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Presentation

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Each year we publish four issues. Starting next issue (No. 361), the magazine will have three sections: Research, Essays and Education Experiences, all of them submitted to referees. In the first issue of the year there is also an index of bibliography, and in the second number a report with statistic information about the journal process of this period and the impact factors, as well as a list of our external advisors.

From 2006 to the second number of 2012 (May-August 358), *Revista de Educación* was published in a double format, paper and electronic. The paper edition included all the articles in the especial section, the abstracts of articles pertaining to the rest of sections, and an index of reviewed and received books. The electronic edition contains all articles and reviews of each issue, and it is available through this web page (www.mecd.gob.es/revista-de-educacion/), where it is possible to find more interesting information about the journal. From the 358 number *Revista de Educación* becomes exclusively an online publication.

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Research

Research

Pedagogy in the face of the Promethean gap in transhumanism[1]

La Pedagogía ante el desfase prometeico del transhumanismo

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Abstract

Introduction: NBIC technologies (nanotechnologies, biotechnologies, information technologies and cognitive sciences) are promoting the perspectives of transhumanism and posthumanism and represent a real challenge for Pedagogy, especially in their anthropological status. We therefore need to reflect on what anthropological approach is assumed in Pedagogy that facilitates understanding the moral dimension that the notion of human improvement contains. Methodology: hermeneutical critical analysis with theoretical-pedagogical projection of the bibliography linked to the research object. Discussion: the article critically discusses three pitfalls of the transhumanist approach applied to education: all human enhancement technologies are equal; an educated subject is the one with more and better memory, attention or reasoning; and, finally, to educate is to help someone to avoid efforts. Results: the idea of human development is impoverished and misrepresented if we only assume it as a project of technological dominance. We must reject, from pedagogy, the theses

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that seek to distance us from the perspective of human formation as an intrinsic good, mistakenly considering the use of the media irrelevant when they are what really allow human formation. Conclusion: pedagogues must combat the idea that the possibilities of education, of the improvement of human development, do not increase by blurring, canceling, or discarding the human condition. We must develop a theory of educational losses or traps caused by transhumanism.

Key words: transhumanism, posthumanism, education, enhancement, biotechnology.

Resumen

Introducción: las tecnologías NBIC (nanotecnologías, biotecnologías, tecnologías de la información y las ciencias cognitivas) están impulsando las perspectivas del transhumanismo y del posthumanismo y suponen un auténtico desafío para la Pedagogía especialmente en su estatuto antropológico. Necesitamos, pues, reflexionar sobre qué enfoque antropológico se asume en la Pedagogía que facilite comprender la dimensión moral que encierra la noción de mejora humana. Metodología: análisis crítico hermenéutico con proyección teórico-pedagógica de la bibliografía vinculada al objeto de investigación. Discusión: el artículo discute críticamente tres trampas del enfoque transhumanista aplicado a la educación: todas las tecnologías del mejoramiento humano son iguales; un sujeto educado es el que tiene más y mejor memoria, atención o razonamiento; y, por último, educar es ayudar a alguien para evitarle esfuerzos. Resultados: la idea de desarrollo humano se empobrece y tergiversa si solamente la asumimos como un proyecto de dominio tecnológico. Debemos rechazar, desde la pedagogía, las tesis que pretenden alejarnos de la perspectiva de la formación humana como un bien intrínseco considerando erróneamente irrelevante el uso de los medios cuando son los que permiten realmente la formación humana. Conclusión: los pedagogos debemos combatir la idea de que las posibilidades de la educación, del mejoramiento del desarrollo humano, no aumentan por desdibujar, anular o descartar la condición humana. Debemos ir elaborando una teoría de las pérdidas o trampas educativas que provoca el transhumanismo.

Palabras Clave: transhumanismo, posthumanismo, educación, mejoramiento, biotecnología.

Introduction

In his book *To save everything, click here: the folly of technological solutionism* (2016) Morozov reports that companies in the USA, China, and Japan can now completely design a kitchen with the latest technology, capable of monitoring the preparation of any dish with visual, sonic, and temperature measuring devices. Once the data have been entered and using the corresponding algorithm, a voice with an augmented image – previously selected according to the customer's preferences, of course – guides you so that you avoid any errors and can make a *perfect meal*.

Before the pandemic, once or twice a month on a Sunday, my family would gather together to eat. One of the most entertaining moments was always the debate about how my brother in law Antonio's omelette had turned out, because who wants a perfect potato omelette? Indeed, what is a perfect potato omelette? What we actually wanted every Sunday was Antonio's omelette. Among other interesting observations, Morozov notes that:

> Silicon Valley's quest to fit us all into a digital straightjacket by promoting efficiency, transparency, certitude, and perfection (…) will prove to be prohibitively expensive in the long run. (…) Imperfection, ambiguity, opacity, disorder, and the opportunity to err, to sin, to do the wrong thing: all of these are constitutive of human freedom, and any concentrated attempt to root them out will root out that freedom as well. (p. xiii and xiv)

The aim of this article is to show that the central idea of education as human development relies on emphasising individuals' hard-working, exacting, and persistent involvement in their own learning more than an artificial improvement of oneself. This argument implies the following corollaries: firstly, that educating oneself involves striving to change for the better, that is to say, education entails helping people to want and make desirable personal and social changes; secondly, that it is only through a dedicated effort to change for the better that we can discover the limits of each of us, in other words, educating also means helping to embrace and accept one's own limitations; and, finally, that disregarding this dedicated effort to change for the better can prevent us from discovering our possibilities and limits, that is to say, our particular potato omelette, that which ultimately makes us unique.

The omelette is, of course, of little importance as it will depend on each individual's preferences. But what would be our position if we could

have perfect children? What would we think faced with the possibility of adding prostheses to our bodies so we could run faster, jump higher, be more flexible, see better, prevent our hips or other bones from breaking? And, above all, as educationalists, what do we think about the use of neuropharmacological implants to improve people's memory, concrete and abstract reasoning, moral decisions, or verbal capacity? Pharmaceutical research into treating mental illnesses and cognitive deterioration does not seem unusual to us; what is novel is the use of what are known as NBIC technologies (nanotechnology, biotechnology, information technology, and cognitive sciences) to direct this research towards improving the mental and moral capacities of people who have good mental health.

Whatever position we take, nobody can deny that these technologies effect multiple fields and present a challenge for understanding the human being in more depth. Technologies that have, as is well-known, encouraged posthumanist and transhumanist perspectives and present a real challenge for pedagogy, especially in its anthropological status. Indeed, these currents "contain a number of 'postanthropological' questions that are far from techno-utopian or -dystopian, but instead involve an entirely new understanding of the relationship between education, technology and the human" (Herbrechter, 2018). Savulescu (2016), one of the best-known supporters of transhumanism, asks: "What is the moral difference between producing a smarter child by immersing that child in a stimulating environment, giving the child a drug, or directly altering the child's brain or genes?". On the same lines, Kayali and Clarke (2020, p. 252) conclude their text on moral education and biological improvement with this thought-provoking question: "In other words, do means matter?" (2020, p. 252). As we will show, not only do they matter, but the choice of means decides whether something is or is not education.

A few years ago, Vilanou (2015, p. 212, own translation) used an expression by Gilles Ferry to remind us of the death of pedagogy: "In other words: the death of metaphysics – which implied the death of man, understood as the child of God – involved the death of pedagogy, a discipline now condemned to a residual place in the postmodern world". However, I believe that for some people, another death of pedagogy might be brewing, albeit not through metaphysical paths this time but rather through NBIC technologies. For this reason, Herbrechter (2018) believes

that "Education may be committing suicide." Tillson and Aldridge, in turn, state that "in discussions of educational enhancement, it is common for education to be regarded highly instrumentally and, furthermore, as a relatively inefficient tool that is likely to become outmoded with no loss" (2018, p. 589). Some authors are starting to discuss the need to use genetics to promote "precision education" (Martschenko, 2020a, p. 34) as they warn us that "the biosocial train is in route (…) the reorientation to biological and physiological processes opens new avenues for education researchers" (Martschenko, 2020b, p. 8 and 7).

How, in pedagogy, are we to confront the desire for precision and perfection that these technologies offer, which will clearly continue to grow? In particular, how can we confront the Promethean gap between what we can do and what we should do (Anders, 2011), between pressing the button for the potato omelette or turning it off, between working with perfect pupils or with the ones we have, between choosing a perfect child or accepting the one who comes?

The matters set out about could be stated in a number of questions: How can the rules of the human be pedagogically reformulated through converging technologies? What image should we, in faculties of education, transmit to our students about what the human being is (García del Dujo *et al.*, 2021; Quintanilla, 2019)? Ultimately, what pedagogical implications do biological understandings of the human have? All of these questions are highly relevant for pedagogy because "the human being is an animal that rejects its own condition as such" (Gabriel, 2019, p. 24).

The argument I put forward is that we need to reflect on what anthropological focus pedagogy should adopt to facilitate comprehension of the moral dimension encapsulated by the notion of human improvement. In particular, as educationalists, we must combat the increasingly widespread idea that the possibilities of education, of improving human development, are not increased by clouding, abolishing, or dismissing the human condition. Removing the white lines does not make us park better. Eliminating the force of gravity would not make us walk better and, as Kant (1978) taught us, birds could not fly without the resistance of the air Ultimately, we do not increase the potential of education, of being more human and better people, by believing that we can omnipotently control the starting conditions of this humanity. Perhaps what has happened is that, as Luri (2019) argues, "technological innovations have enabled the

sense of the possible to grow at the expense of the sense of the real in the conscience of citizens" (p. 187, own translation).

Transhumanism in education

Transhumanism can be understood as a way of redesigning the human condition by improving our physical, emotional, and cognitive capacities through the use of NBIC technologies (Tirosh-Samuelson, 2018). The last point of the "*Transhumanist Declaration*" (various authors, 2009), which numerous renowned scientists and technology companies signed, states:

> We favour allowing individuals wide personal choice over how they enable their lives. This includes use of techniques that may be developed to assist memory, concentration, and mental energy; life extension therapies; reproductive choice technologies; cryonics procedures; and many other possible human modification and enhancement technologies (Point 8).

The aim of transhumanism is, ultimately, "to improve human beings technologically as individuals and as a society by means of manipulating them as a biological species, on the basis that this improvement would be *intrinsically good*, *desirable, and inalienable*" (Hernández, 2009, p. 578; emphasis in original, own translation). "Such manipulation is equivalent to *cyborganisation*, hybridisation of the organic and the synthetic, of man and machine aimed at neutralising the flaws that limit and torment us" (Martorell, 2012, p. 491; emphasis in original, own translation). "Put differently, transhumanism is the programme that will bring about techno-scientific posthumanism, the desired telos" (Tirosh-Samuelson, 2018; Bostrom, 2003) and which, specifically, asserts "morphological liberty", that is, "the capacity to alter the form of the body at will through technologies such as surgery, genetic engineering, nanotechnology, or mind uploading" (Rueda Etxeberria, 2020, p. 316, own translation; More, 2013; Haraway, 2020).

