellegrini (2015)
	Critical response to archer <i>et al.</i> (2015) science capital: A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts	P	University of Warwick / UK	Jensen & Wright (2015)
	Teachers' understanding and operationalisation of 'science capital'	P	King's College London / UK	King <i>et al.</i> (2015)
	Science lives: School choices and 'natural tendencies'	P	Brunel University London / UK	Salehjee & Watts (2015)
2016	Disorientating, fun or meaningful? Disadvantaged families' experiences of a science museum visit	P	King's College London / UK	Archer <i>et al.</i> (2016)
	Valuing difference in students' culture and experience in school science lessons	P	University of Leeds / UK	Banner (2016)
	Re-thinking science capital: the role of 'capital' and 'identity' in mediating students' engagement with mathematically demanding programmes at university.	P	University of Manchester / UK	Black & Hernandez-Martinez (2016)
	Embracing 'science capital': An investigation into the approaches and initiatives established by a post-primary school to promote the uptake of STEM related subjects and subsequently STEM related careers with a particular focus on how this is helping to reduce the gender imbalance.	P	St Mary's University College / UK	Conlan (2016)
	Dimensions of science capital: exploring its potential for understanding students' science participation.	P	King's College London / UK	DeWitt, Archer & Mau (2016)
	Innovative methods for evaluating the science capital of young people	P	Northumbria University / UK	Padwick <i>et al.</i> (2016)
	Five 'Types' of Science Participation	BC	University of Roehampton / UK	Wong (2016a)
	Minority ethnic students and science participation: A qualitative mapping of achievement, aspiration, interest and capital	P	University of Roehampton / UK	Wong (2016b)
Science capital	BC	University of Roehampton / UK	Wong (2016c)	
2017	Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England	P	King's College London / UK	Archer <i>et al.</i> (2017)

	Participation in informal science learning experiences: the rich get richer?	P	University College London / UK	DeWitt & Archer (2017)
	A critique of the STEM pipeline: young people's identities in Sweden and science education policy.	P	Umeå University / SE	Mendick, Berge & Danielsson (2017)
	Building 'science capital' in the classroom	P	University College London / UK	Nomikou, Archer & King (2017)
2018	A coding lab to increase science capital of school dropout teenagers.	P	International School for Advanced Studies (SISSA) / IT	Cerrato <i>et al.</i> (2018)
	Realising the Potential of Online Citizen Science.	BC	University of Glasgow / UK	Curtis (2018a)
	Who Takes Part in Online Citizen Science?	BC	University of Glasgow / UK	Curtis (2018b)
	Reimagining publics and (non) participation: exploring exclusion from science communication through the experiences of low-income, minority ethnic groups.	P	University College London / UK	Dawson (2018)
	Examining Student Engagement with Science Through a Bourdieusian Notion of Field	P	University College London / UK	Godec <i>et al.</i> (2018)
	Fostering critical teacher agency: the impact of a science capital pedagogical approach	P	King's College London / UK	King & Nomikou (2018)
	Students' science attitudes, beliefs, and context: associations with science and chemistry aspirations.	P	University College London / UK	Mujtaba <i>et al.</i> (2018)
	Rethinking teaching and learning of science inference competencies of lower track students in Singapore: A Rasch investigation.	P	Nanyang Technological University / SG	Teo <i>et al.</i> (2018)
	Becoming a "Science Person": Faculty Recognition and the Development of Cultural Capital in the Context of Undergraduate Biology Research.	P	University of Georgia / US	Thompson & Jensen-Ryan (2018)
	Forms of science capital mobilized in adolescents' engineering projects.	P	Utah State University / US	Wilson-Lopez <i>et al.</i> (2018)
2019	Can the subaltern 'speak' science? An intersectional analysis of performances of 'talking science through muscular intellect' by 'subaltern' students in UK urban secondary science classrooms	P	University College London / UK	Archer <i>et al.</i> (2019)
	Recognizing and valuing student engagement in science museums	P	University College London / UK	DeWitt, Nomikou & Godec (2019)
	Science career aspiration and science capital in China and UK: a comparative study using PISA data	P	Xi'an Jiaotong University / CN	Du & Wong (2019)
	Science capital in primary PGCE students: Factors influencing its development and its impact on science teaching.	P	University of East Anglia / UK	Jones & Spicer (2019)
	Using homework to develop science capital	P	Leeds Trinity University / UK	Livesy & Hoath (2019)
	Who has high science capital? An exploration of emerging patterns of science capital among students aged 17/18 in England	P	University College London / UK	Moote <i>et al.</i> (2019)
	Middle years students' engagement with science in rural and urban communities in Australia: exploring science capital, place-based knowledges and	P	University of South Australia / AU	Stahl <i>et al.</i> (2019)

	familial relationships			
2020	Science faculty's support for underrepresented students: Building science capital.	P	Queens University of Charlotte / US	Ceglie (2020)
	Demographic predictors of senior secondary participation in biology, physics, chemistry and earth/space sciences: students' access to cultural, social and science capital.	P	RMIT University / AU	Cooper & Berry (2020)
	The social reproduction of science education outcomes for high school students in Israel.	P	Hebrew university of Jerusalem / IL	Diamond (2020)
	The Development and Validation of a Measure of Science capital, Habitus, and Future Science Interests.	P	NC State University, Raleigh / US	Jones <i>et al.</i> (2020)
	Science capital or STEM capital? Exploring relationships between science capital and technology, engineering, and math aspirations and attitudes among young people aged 17/18.	P	University College London / UK	Moote <i>et al.</i> (2020)
	Expanding the Science capital in K–12 Science Textbooks: A Notable Doctor's Insights into Biology & Other Accomplishments of African American Scientists.	P	Howard University / US	Quinlan (2020)
	Secondary school students' acquisition of science capital in the field of chemistry	P	Ludwigsburg University of Education / DE	Rüschepöhler&Markic (2020)
	The oil industry in our schools: from Petro Pete to science capital in the age of climate crisis	P	University College London / UK	Tannock (2020)
	The Impact of Science capital on Self-Concept in Science: A Study of University Students in New Zealand	P	The University of Auckland / NZ	Turnbull <i>et al.</i> (2020)
2021	Using the lens of science capital to capture and explore children's attitudes toward science in an informal making-based space.	P	Norwegian University of Science and Technology / NO	Christidou, Papavlasopoulou& Giannakos (2021)
	Interested but not being served: mapping young people's participation in informal STEM education through an equity lens	P	University College London / UK	Godec, Archer & Dawson (2021)
	"Anybody can do science if they're brave enough": Understanding the role of science capital in science majors' identity trajectories into and through postsecondary science.	P	McGill University / CA	Gonsalves <i>et al.</i> (2021)
	Understanding science career aspirations: Factors predicting future science task value.	P	NC State University / US	Jones <i>et al.</i> (2021)

Note: P = paper; BC= book chapter  
 Source: Prepared by the authors (2021)