This point is where I wish to focus my attention: I fear that characteristics and conditions that are an inescapable part of the particular and singular form of human development might in future be regarded as "flaws that limit and torment us". According to the dictionary of the Royal Academy of the Spanish Language, 'tacha' (flaw), in the first definition, means: "Fault, note or defect in a thing that makes it imperfect". Is ageing an imperfection? Is it a flaw that we cannot recall things as well as a machine?

Would having to make an effort to learn be an embarrassing limitation if we could turn to cerebral implants? Alexandre (2017) claims that "by 2100, allowing children with an IQ below 160 to be born would seem as outlandish as consciously bringing a baby with Down's syndrome into the world seems to us today" (cited in Contreras, 2019, own translation).

In contrast, I believe that

> The human condition, of course, is not free from faults and deficiencies: illness and pain are a part of it. They affect our existence and deny us the normal use of our bodies. But transhumanism does not start from an interest in health: instead, it regards the perfectly healthy human body as defective, as insufficient. (…). Transhumanism has a totally different aim: it does not set out to repair the human body but to replace it. (Bellamy, 2020, p. 87, own translation)

This article is part of what has been called the bio-conservative – not bio-Luddite – perspective on transhumanism, which considers it necessary to start from a position that recognises and respects the human condition and centres on determining what type of improvements are ethically – or in this case pedagogically – acceptable, as it may be, as noted by important authors such as Fukuyama (2002), Sandel (2015), or Habermas (2012), that the type of optimisation and improvement desired will strip the human condition of its basic attributes of freely assuming responsibilities and taking a position with regards to life, in other words, the particular conditions of our educability. For example, for the human condition, is it the same for a prisoner to change his or her moral standards as a result of a freely adopted idea as it is to give him or her citalopram – an antidepressant that by increasing serotonin levels improves the moral valuation of the harm caused to others (Serra, 2016, p. 179)? Is there no anthropologically decisive gain in the effort one makes every day to maintain a relationship with others that generates joy and enthusiasm with life compared with achieving the same through pharmaceuticals or a few drinks?

Not everyone who approaches the ideas of strong transhumanism from the pedagogical perspective accepts the educational interest of these questions. For example, for Peres Díaz (2016)

> we already use technology for humanist aims, and education pursues this very end; there would be no difference between what we do now and what we would do if we applied NBIC technologies in the future, as these and

education, which is the current way in which human societies seek "human improvement", have the same end. (p. 130, own translation)

Some very influential and internationally recognised authors who work on this topic, such as Bostrom and Sandberg, even consider that taking medication is "looked down on", it has side effects and, in some cases, there can be problems acquiring it, "but genetic modification would make the individual independent of an external drug supply and would guarantee that the substances end up in the right place" (2009, p. 319). When analysing the possible risks of physical intervention on the brain or genetic modification, they argue that "even education is a risky enhancement method. Education can enhance cognitive skills and capacities, but it can also create fanatics, dogmatists, sophistic arguers, skilled rationalizers, cynical manipulators, and indoctrinated, prejudiced, confused, or selfishly calculating minds" (p. 322). Finally, these authors consider that to normalise any type of advance in cognitive and moral improvement of individuals, above all it is necessary to set in motion a series of strategies to extend their cultural acceptance as soon as possible. Among these, they suggest including improvements in the professional efficacy of certain sectors, which would increase economic income compared with the competition as "many people would prefer to fly with airlines or go to hospitals where the personnel take alertness-enhancing drugs" (p. 328; Savulescu, 2012; Savulescu *et al.*, 2011; Persson, & Savulescu, 2014; Sloterdijk, 2006; Singer, 2002).

It is also worth noting the existence of other very widespread approaches on similar lines, such as those of Braidotti, which are not so much interested in what can be achieved by physical, cognitive, or moral improvements but rather that what she calls a "nomadic concept of subjectivity" (2015, p. 229) should be culturally favoured to counterbalance the ideal of the liberal, individualist, natural, rational, and moral Vitruvian man, which defines human perfection in terms of autonomy and self-determination and with the aim of establishing a truth.

Analysis and discussion: Cheating in education

Having set out our argument as well as a number of questions and positions in favour of transhumanism's hardest approaches, we now analyse from a critical-pedagogical perspective in some detail what we

regard as *forms of cheating* that these trends might impose in educational thought and practice[2]. We will concern ourselves with identifying three possible forms of cheating, bearing in mind that they are not all equal, since in some cases, as we will see, they are limitations while in others they are disadvantages or are even inappropriate. What we cannot say is that transhumanism and its posthumanist approaches and consequences are a bluff or are simply a fashionable topic.

First type of cheating: all human improvement technologies are equal

There is a self-interested levelling out or equalisation of all of the technologies – as we saw above in the case of Peres Díaz – which views them as equal to one another because they are technologies. One cause of this equalisation is what Stiegler (2002) – following Heidegger (1997) – calls "originary technicity": we are prostheses as the human and the technical have never been separated, but instead have evolved jointly and inseparably, and so each era has to recognise its technological possibilities as part of its possibilities of humanisation. It is precisely because of this that the technology for making a perfect potato omelette is not the same as the technology for modifying the moral judgement of a prisoner. The historical tendency when analysing technology (Hansen, 2000) has been to view it as something external and dependent on the will of the subject, but NBIC technologies take "originary technology" theses to an extreme by showing us the possibilities of prostheses that are internal and cannot be controlled by the subject's will, accentuating "the risks of robotisation of human subjectivity" (Fernández Agis, 2020, p. 241). We have therefore gone from shaping technology to being shaped by it. Accordingly, technologies are only comparable if we equalise them in their category of means. But they are not the same in how they help promote the human.

As Diéguez suggests, "we should not group improved cartilage together with an attempt to make some humans capable of photosynthesis, as Jaime de Foxá fantasised about in his novel *Marea verde* [Green tide]" (2018, p. 29, own translation). Therefore, it seems advisable to me to maintain

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[2] The idea of 'cheating' appears in the special edition of the journal *Educational Theory* dedicated to this matter in 2018 with the apt title: "*Cheating Education*".

the distinction between humanising and dehumanising technologies. As Bertrand Russell himself who, of course, also lived through a time of intense scientific discoveries, noted in Faustian terms: "the pursuit of knowledge may become harmful unless it is combined with (…) a certain awareness of the ends of human life" (Russell, 1954).

Faced with how pedagogy might use advances in biotechnology, it is again worth recalling that education is essentially an ethical and political project (García Gutiérrez *et al.*, 2017). No technology – from the past or current ones – tells us anything about the ultimate reasons of education, that is to say, of the type of man or woman we aspire to become as educated subjects. Nor do they tell us anything about what is valuable as content to memorise, consider, and reflect on and, much less, anything about why it is valuable in itself to memorise, consider and reflect on this content as an end.

Insisting on this idea seems interesting to me because there is a trend, which has recently become especially accentuated, thanks to the development of neuroeducation (Pallarés-Domínguez, 2021; Cabanas Díaz & González-Lamas, 2021), that establishes as the basis of its knowledge a sort of direct correspondence between a detailed description of the structure of the capacities of individuals and the particular directions or senses in which we put into practice these capacities to achieve learning.

This is not how education works. Education, of course, starts from an understanding of the structure of the real that is as faithful as possible, but this structure does not establish a set of ends that are the only possible ones for human development. The most complete, thorough, and detailed understanding of the structure of reality and, therefore, of technologies will never give us all of its possible educational pathways or directions in a wholly closed form. Technical adaptation is a condition for application of the end, but it is not a condition for knowledge of the end as humanly desirable. Therefore, in education it cannot be held that biotechnological advances follow one path and the ends of education, or the models of man and woman follow the other. As Selwyn notes, "technology is not simply something with which humans work. On the contrary, technology is interwoven with policies that determine what education is, and what type of education we want for future societies" (2019, p. 131, own translation). Indeed, Floridi's well-known *The Onlife Manifesto* (2015) stated that

> ICTs are not mere tools but rather environmental forces that are increasingly affecting: 1. our self-conception (who we are); 2. our mutual interactions (how we socialise); 3. our conception of reality (our metaphysics); and 4. our interactions with reality (our agency) (p. 2).

With regards to this first form of cheating, in addition to what has already been said it is worth noting that progress does not just depend on the good that is in play but also that we are used to thinking, and this is also the case in education, that what is yet to come is always better than what we already have. Consequently, as Bellamy (2021) has observed, little by little a suspicion, a resentment, and a misgiving towards the present works its way into us and we come to perceive and experience it as a limit, a wound. The pioneer of nanotechnology Eric K. Drexler stated as long ago as 1997 that "if something has to change, I believe it will be for the better. To accept the contrary would be to fall into a radical and unsustainable ideology. Nowadays, what is truly conservative, even though it seems untrue, is to think about a continuous advancement of technology". An advance under the law of accelerated performance will, according to Kurzweil (2013), lead humankind to the technological singularity, in other words, overcoming biological limits by converging with the artificial intelligence of machines.

The focus of post-critical pedagogy attempts to counter this tendency and others by emphasising the idea that if our principal critical perspective is the change that the future might bring us, we might find we lose the capacity to value the permanent and precious goods that form part of and surround our current life (Hodgson *et al.*, 2020). Markus Gabriel (2016), one of Germany's best-known current philosophers similarly considers that

> there is no pending utopia, an age after times that in principle would be better and more suited to promoting liberty than the one we find ourselves in; neither postmodernism not posthumanism will better satisfy aspirations for liberty. (p. 289, own translation)

To conclude the analysis of this first form of cheating, we must also mention the tendency to conceal or downplay the negative effects of biotechnologies, in particular the use of deep brain stimulation (DBS) implants. Gallagher has compiled these effects. Among all of them, I would like to draw attention to one he describes as feelings of alienation: patients did not recognise themselves, they did not feel like they were themselves, they felt empty (Gallagher, 2018, pp. 633-634). Focquaert and

Schermer offer an explanation of great pedagogical interest. Among all of the possible techniques for improving the human being, these authors distinguish between direct passive interventions and indirect active ones. For them "direct, passive interventions may induce such radical and/or abrupt psychological changes, with little or no link to an individual's narrative life story, that the continuity of one's narrative identity is threatened. (…)". They also note that "the possibility of concealed narrative identity changes, changes that, to a lesser or greater extent, go unnoticed or are denied by the individual undergoing the treatment may result in a situation of self-blindness" (2015, p. 149).

It is not only negative effects caused by implants that we must mention. Sometimes pharmaceuticals can cause cases such as one described by Agar (2015): after a woman was given medication to improve her degree of empathy, she was admitted to hospital where she had the idea of stealing a dialysis machine to sell it online and use the money she made to improve the quality of her son's education.

In this way, a demand undoubtedly appears for responsibility as a condition for considering the consequences of applying new technologies, especially when these are always accompanied by an exaggerated optimism that calls for all manner of changes since, as we saw above, is sees them as being progress in themselves. Stiegler considers that "the development of digital medication has now become something very problematic, uncontrollable, and dangerous" (2015, p. 12, own translation). Hence the importance of recalling the words of Hans Jonás when he said "(p)utting it simply, it is a case of the rule that one must give more credit to catastrophic predictions than to optimistic ones" (Jonas, 1995, p. 71, own translation). And Anders, paraphrasing a very famous quotation of Marx, says: "it is no longer enough to change the world, what is more important than anything is to preserve it" (2009, p. 84, own translation).

Second form of cheating: educating people involves saving them effort

Quite the contrary. Education is especially at play in the effort we make to improve our capacities. Seeing NBIC technologies as substitutes for education disregards the educational effect on our capacities and, above

all on how we make ourselves, our way of being, of work, study, sustained, tenacious, meticulous, even stubborn, effort that resists frustration.

As Castillejo put it in an apt expression: "We are what we are, we act in accordance with who we are and we make ourselves in accordance with how we act" (1981, p. 35, own translation). It is in this making of ourselves that our best identity is found. We are, above all, what we do, bit by bit, with our successes and failures, to be able to improve by ourselves and with the help of others. And this is what is truly great about education: its self-structuring power not just as a perfective end that we reach but as a means for our own human development. The act of persisting, the dedication, for example, with which an individual with serious impairments finally manages to eat with a knife and fork, contains the most magnificent pedagogical mission.

George Steiner in an interview with Laura Adler gave a real example of these ideas applied to himself:

> The first few years of my life were very difficult because my arm was more or less attached to my body (…). There were shoes with zippers – very easy to put on. 'No', my mother said, 'You're going to learn how to tie your laces'. I can tell you, it was hard (…) and after six or seven months, I managed to tie my shoes. And my mother said, 'You can write with your left hand'. I refused. Then she held my other hand behind my back, 'You're going to learn to write with your bad hand – yes you are'. And she taught me how. I was able to draw pictures and sketch with my left hand. It was a metaphysics of effort. It was a metaphysics of will, discipline, and especially happiness to see all that as a great privilege; and it continued throughout my life. (Steiner, 2016, pp. 11-12)

Could anyone doubt that this vital, continued, and determined, experience of effort, will, and discipline imprints character? As Aristotle taught us (1985, 1106a-1106b), virtues are not faculties but ways of being.

But there is still more. The sustained and determined effort we advocate for confronting our limitations and, when appropriate, overcoming them, should not be applied pedagogically only to what we like. The shaping force of the exercise of directing our will towards a goal does not, first of all, entail choosing an activity that is always pleasant. Instead, educators must often set learners challenges in directions other than their tastes. We are currently in a moment when some believe the curriculum and education in general should be limited to cultivating what children like – if it is cooking, take cooking, if it is painting take painting, etc. It is worth recalling the ever-intelligent thoughts of Alain:

> I should now state that education should not be guided by the features of a vocation. First, because preferences can change. And also because, it is always good to find out about what we do not want to know. So we should challenge tastes, firstly and at length. This pupil only likes science; so he can cultivate history, law, literature; he needs it more than some others do. (Alain, cited in Château, 2017, p. 378)

The best interpretative framework for understanding human development from a pedagogical perspective is not found in medication, neuronal implants, or genetic modifications that give us high capacities but, above all, in the personal effort we make to surpass ourselves, whether or not these efforts finally bear fruit. As Carter explains (2018), one very valuable aspect of a human life in development is making progress rather than success, that is to say, achieving goals as a consequence of our efforts. Education would therefore be more of a consequence than a result.

Of course, we cannot end the analysis of this second form of cheating without noting the obvious limitation of our own thesis. The effort and determination in an assignment or mission do not actually guarantee us happiness nor will they enable us to achieve a truly well-lived life. Discovering the anthropological core of effort in human development is not the same as discovering the humanising core of the appropriate ends of this effort in human development. Efficient causes are not the same as final causes. That said, as Ibáñez-Martín has explained, school

> must be a place where people learn to distinguish and value quality, and where they discover that quality products – no product is more important than achieving a well-lived life – are usually only obtained after a sustained effort. (2017, p. 148, own translation)

Third form of cheating: an educated individual is one who has more and better memory, attention, or reasoning

Tillson (2018) draws upon an interesting proposal by Donald Davidson to understand the scope of human learning in sufficient depth. Davidson refers to the concept of causal history in learning, stating that even if we could insert propositional knowledge into a person's brain, it is still difficult to imagine that inserting the personal history of learning the particular and unique meaning of this knowledge at the same time would

be possible. A replica of me, Davidson would say, might say 'house' when it sees my house, but without a causal history of the sentimental appropriation of the personal meaning of that house it could not see it or feel it as *home*. In pedagogy, it is very important to be aware that "aspects of the natural history of how someone learned the use of a word necessarily make a difference to what the word means" (Davidson, 1987, p. 443, cited in Tillson, 2018, p. 602). The roots of this line of argument are, of course, in Searle's famous theses against the strong artificial intelligence proposals, posed in the famous Chinese room simulation: "the computer works by manipulating symbols. Its processes are purely syntactically defined, while the human mind has something more than uninterpreted symbols: it associates them with meanings" (Searle, 2006, pp. 120-121).

Asimov must have sensed some of this when writing his famous novel *Profession*, which is set in the 66th century and considers the worlds of work and education. In it, he describes two fundamental days in the educational history of the individual: reading day at the age of 8 and education day at the age of 18. What Asimov calls "tape" and we would now call neurological implants is inserted on both of these days: on the first day it contains the ability to read, and on the second the theoretical and practical requisites for exercising a profession, which, as the author notes, is of course chosen by the pedagogues of the time according to individuals' cerebral dispositions and never according to their desires. The novel tells the story of George Paten, who takes the initiative to read books on his own account, driven by an insatiable curiosity to learn, and according to the story, "little by little", "step by step" and feeling "the satisfaction of learning", he transforms, modifies, alters, his brain so that he has to be detained, for cerebral conversion, in an institution for the "feeble minded" as it is impossible to implant any program profession in him. There he has the following conversation with a pedagogue: "'What good does it do you to read the book? (…) 'Call it the satisfaction of curiosity,' he said. 'I understand a little of it today, perhaps a little more tomorrow. That's a victory in a way'" (Asimov, 1957, p. 1). Yes, a human victory from its self-structuring liberty (Gracia & Gozálvez, 2019).

The day that it is possible to implant the *Nicomachean Ethics*, for example, in our memory, how will it be possible to speak of different readings? Where will be the personal and professional achievements we experience while we read it and which directly affect the learning of their

content? We argue that learning should not be separated from being. As long as we learn, we literally make ourselves different. *Rather than acquiring knowledge, the human being makes itself in what it knows and, above all, while it knows*. We are beings of embodied knowledge. This is why we must avoid the meliorative fallacy since "it is human beings who think and reason, not their brains" (Bennett & Hacker, 2003, p. 3). Moreover: to advance in our development we need to feel attracted by singular – and, better yet, exemplary – lives of this embodied knowledge, not by machines. No two maths teachers are the same. As Aldridge says

> my knowing is not a matter of having extracted words from the page as 'information,' but to have seen those words on that page in dappled sunlight under the shade of a particular tree, and to have rested my head on the shoulder of the one who read them to me (2018, p. 624).

We are not mere capacities, however perfected they may be. We are not a memory, reasoning, or attention. We are not brains in a tank. It is not a matter of implanting content. In education, what matters is not reaching Rome but how one gets there. Not all roads are valid, not all means are valid. And not just because the dignity of the learner must be respected in all cases but because human beings realise themselves in the act, not in their capacity. In other words, they need determination in their actions in order to develop in their distinctiveness.

Conclusions

In my opinion, it is vital that pedagogy participates in discussions about biotechnology because "the transhumanist project will undoubtedly decisively mark our political and philosophical debates over the coming decades" (Bellamy, 2020, p. 86, own translation).

I believe that this public voice of pedagogy must focus on raising three questions that are the basis of the present article. Firstly, that the idea of human development and consequently of the human condition is impoverished and twisted if we only approach it as a project of technological command. In effect, on the one hand, because

> in the age of converging technologies, we should not be obsessed about being faster, taller, stronger, smarter, younger-looking, or long living, as

transhumanists urge us, but rather being more humane, that is, more caring and less smug, callous, cruel, or indifferent (Tirosh-Samuelson, 2018).

And, on the other hand, because as Scruton (2018) has observed, we cannot explain the meaning of a marble sculpture by considering its physical and chemical properties and this is even less possible with the human being. Ultimately, transhumanism is wrong in wanting to help people achieve a better life by focussing exclusively on technological mediation (Güell *et al*., 2019) because "anthropotechnology is ultimately another attempt to free ourselves once and for all from the political harness and design our life, saving us the mediation of the politeia in the shaping of what we are" (Luri, 2019, p. 143, own translation).

Secondly, we should also expose, from education, those who attempt to distance us from the perspective of human education as an intrinsic good. Indeed, one of the most widespread contemporary errors in pedagogy involves reducing the perspective of analysis of human education to a sort of training for ends other than itself. Education seems to have become just a means *to an end*, with which, as we have seen, for some, the means chosen is unimportant so long as this end is obtained: a pharmaceutical, an implant, a genetic alteration, a punishment, etc. Educating does not mean making the means indifferent agents. Educating is not managing. Educating is not measuring or calculating (Gil Cantero, 2020). Educating means taking ownership of the goods that resonate and ring in some ends, limits or values. Education is an endeavour, a task, an essentially immanent action, that transforms us from within, making us better or worse while it happens, while we act.

Ultimately, I believe that as educationalists we must remain alert in order to formulate what we could call a theory of educational losses or ways of cheating. "After all, are we are educators, not philosophers. We are of necessity in sustained engagement with political, theoretical and also practical questions of education. We must therefore adopt and develop frameworks consistent with this engagement (…)" (Friesen, 2018). In effect, all of the meliorative literature sets out to win this cultural battle by making us see only what we gain; we must also note what these forms of cheating might make us lose, thus avoiding the tendency to "neutralise any possibility of the risks to come" (Sadin, 2020, p. 119, own translation). And among these forms of cheating, it is important to note the great pedagogical loss resulting from, on the one hand, neglecting the educational importance of emphasising learners' place as agents without

delegating to anyone or anything the possibilities of the effort of each of them and, on the other hand, confounding priorities in human education since "true progress does not comprise the illusory ideal of improving the spirit and the human being, but improving the moral and legal order in light of our knowledge" (Gabriel, 2016, p. 289, own translation).

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Observed and Self-Perceived Information Literacy among teachers and future teachers and their relationship with sociodemographic variables[1]

Competencia Informacional Observada y Auto-percibida en docentes y futuros docentes y su relación con variables socio-demográficas

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Abstract

The relationship between the levels of Self-Perceived Informational Literacy (CIA) and Observed Informational Literacy (CIO) of a sample of 442 teachers and future teachers of Compulsory Education in Castile and León is studied in order to relate these levels with different socio-demographic variables. These variables include age, gender, occupation (future teacher versus in-service teachers) and educational level (Primary Education versus Secondary Education). Descriptive analyses and inferential analyses carried out show that the Self-Perceived Information Literacy is overrated in all the groups evaluated, which has allowed to introduce a variable named "valuation discrepancy" which measures the difference between self-assessment and performance (CIA-CIO) in Informational Literacy. The valuation discrepancy shows especially large values for future teacher as well as for males, and if the values for the dimensions considered are

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analyzed, the valuation discrepancy is greater for the Information Search and the Evaluation of Information. The variance models which have been developed have found influence of gender, educational level and occupation on the levels of Self-Perceived Informational Literacy, Observed Informational Literacy and valuation discrepancy, and influence of age only on CIA, and there is also an interaction between educational level and gender at CIA and CIO levels. These results are relevant to design training activities for in-service teachers and future teachers, as they allow to draw a profile of teachers or future teachers who may have more need for training in Information Competence. They also could explain the results found in other studies according to which the highest level of digital and technological skills is found among male and younger people; these results could be consequence of using self-assessments and do not correspond to the actual performance.

Resumen

Se estudia la relación existente entre los niveles de Competencia Informacional Auto-percibida y Competencia Informacional Observada de una muestra de 442 docentes y futuros docentes de Educación Obligatoria en Castilla y León, con el objeto de relacionar dichos niveles con diferentes variables socio-demográficas. Entre estas variables se encuentran la edad, el género, la ocupación (futuros profesores/profesores en activo) y la etapa educativa (Educación Primaria/ Educación Secundaria). Los análisis descriptivos e inferenciales realizados muestran que la Competencia Informacional Auto-Percibida (CIA) está sobrevalorada frente a la Competencia Informacional Observada (CIO) en todos los colectivos evaluados, lo que ha permitido introducir una variable denominada "discrepancia valorativa" que mide las diferencias CIA-CIO entre la autovaloración y el nivel de desempeño en Competencia Informacional. Esta discrepancia valorativa muestra valores especialmente grandes para los futuros profesores, así como para los varones; y si se analizan los valores para las dimensiones consideradas, la discrepancia valorativa es mayor para las dimensiones de Búsqueda y Evaluación de la Información. Los modelos ANOVA desarrollados han encontrado influencia del género, la etapa educativa y la ocupación en los niveles de CIA, CIO y discrepancia valorativa y de la edad solamente en CIA, y se observa también una interacción entre la etapa educativa y el género en los niveles de CIA y CIO. Estos resultados son relevantes para diseñar actividades de formación del profesorado en activo y de los futuros profesores, pues permiten dibujar un perfil de los docentes o futuros docentes que pueden tener más necesidad de formación en Competencia Informacional.

También permitirían explicar los resultados de otros estudios según los cuales el mayor nivel de habilidades digitales y tecnológicas se encuentra entre los hombres y los sujetos más jóvenes; estos resultados serían consecuencia de la utilización de auto-valoraciones y no se corresponderían con el verdadero desempeño de los sujetos.

Introduction and objectives

Incorporating Information and Communication Technologies (ICT) into compulsory education today is a necessity, as an essential resource for teachers but also as a comprehensive part of educating new generations in a world influenced by technology development. We can thus differentiate two levels of ICT incorporation: the use of tools (interactive digital whiteboard, online resources, educational apps) specific to education, which form part of 'professional' teaching knowledge; and more general skills and tools present at all levels of education in today's society, such as searching for information, selection and assessment, processing and handling, and subsequent communication to others. In a study reviewing future teacher training in the digital era, Starkey (2020) highlights the differences between 'general' digital competence and specific digital competence, referring to the use of pedagogical and professional applications.

Compulsory education (6-16 years in Spain) is the most suitable period for training future generations in digital competence, and evidently, teachers during these stages must also have these skills in order to convey them (Redecker, 2017). Therefore, it is important to correctly diagnose the levels of Digital and Information Literacy of both teachers and future teachers in order to determine competence level and the most suitable teaching profiles.

This diagnosis must also be based on performance indicators and not self-reports or self-assessments. Some recent studies (Starkey, 2020;

Svoboda et al., 2019) emphasise the abundance of self-assessment based research, highlighting how self-perceived digital and information literacy are overvalued in primary and secondary teachers (Hatlevik, 2017; Maderick et al., 2016) and future teachers (Dinçer, 2018).

This paper globally analyses the relationship between performance levels and self-assessment of information literacy considering the factors of Search, Assessment, Processing and Communication proposed by Area and Guarro (2012) with some sociodemographic variables of current and future primary and secondary teachers, such as age, gender, occupation (active teachers versus future teachers) and education stage (primary versus secondary). Comparing self-perceived and performance levels related to the characteristics of teachers and future teachers allows us to diagnose training needs for these groups in specific aspects of information literacy, and also to effectively design ongoing training strategies and initial training for future teachers.

The following research questions have been set, based on Self-Perceived Information Literacy and Observed Information Literacy (globally and by factor) among current and future primary and secondary teachers in Castile and León: What is the relationship between these levels and sociodemographic variables? Does the discrepancy between self-perception and performance depend on the characteristics of the groups analysed? What training recommendations can be taken from these results?

Information Literacy and Digital Literacy

Digital Literacy in teachers has been addressed from different perspectives. In Spain, the institutional diagnosis tool is part of the Common Digital Competence Framework for Teachers (INTEF, 2017), which adapts to the European Digital Competence Framework v2.1, DIGCOMP (Carretero et al., 2017) and the European Digital Competence Framework for Educators, DIGCOMPEDU (Redecker, 2017).

This paper specifically focuses on Information Literacy as an essential part of Digital Competence; a decision based on the importance of training citizens in the correct search, selection and assessment of information in today's society in order to address the misinformation, 'fake news' and biased, malicious or opportunist information available

online. Also, within the specific scope of teaching, various studies agree on the majority use of internet in the classroom as a tool to search for information: Cabanillas et al (2020) show how teachers stress the importance of the Search for information over the Selection and creation of content or Communication. De Aldama and Pozo (2016), Losada et al. (2017), and Camacho and Esteve-Mon (2018), point to the search for information as one of the most frequent activities in primary classrooms; these results are confirmed in the review study by Colás et al. (2018).

Information Literacy in teachers is therefore decisive in many of the tasks proposed in the classroom; it also influences the search and organisation of teaching material and resources for the classroom. This paper will therefore focus on studying this aspect, and not only globally, but broken down in its components: Search, Assessment, Processing and Communication (Area & Guarro, 2012). This breakdown will enable a more detailed analysis in the areas in which teachers and future teachers have a higher or lower level, and will afford us greater accuracy when relating them to the sociodemographic variables of the subjects.

Prior studies with active teachers

Various studies in Spain and other neighbouring countries have addressed the relationship between sociodemographic characteristics of compulsory education teachers and some aspects of using ICTs in the classroom, including digital competence levels (generally self-perception). The most frequently studied characteristics are age, teaching experience and gender during primary and secondary education, although some studies include non-compulsory stages such as preschool education, non-compulsory secondary education and vocational training.

The influence of these sociodemographic characteristics offer different results. Some studies, such as Lucas et al. (2021) in Portugal, show the greater importance of personal factors (gender, age, teaching experience) compared to contextual factors (school equipment, access to resources, etc.) in digital competence self-assessments; however, this aspect is not so important in other studies, for example, Falcó (2017) finds that personal variables (age, experience, gender) have no influence on the digital competence of compulsory secondary education teachers in Aragón.

Influence of age and/or teaching experience

Several studies in Spain find that self-perceived digital competence is greater among younger teachers. For example, Almerich et al. (2016), with teachers in the Region of Valencia, or Fernández-Cruz and Fernández-Díaz (2016) in the Region of Madrid. Recent studies such as Cabanillas et al. (2020) in Extremadura, and Guillén-Gámez et al. (2020) in the Region of Madrid, find age has a negative influence on self-perceived teacher digital competence. Lucas et al. (2021) also find that younger teachers perceive themselves are more digitally competent.

Nevertheless, Area et al. (2016) with primary and compulsory secondary education teachers throughout Spain, point out that teachers with more professional experience use ICTs in the classroom more frequently, and in more educational situations. In the study by Fernández de la Iglesia et al. (2016) in Galicia, younger teachers consider that they have greater competence in technical—not didactic—dimensions. López-Belmonte et al. (2020) with Spanish pre-university teachers from eight autonomous regions show that younger teachers perceive themselves to be more competent in information and information literacy, communication and collaboration, and digital content creation. However, no relationship is found between age and problem-solving, and in digital security the highest self-assessments can be found in intermediate age groups.

This divergence among previous studies is an example of the differences between self-perception and real performance. In studies in which younger teachers have a higher level of Information Literacy, these levels were generally obtained from self-reporting questionnaires, while data on ICT use are quantitative, more objective, and refer to real use of technologies. Older teachers show better performance data despite perceiving themselves as less digitally competent.

These findings in Spain are confirmed by an international literature review study on the use of digital technology by primary teachers; Spiteri and Rundgren (2018) find that, although younger teachers perceive themselves to be better prepared to work with ICTs, teachers with more experience use them more frequently. Likewise, international studies by Eickelmann and Vennemann (2017) and Drossel et al. (2017), find that even though teachers more favourable to ICT use in the classroom are younger, older teachers with more experience use technology more often.

Gender and digital and information competence

Results on how gender affects digital and information competence among teachers in Spain are contradictory. While in Almerich et al. (2016), men claim to have a lesser domain of technological resources, Fernández de la Iglesia et al. (2016) and Guillén-Gámez et al. (2020) observe a significant inverse relationship. In Cabanillas et al. (2020) or Pozo et al. (2020), the effects of gender differ depending on the digital competence area considered, and Area et al. (2016) find no significant differences based on gender.

Studies with disparate conclusions can also be found in other countries. For example, in Lucas et al. (2021) male teachers in Portugal consider themselves to be more competent in most areas of digital competence; however, Scherer and Siddiq (2015) with compulsory secondary education teachers in Norway, find no difference between genders in terms of self-efficiency in the use of computers for education, but males show greater self-efficiency in general computer use (not specific to education). Gebhardt et al. (2019), with compulsory secondary education teachers from ICILS (International Computer and Information Literacy Study) participant countries, find that gender-based differences are minor and inconsistent, varying depending on the country.

Prior studies among future teachers

Studies with future teachers generally use data from Bachelor's Degree in Primary Education (PE) or Master's Degree in Secondary Education (MS) students. In PE, Esteve et al. (2016) find that students under 24 feel they are better trained for using ICTs in the classroom; however, Gabarda et al. (2017) find no significant correlation between age and self-perceived digital competence. Almerich et al. (2018) find that gender does not affect technological competence and a minor effect of age; the study by Grande-de-Prado et al. (2020) shows that the effect of gender depends on the digital competence area considered.

Some studies include older postgraduate or MS students: Jiménez-Hernández et al. (2020) show that those born before 1990 (Generation Z) perceive themselves to have a higher level of digital competence; the same applies to men versus women. Moreno et al. (2020) conclude

that age is an influential but not decisive factor in the self-assessment of Information Literacy among future compulsory secondary education teachers, although some variations are found depending on the specific areas and the strength of association is low. García-Martín and García-Sánchez (2017) find that level of knowledge and use of 2.0 tools among MS students depends on gender with women showing a higher level.

In other countries, such as Norway, Gundmundsdottir and Hatlevik (2018) find that future male teachers have a higher level of efficiency in ICT use for teaching. However, Tondeur et al. (2018) state that personal variables such as gender and age do not affect ICT competence perceived by trainee teachers in Belgium. Aslan and Zhu find contradictory results in the effect of gender on integrating ICTs among future compulsory secondary education teachers in Turkey, with studies in which gender has no effect (2017) and others where the effect is significant (2016). In the study by Cabezas et al. (2017) in Portugal, men perceive themselves to have greater knowledge in ICT concepts and devices, in handling technology and in attitude towards ICTs. In terms of age, the only significant differences are in the attitude block, which if favourable to older students.

Method

Based on the literature review and research questions, the following hypotheses are proposed:

- ■ H1: Self-Perceived Information Literacy will be overvalued compared to Observed Information Literacy in all groups, and this overvaluation will be greater for younger groups (future teachers).

- ■ H2: For each of the groups analysed, Self-Perceived Information Literacy will be higher among men, but there will be no significant gender-based differences in Observed Information Literacy.

- ■ H3: The factors of occupation (teacher/student), education stage (primary/secondary) and gender (man/woman) will have significant effects in explaining the variables of OIL (Observed Information Literacy), SIL (Self-perceived Information Literacy),

and the SIL-OIL variable (valuation mismatch, i.e., the difference between observed and self-perceived).

- ■ H4: Age will affect Self-Perceived Information Literacy but not Observed Information Literacy.

This study was based on a quantitative perspective that consisted in applying a diagnostic assessment to primary and compulsory secondary education teachers, and to Bachelor's Degree in Primary Education and Master's Degree in Secondary Education students in Castile and León. Thus, the process is a cross-cutting, non-experimental research design that assessed and analysed variables of interest in their natural context, without manipulation.

Sample

This study focuses on primary and compulsory secondary education teachers and future teachers in Castile and León (Spain), with an incidental sample of 442 participants: 199 future primary teachers, 161 future secondary teachers, 37 primary teachers and 45 secondary teachers. Information was collected with informed consent from the Regional Ministry of Education of Castile and León in the case of teachers, and from degree coordinators (Bachelor's in Primary Education and Master's in Secondary Education) for future teachers. The sample of teachers came from eight different schools in León, Salamanca, Valladolid and Burgos: 4 secondary schools, 3 primary, 1 rural school and 1 state-subsidised private school. The sample of future teachers included representatives from the four public universities in the Region.

The sample included 31.3% of men and 68.6% of women, with a similar gender distribution in the four groups. The average age of teachers was 45.37 years and around 35% had 15 years or less teaching experience, 40% between 16 and 25, and the remaining 25% over 25 years. Difference in the average age of both groups of teachers was only 2 years (primary teachers had a higher average age), and both groups claimed to have been using computers for the same amount of time (approximate average of 22 years) and internet (average of around 17 years). The average age of future teachers was over 28 among future secondary teachers and under 22 in the case of primary education; they claimed to have been

using computers for an average of around 15 years and the internet for 13.

Distribution of ICT use for different purposes was similar in all groups when finding information online: a little more than 40% of subjects in both samples declared to spend between 1 and 5 hours per week, and approximately 30% in both cases between 6 and 15 hours. However, future teachers claimed to dedicate more hours to social networks, gaming or viewing audiovisual content: most teachers declared to spend less than one hour while students mostly claimed to dedicate over 5 hours per week to these activities.

Variables and Instruments

The main overall variables of the Observed Information Literacy (IL) and Self-perceived IL study are broken down into Search, Assessment, Processing and Communication of information, as well as a new variable called 'valuation discrepancy', obtained from the SIL-OIL difference. Explanatory variables used in this study were occupation (identifying the subject as a teacher or future teacher), education stage (associating the subject to primary or secondary education), gender and age.

Information collection tools come from prior studies and have previously been validated; they are considered to be suitable from a technical and psychometric perspective:

- **Observed IL**: the instrument used is validated at content level (expert judgement) and statistical level: with a one-parameter Rasch model, reliability is over .75 (ordinal Cronbach's alpha), with acceptable Infit scores for 97% of items, and acceptable Outfit scores for 85% (Bielba et al., 2015, 2017). It comprises 18 exercises designed to assess the dimensions of Search (6 items), Assessment (3 items), Processing (5 items) and Communication of information (4 items).

- **Self-perceived IL**: an adapted version (Rodríguez-Conde et al., 2012) of the IL-HUMASS instrument (Pinto, 2010) was created, updated according to European DIGCOMP indicators (Carretero et al., 2017; Redecker, 2017). It contains 18 Likert-type scale exercises with five levels assessing the dimensions of Search (4 items),

Assessment (5 items), Processing (4 items) and Communication of information (5 items). The statistical validation of this adaptation showed a reliability over .89 on the complete scale (and over .7 in each sub-scale), with a factorial structure with four empirical dimensions corresponding to the theoretical distribution of the dimensions considered and absorbing over 50% of variance.

Both instruments were developed using the *Google Forms* platform, in a single questionnaire filled out by study subjects during a single session. The questionnaire is available at https://bit.ly/2JHsRIV

Procedure

Descriptive and inferential analyses were applied, starting with a significance level of 5%. At descriptive level, the mean was obtained as the central tendency statistic and standard deviation as the dispersion statistic. Confidence intervals were calculated around the mean in order to view and compare results in criterion variables by interest group. Correlation statistics (Pearson or Spearman) were also calculated to study the association between criterion variables and age.

Parametric inferential techniques were also applied, specifically t-tests for related and independent groups and Analysis of Variance. In this latter case, a 3-factor model was applied, including all significant interactions in the final model.

Effect size was included in inferential analyses as a complementary measure (Gravetter et al., 2018) to prevent biases based on the different size of samples compared: small (values around d=0.2 and h²=.01), medium (values around d=0.5 and h²=.06) and large (values around d=0.8 and h²=.15) effects were therefore considered.

Results

Initial exploration of SIL-OIL difference by sociodemographic profile

Table 1 shows overall scores in excess of 8 points and similar in the 4 groups in Self-perceived IL (SIL). Average scores in Observed IL (OIL)

range between 5 and 7 points, with differences of almost 2 points between the most distant groups. Thus, both intra-group and inter-group dispersion is greater in the OIL variable. Differences between SIL and OIL are significant in the 4 groups, with a larger size effect in future primary teachers and lower in secondary teachers.

TABLE 1. Descriptive exploration and inferential comparison of SIL-OIL performance

	OIL		SIL			SIL-OIL (related groups)					
	Mean	SD	Mean	SD	Mean	SD	t	df	p	d
Future primary teacher	5.24	1.73	8.21	0.80	2.96	1.77	23.45	196	<.001	1.67
Future secondary teacher	6.67	1.38	8.70	0.96	2.03	1.58	16.29	35	<.001	1.28
Primary teacher	6.13	1.24	8.15	1.19	1.98	1.54	7.72	44	<.001	1.29
Secondary teacher	7.04	1.22	8.22	0.94	1.18	1.26	6.28	160	<.001	0.94

Analysing the SIL-OIL comparison by dimension (figure 1) shows averages and confidence intervals above 0. There is thus a perceptual mismatch favourable to SIL in all dimensions and groups based on level and occupation. Future teachers generally show a greater SIL-OIL valuation discrepancy than active teachers. These valuation mismatches are greater in the Search dimension, and most adjusted in Communication.

FIGURE 1. Sample distribution in SIL-OIL difference based on level and occupation
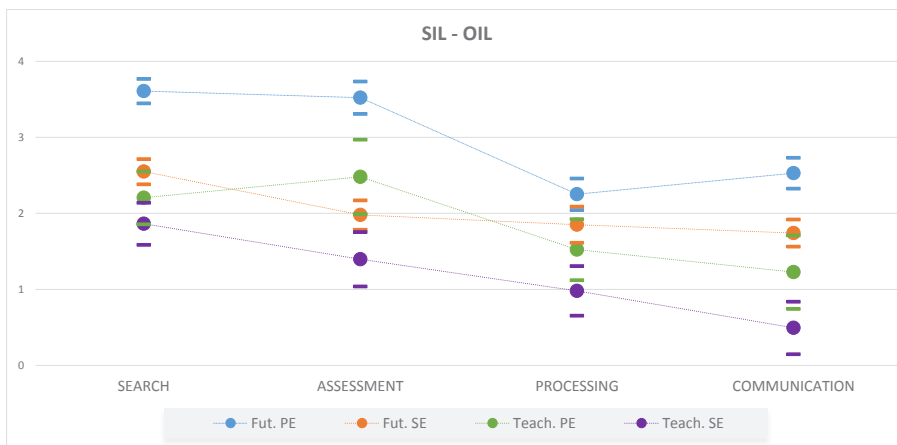
Table 2 compares SIL and OIL scores in each dimension, confirming this tendency. Significant differences can be observed between self-assessment and performance in all groups, with generally high effect sizes in future teachers and medium in active teachers. According to effect sizes, the Search dimension shows the highest level of perceptual mismatch.

TABLE 2. Inferential comparison of SIL-OIL dimension performance by occupation and stage (t-test for related groups)*

	Search			Assessment			Processing			Communication		
	t	p	d	t	p	d	t	p	d	t	p	d
Fut. Primary	-22.51	<.001	-1.60	-16.41	<.001	-1.67	-10.84	<.001	-0.77	-12.42	<.001	-0.83
Fut. Secondary	-15.34	<.001	-1.21	-10.23	<.001	-0,806	-7.78	<.001	-0.61	-9.76	<.001	-0.77
Teach. Primary	-6.34	<.001	-1.04	-5.01	<.001	-0.83	-3.74	<.001	0.62	-2.51	.016	-0.41
Teach. Secondary	-6.73	<.001	-1.00	-3.90	<.001	-0.58	-3.00	.004	-0.45	-1.43	.160	-0.21

* Degrees of freedom are the same as in table 1.

Table 3 compares Information Literacy levels in men and women, who reach similar levels in OIL, but men feel more competent in SIL (with a low effect size). However, SIL-OIL perceptual mismatch is similar in men and women.

TABLE 3. Distribution of SIL-OIL variables based on gender

	Man		Woman		Independent groups			
	Mean	**SD**	**Mean**	**SD**	**t**	**df**	**p**	**d**
OIL	6.02	1.92	6.02	1.57	0.03	437	.982	0.00
SIL	8.58	0.98	8.31	0.91	2.83	436	.011	0.29
SIL-OIL	2.55	1.87	2.27	1.68	1.60	435	.110	0.17

Figures 2, 3 and 4 show average scores (and confidence intervals) in OIL, SIL and SIL-OIL variables by dimension based on gender. The OIL variable obtains scores with an unclear tendency: there are only significant differences favourable to women in assessment, although men in the sample obtain significantly higher average scores in processing and search.

FIGURE 2. Sample distribution in OIL variable based on gender
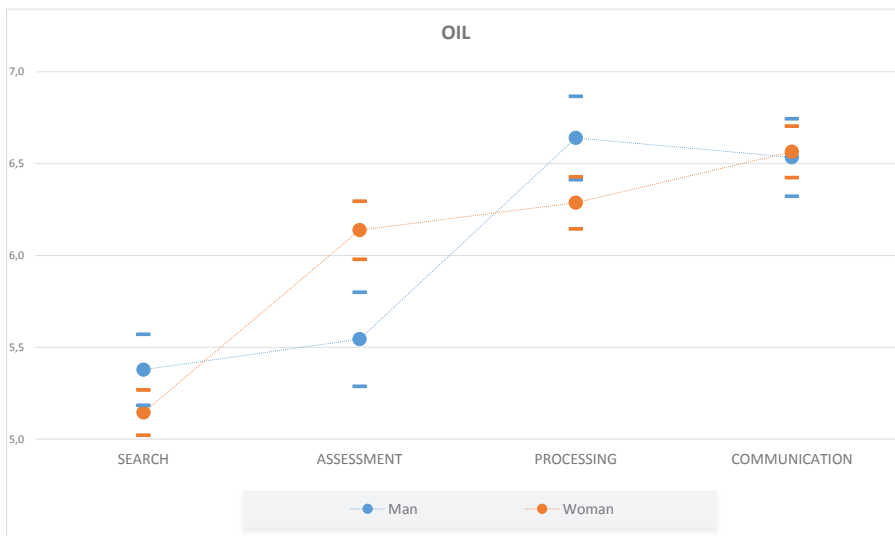
In the SIL variable, men have a higher average self-perception in all dimensions, with a significantly higher distance in Search. Significant differences are found in Search and Processing.

FIGURE 3. Sample distribution in SIL variable based on gender
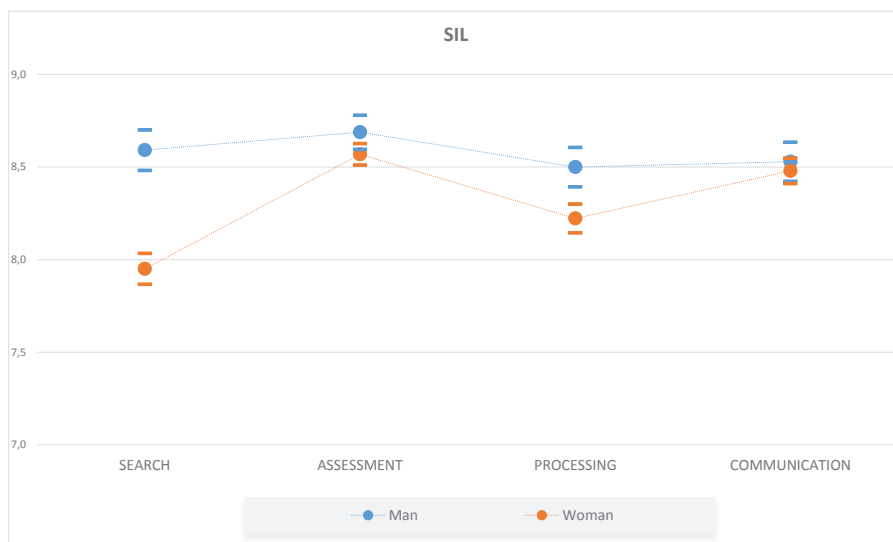
Finally, significant SIL-OIL perceptual differences are observed in the Search and Assessment dimensions; the mismatch is higher among men in both cases.

FIGURE 4. Sample distribution in SIL-OIL difference based on gender
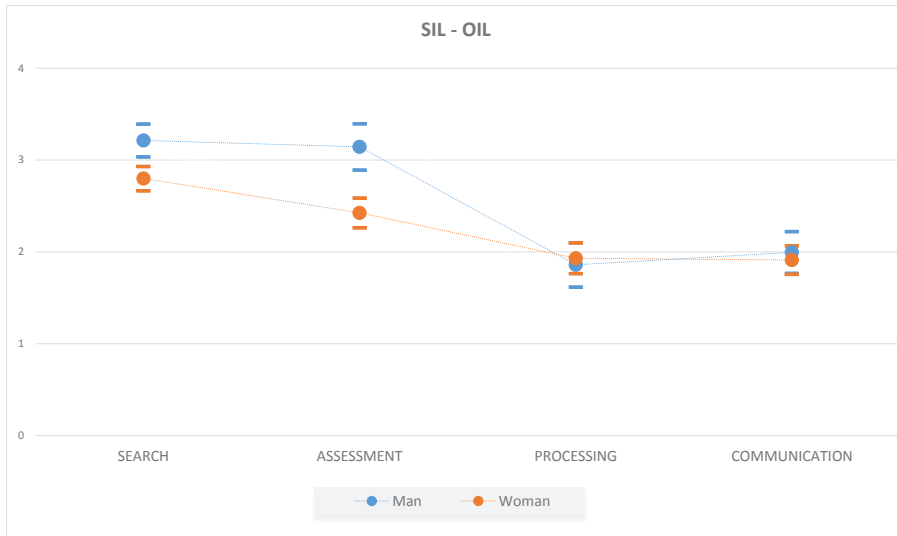
Table 4 confirms the above observations: men achieve higher SIL levels in Search and higher SIL-OIL perceptual mismatches in Assessment. Women, meanwhile, achieve higher OIL levels in Assessment. Effect size in low or medium-low in all cases.

TABLE 4. Differences in SIL-OIL dimensions based on gender (t-test for independent groups)*

	OIL			SIL			SIL-OIL		
	t	p	d	t	p	d	t	p	d
Search	1.04	.299	0.11	4.47	<.001	0.46	1.80	.072	0.19
Assessment	-2.04	.042	-0.21	1.12	.262	0.12	2.45	.015	0.25
Processing	1.36	.175	0.14	2.04	.042	0.21	-0.24	.810	-0.03
Communi-cation	-0.12	.903	-0.01	0.39	.695	0.04	0.30	.763	0.03

* Degrees of freedom are the same as in table 3.

Table 5 shows the relationship between the age variable and OIL, SIL and SIL-OIL levels. While performance levels (OIL) are similar based on age (with insignificant correlations), younger people feel more competent in the dimensions Search, Assessment and Communication (negative correlations indicate that a higher age equates to lower SIL level, and vice versa). In terms of SIL-OIL perceptual mismatch, negative correlations indicate that older people have a lower mismatch in Search and Communication, although tendencies are of moderate or even low intensity. These tendencies are confirmed by observing age-OIL_total and age-SIL-OIL_total correlations.

TABLE 5. Relationship between age and OIL, SIL and SIL-OIL variables

	OIL		SIL		SIL-OIL	
	r	p	r	p	r	p
Search	-.084	.196	-.399	<.001	-.196	<.001
Assessment	-.075	.247	-.150	.021	.020	.757
Processing	-.009	.889	-.120	.066	-.046	.482
Communication	.065	.322	-.294	<.001	-.205	<.001
Total	-.060	.360	-.299	<.001	-.142	.029

Explanatory power of sociodemographic variables

After observing that occupation, stage and gender are the variables with the clearest influence on Information Literacy, a 3-factor (occupation, stage and gender) variance analysis model was applied to each of the three criterion variables: OIL, SIL and SIL-OIL (table 6). Significant main effects are obtained in the occupation and stage variables in all 3 models, and significant gender effects in the SIL-OIL model. In the case of SIL, significant gender effects can be found in interaction with level. Higher effect sizes are observed in the stage variable; they are high in the OIL model.

TABLE 6. 3-factor ANOVA models for OIL, SIL and SIL-OIL*

	OIL			SIL			SIL-OIL		
	F	**p**	η^2	**F**	**p**	η^2	**F**	**p**	η^2
Occupation	11.19	.001	.025	4.55	.034	.010	18.71	<.001	.041
Stage	89.58	<.001	.171	22.96	<.001	.050	36.69	<.001	.078
Gender	2.02	.156	.005	3.54	.060	.008	5.66	.018	.013
Stage*Gender	5.78	.017	.013	5.04	.025	.010	-	-	-
R²	19.30%			6.60%			12.20%		

* Total degrees of freedom=438

Table 7 complements these results, showing the average score of these criterion variables based on occupation and education stage.

TABLE 7. Mean (SD) IL based on occupation and stage

	Occupation		Education stage	
	Student	**Teacher**	**Primary**	**Secondary**
OIL	5.88 (1.73)	6.63 (1.30)	5.37 (1.69)	6.75 (1.35)
SIL	8.43 (0.91)	8.19 (1.05)	8.20 (0.87)	8.60 (0.98)
SIL-OIL	2.54 (1.75)	1.54 (1.44)	2.81 (1.77)	1.85 (1.56)

Significant interaction is observed between education stage and gender in the OIL and SIL models, but not in SIL-OIL (figure 5). Specifically, while in OIL, women in primary education have the highest levels with no clear differences in secondary education, in SIL both groups are similar in primary but men in secondary perceive that they have higher levels.

FIGURE 5. Interaction between gender and education stage in OIL and SIL
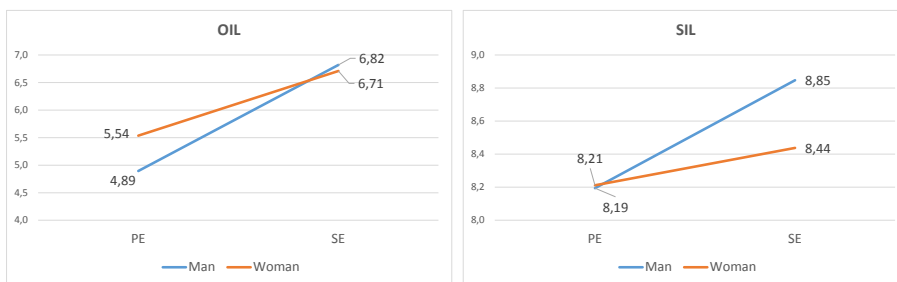
Discussion and conclusions

This paper has analysed Information Literacy (IL) from a sample of active and future primary education and secondary education teachers, adopting a dual approach. Firstly, scores were obtained overall and by component from self-assessments and from real performance for subjects in each group analysed. The relationship between these scores and different sociodemographic variables: gender, age, occupation (future teachers/teachers) and education stage (primary education/secondary education) was then analysed.

As a first conclusion, systematic overvaluation from self-assessments (Self-perceived IL-SIL) compared with performance measurements (Observed IL-OIL) was confirmed, as highlighted in other studies in the field of teaching (Dinçer, 2018 Hatlevik, 2017; Maderick et al. 2016). In this sense, authors such as Maderick et al. (2016) and Dinçer (2018) defend that levels based on self-assessments are not adequate measurements of Digital Literacy; they recommend explicitly labelling these scales as 'digital competence assessment scales' and not 'digital competence scales'. The first part of hypothesis H1 is therefore confirmed, leading to a new variable called 'valuation discrepancy'. This is the difference between SIL values and OIL values and it accounts for the mismatch between a subject's self-assessment and their performance.

Analysing SIL and OIL scores obtained by the different groups leads to interesting conclusions from two perspectives. Considering the dimensional structure of IL, overvaluation of self-perception compared to performance is true in all components considered and is especially

intense in the Search for Information. This component is highly significant as it is the first step in information management and a major part of the activity both inside and outside the classroom (De Aldama & Pozo, 2016; Cabanillas et al., 2020; Camacho & Esteve-Mon, 2018; Colás et al., 2018; Losada et al., 2017). Based on the groups studied, lower performance (OIL) by the two groups of future teachers is noteworthy—especially future primary teachers—, which confirms the second part of hypothesis H2. This difference is clear when analysing valuation discrepancy (SIL-OIL); these values are much higher in primary education students than the other groups, showing very poor performance by this group.

The second block of conclusions refers to how sociodemographic variables influence SIL, OIL and valuation discrepancy. The individual effect of each of these sociodemographic variables was studied in H2 (gender) and H4 (age), and a series of variance analysis models were also proposed to verify the explanatory power of these variables and how they interact (hypothesis H3).

In terms of how gender influences IL levels, hypothesis H2 is confirmed, showing that there are no significant differences in performance (OIL) based on gender. There are, however, differences in self-perceived levels (SIL) as men consider themselves to be more competent than women, in line with prior studies (Aslan & Zhu, 2016; Cabezas et al., 2017; García-Martín & García-Sánchez, 2017; Grande-de-Prado et al. 2020; Gundmundsdottir & Hatlevik, 2018; Jiménez-Hernández et al., 2020, Lucas et al., 2021), although other authors have not found differences based on gender (Aslan & Zhu, 2017; Falcón, 2017; Gebhardt et al., 2019; Scherer & Siddiq, 2015; Tondeur et al., 2018). In a more detailed analysis of SIL-OIL difference by component, significant values are found in Search for Information and especially in Assessment of Information, the dimension in which men have a greater valuation discrepancy due to their high self-perception (SIL) and lower performance (OIL) compared to women. Meanwhile, variance analysis models only highlight that gender has a significant impact on SIL-OIL valuation discrepancy, interacting with education stage in SIL and OIL and partially confirming hypothesis H3. In primary education, women show the same high self-perception values (SIL) as men but their performance (OIL) is much better, while in secondary education the performance of both men and women (OIL) is similar, but men consider themselves to be much more competent (SIL).

Regarding the effect of age, hypothesis H4 is confirmed: OIL levels show no significant difference based on age, but an influence is notable in SIL levels and this is significant in Search and Communication of Information. Younger subjects assess themselves as much more competent in these components, as shown in various prior studies (Almerich et al., 2016; Cabanillas et al., 2020; Esteve et al., 2016; Fernández-Cruz & Fernández-Díaz, 2016; Guillén-Gámez et al., 2020; Jiménez-Hernández et al. 2020; Lucas et al., 2021), although other authors find that age has no influence or claim that this influence depends on the dimension considered or teaching experience (Area et al. 2016; Drossel et al., 2017; Eickelmann & Vennemann, 2017; Falcó, 2017; Fernández de la Iglesia et al., 2016; Gabarda et al., 2017; López-Belmonte et al. 2020; Spiteri & Rundgren, 2018; Tondeur et al., 2018).

In terms of interactions between variables, in addition to the interaction indicated above between gender and education stage, age is found to have no influence and the significant factor that most affects SIL, OIL and SIL-OIL valuation discrepancy is education stage: secondary teachers and future teachers have higher levels than primary teachers and future teachers. Occupation also has a significant influence: active teachers of any stage have better Information Literacy values than the future teachers of those same stages.

The results of this study also point to interesting factors for teacher and future teacher training. Regarding active teachers, even though the Professional Teacher Competences of Castile and León do not specifically include Information Literacy, Digital Competence does include the skill of 'Analysing, search and processing information'. This paper first highlights the need to reinforce IL among active teachers, especially primary teachers, and particularly in the area of Search for Information. Secondly, this training must be independent of the level reported by teachers in self-assessments: if teachers consider themselves to have a good IL level, they are not likely to request specific training that would be of great interest to improve their performance. Evidence of performance must therefore be sought or, in any case, self-assessment scales must be adjusted to better adapt to reality.

Poorer performance of future teachers compared to active teachers highlights the essential role of experience and refutes the existence of a 'generational' effect according to which younger subjects have a better level of information competence. High valuation discrepancy in

future primary teachers and wide dispersion of OIL scores indicate the need to provide Bachelor's Degree in Education students with specific training, particularly in Search for Information. In the case of Master's Degree in Secondary Education students, although their performance is mildly better, there is also a notable need to improve their IL training, particularly education-specific training.

Limitations and future studies

Although this study analyses data from various schools in difference provinces, it is limited to a single Autonomous Region which could limit the scope of the conclusions. Increasing the number of participating subjects would also be highly desirable—especially active teachers from both education stages—in order to confirm some results.

Adding new sociodemographic variables to outline a much more detailed profile of Observed IL levels in compulsory education would also be interesting. For example, variables related to the school for active teachers (ICT equipment, access to computers, institutional policies, training plan attendance, etc.); and for future teachers, data on specific training received during their university studies or on computer use (training or education tasks, leisure, social media use, etc.).

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STEM talent in k-10: a systematic review

El talento STEM en la educación obligatoria: una revisión sistemática

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Abstract

STEM talent (science, technology, engineering and mathematics) is a current research topic both for the renewed understanding of giftedness in specific talent domains and the recent interest in STEM education. This research conducts a systematic review to delve into a specific talent, STEM talent. It intends to illustrate the trajectory of STEM talent during the stage of compulsory education. In particular, it aims to explore the state of the art of this field of research, the set of personal and contextual variables, which affect the trajectory of STEM talent during compulsory education, the most relevant methodologies for the advancement of STEM talent, and the milestones/stages that students go through during this developmental stage. To this end, a protocol for this review of research was developed based on the guidelines of the PRISMA declaration (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) and the Campbell collaboration. Following the application of said protocol, a total of 225 studies were obtained, of which 108 were finally included after reviewing the eligibility criteria. The results not only show the state of the field of research, but also a set of dispositional (cognitive, psychosocial, and sociodemographic) and contextual variables (in formal, non-formal, and other scenarios) that interact with each other to advance or hinder the course of the trajectory; that *hands-on* methodologies are the most implemented to promote STEM talent and finally,

brief guidelines regarding the stages and milestones that take place during the STEM talent trajectory, which offer new lines of research. These results contribute to understanding the most relevant educational policies and practices for the advancement of STEM talent during compulsory education, so some guidelines are given.

Key words: talent, talent development, giftedness, compulsory education, STEM education, STEM

Resumen

El talento STEM (ciencia, tecnología, ingeniería y matemáticas) es un tema de plena actualidad en la investigación tanto por la renovada comprensión de las altas capacidades en dominios específicos del talento, como por el reciente interés hacia la educación STEM. Esta investigación conduce una revisión sistemática para indagar en un talento específico, el talento STEM. Se pretende ilustrar su trayectoria durante la educación obligatoria. En concreto, se busca conocer el estado de la investigación del campo, los conjuntos de variables personales y situacionales que inciden en la trayectoria del talento STEM durante la educación obligatoria, la identificación de las metodologías más pertinentes para la promoción del talento STEM y los hitos/estadios que atraviesa el alumnado durante este momento madurativo. Para ello, a partir de las directrices de la declaración PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) y de la colaboración Campbell se elaboró un protocolo para esta revisión de la investigación. Tras su aplicación se obtienen un total de 225 estudios, de los que finalmente se incluyen 108 tras la revisión de los criterios de elegibilidad. Se concluye cómo se encuentra la investigación del campo, un conjunto de variables disposicionales (cognitivas, psicosociales y demográficas) y contextuales (en la educación formal, no formal y en otros escenarios) que interaccionan entre ellas para favorecer o dificultar el curso de la trayectoria; que las metodologías *hands-on* son las más implementadas para favorecer el talento STEM y, por último, unas tenues orientaciones sobre los estadios e hitos que acontecen en la trayectoria del talento STEM, que dibujan nuevas líneas de investigación. Dichos resultados contribuyen a la comprensión sobre las políticas y prácticas educativas más pertinentes para la promoción del talento STEM durante la educación obligatoria, por lo que se proporcionan algunas orientaciones.

Palabras clave: talento, desarrollo del talento, altas capacidades, educación obligatoria, educación STEM, STEM

Introduction

After a century of research, the study of giftedness has advanced notably. The first approaches that focused on measuring intelligence as a stable trait in a homogeneous set of subjects, have given way to renewed ways of understanding it.

Despite being a construct that can be defined from different perspectives, there seems to be a certain consensus in the field of giftedness in terms of considering human potential as being shaped in a much more plural, contextual, and evolutionarily manner than what was suggested by those who founded the field of research (Dai, 2018). It is a complex phenomenon of genetic and environmental nature, multidimensional, diverse, malleable, dynamic, and in constant development, a result of covariation throughout life (Sastre-Riba, 2020). High intellectual abilities are understood from this complexity, given that the mere general cognitive abilities with which they were associated are integrated with new factors that contribute to later success.

Subotnik et al. (2011, p.7) define giftedness as "the manifestation of performance that is clearly at the upper end of the distribution in a talent domain even relative to other high-functioning individuals in that domain". They add that it involves both cognitive and psychosocial variables, which are malleable and need to be deliberately fostered at each developmental moment and in each talent domain.

Two key considerations emerge from this definition. First, giftedness is understood from an evolutionary perspective throughout the life cycle (Dai, 2017; Subotnik et al., 2011; Ziegler et al., 2019). Abilities are necessary, but not sufficient (Subotnik, et al., 2011) for each individual to successfully complete the trajectory of a specific talent domain. Regarding trajectory, Olszewski-Kubilius et al., (2015, 2016) suggest that: it is necessary to offer opportunities and that these be taken advantage of, psychosocial variables play a determining role in the effective development of talent, developing eminence is the end result to which talent education aspires, skills are important, especially those related to specific domains, and talent domains differ in evolutionary trajectories starting at different ages.

Second, a large number of definitions about giftedness include references to specific talents (Callahan and Price, 2021). The multidimensional reality of giftedness has focused its attention on specific

skills and abilities in particular areas of talent (Tourón, 2020). Among the specific talents, STEM talent (science, technology, engineering, and mathematics) is substantially valuable, given its role in the economic growth of countries (Beasley and Fisher, 2012) and how instrumental it is to achieve the Sustainable Development Goals, SDG (MacDonald and Huser, 2020).

STEM talent is understood in adulthood as "transformative discovery or innovation in STEM" (Subotnik et al., 2009, p. 1315). The probability of successfully reaching one's talent potential is conditioned by the acquisition of the necessary skills at each developmental moment (Olszewski-Kubilius et al., 2019), so that compulsory education becomes the first link in the chain to achieve this result.

Despite the existence of different ways of understanding STEM in educational practice, those who defend it claim that:

> Boon (2019):
> "the practice should embrace an interdisciplinary teaching approach, which removes the learning and development barriers between the four disciplines of Science, Technology, Engineering and Mathematics.… They consider that bringing the four disciplines together as STEM is theoretically sound and valid, since science and mathematics are generally considered to form the basis of applied science, which includes technology and engineering" (p.7).

In addition to defending the integration of STEM disciplines, although still with a certain lack of empirical evidence (Martín-Páez et al., 2019), disciplinary integration is part of good practices for talent education (VanTassel-Baska and Brown, 2007).

If the development of talent is an indispensable condition to lead innovation and community development (Pérez and Jiménez, 2018), educational and social policies must educate for excellence (Jiménez and Baeza, 2012). In addition, one of the main objectives of education is to respond to social demands by promoting social, economic, scientific, and technological development (Türk et al., 2018), which means that STEM talent development will be an essential resource of 21st century societies and a priority for every educational system. For all these reasons, understanding how student's STEM talent is facilitated in compulsory education must be a priority in educational systems.

Research motivation and objectives

Despite the relevance of STEM talent development in compulsory education, research in this field is still scarce. Olszewski-Kubilius et al. (2019) identify a set of psychosocial variables that favor the development of all talent trajectories, including STEM, at different stages. In this regard, Subotnik et al. (2019) explore the factors that favor graduating from STEM trajectories during post-compulsory secondary education. However, this focus of research has not been applied yet to compulsory education.

Opportunities for developing this talent can be found during the primary and secondary education stages through inquiry-based learning, collaboration among equals, open methodologies with less restrictions, and real-life problem solving (Robinson et al., 2014). Early abilities are transformed into competence when students receive appropriate educational experiences with family support and quality teacher-student learning (Subotnik and Jarvin, 2005).

Therefore, the objective of this research is to deepen the knowledge of the STEM talent trajectory during compulsory education.

The specific objectives are:

– Describe the state of the art in STEM talent research.
– Understand the variables that modulate the STEM talent trajectory.
– Identify the methodologies that favor STEM talent education.
– Determine the milestones and/or stages that mark the learning progress of STEM talent

To address these objectives, a systematic review of the scientific literature was carried out following the methodology described below.

Method

This systematic review was carried out following the international guidelines established in the health sciences guide of the *Preferred Reporting Items for Systematic reviews and Meta-Analyses*, PRISMA (Moher et al., 2015) to assess research quality; and the Campbell Collaboration's Guide to the Social Sciences (Petticrew & Roberts, 2006), which provides steps for conducting systematic reviews in this field.

The method goes through this sequence: systematic review protocol registration, search strategy, inclusion and exclusion criteria, assessment of the quality of evidence of the included research articles, and the process of collecting and processing data for its interpretation.

Protocol registration

Developing and registering protocols is suggested by international organizations that promote good practices (suggested in the aforementioned guidelines). However, it is not yet a widespread practice in the social sciences.

The protocol for this systematic review was prepared and notified before the start of said review, in June 2020, to improve the quality of the procedure, favor its replicability, and increase the confidence of its results (Herce, in press). It specifies the methodological process described below.

Search strategy

The strategy includes search equation selection, database selection, and finally, the specification of the search strategy for each database, which was carried out at the beginning of the second semester of 2020 and following the guidelines of the protocol.

- Search equation: the terms that define the equation were identified using the European Education Thesaurus (ERIC). In addition, they were reviewed in an exploratory search after which the Boolean operator "NOT" was introduced to exclude three concepts and reject the terms "science", "mathematics", "engineering", and "technology", given that in both cases a high level of 'noise' was generated with these terms. The resulting equation was: ("STEM talent" OR "STEM gifted*") AND ("Elementary*" OR "Primary*" OR "Secondary*" OR "middle*" OR "K-12" OR "K-5" OR "K-6" OR "K-8") NOT ("cell" OR "stem cells" OR "plants").
- Databases: social science (education), science (engineering and technology), and multidisciplinary ACM Digital Library, IEEE

Xplore, ScienceDirect, EBSCOhost, Scopus, and WOS (core collection) databases were included

– Specification of the search strategy: the strategy for each database was defined in the protocol, with each algorithm and field operators (Herce, in press).

Eligibility criteria

The eligibility criteria (Table 1) comply with what is specified in the protocol of this systematic review (Herce, in press) and to the PICOC format (Petticrew and Roberts, 2006):

TABLE 1. Selection criteria (own elaboration)

Criteria for identifying potential articles	Article selection criteria (PICOC)
Quantitative and qualitative primary studies	The direct or indirect population is the student body at any educational level in the stages of primary and/or compulsory secondary education
Articles published in peer-reviewed scientific journals or conference communications in indexed proceedings in defined databases	At least one of the objectives must be addressed
Access to research	In the context of formal and non-formal education
In English or Spanish language	

After the initial search, a total of 225 articles were obtained from the databases. Duplicates were eliminated with the reference management software "Refworks 2.0", resulting in 202 studies. After applying the criteria for potential items, 34 were excluded and 60 more were eliminated after applying the PICOC criteria. The total number of publications resulted in N=108 (available at: https://tinyurl.com/yb27uvg7). The search was carried out by the first researcher, the second researcher reviewed 15% of the set of articles until an agreement was reached between both of them.

Figure 1 illustrates this process of searching and applying the eligibility criteria, with an adaptation of the PRISMA-P flow diagram (Moher et al., 2015).

FIGURE 1. Flowchart of search results and eligibility process (adapted from PRISMA-P, from Moher et al., 2015)
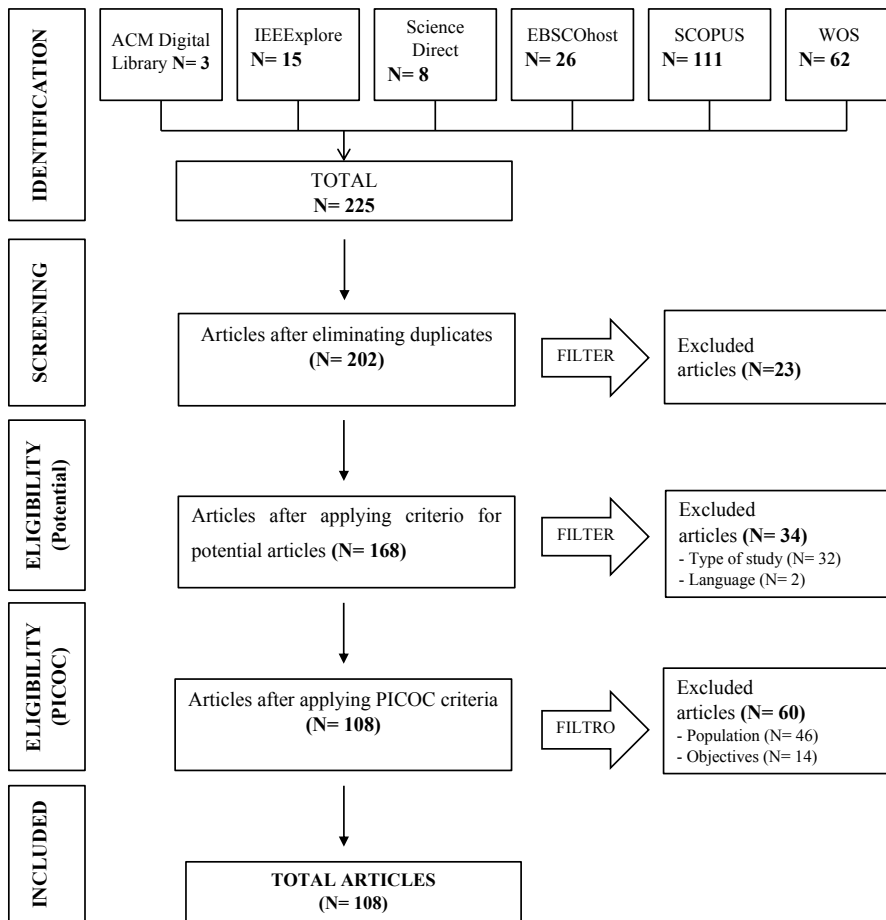
Assessment of the evidence quality of the research articles

To assess the quality of the evidence, the *Standard quality assessment criteria for evaluating primary research papers from a variety of fields* (Kmet et al., 2004) applied to quantitative, qualitative, and mixed research was completed. The results show high quality evidence (between 0.75 and 1) in all quantitative studies except two moderate ones (between 0.5 and 0.74); high quality evidence in all qualitative studies, except in two moderate ones; and high quality evidence for studies in which both types of research designs apply (Herce et al., 2020). With this, the selection of the set of studies for the review was concluded, after being verified by the three researchers.

Data collection and processing

Following the protocol of this review, data extraction and treatment began at three levels: descriptive analysis with an Excel table that included authorship, date, journal, abstract, eligibility criteria (potential articles and selection) with a list of the embedded articles; an Excel table with the quality of the evidence of each study according to the different type of design; and an Excel table with the answer to the questions asked (Herce, in press).

The data was analyzed using the deductive method, starting from three general dimensions (with percentages) that are then broken down into categories. For each category, percentages over the total of each dimension were calculated (not over the total of all articles). Overlaps existed due to the fact that the same article could be considered for different variables.

The analysis was structured into three dimensions that correspond to the last three objectives of this research:

– Modulating variables dimension: percentage of dispositional variables (cognitive and non-cognitive variables of the individual), contextual variables (opportunities in the environment) and the combination of both.
– Methodology dimension: percentage of the methodologies being implemented.

– Milestones/stages dimension: percentage of milestones (critical variables for the progress of talent) and developmental stages that are experienced during the STEM trajectory.

Results and discussion

Descriptive analysis

The systematic review places STEM talent development research into the 21st century and illustrates the growing interest it has received in recent years. Until 2014 the evolution had been slow, but as of 2017 publication output increased considerably (Figure 2).

FIGURE 2. Evolution of scientific output regarding STEM talent (own elaboration)
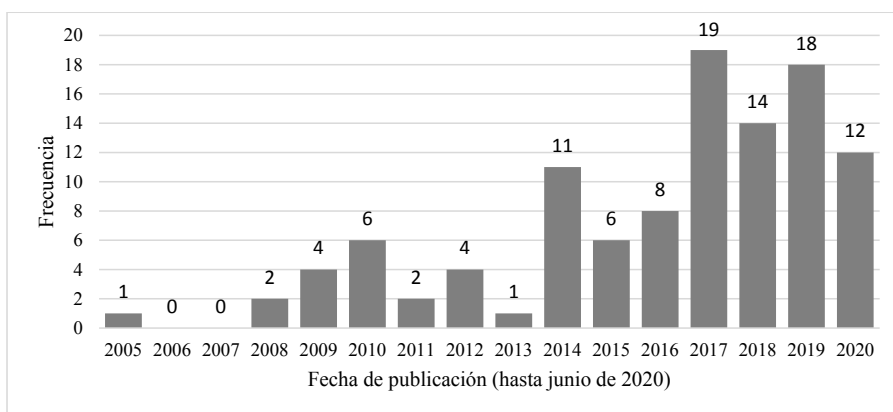
This evolution can be attributed to two different reasons. First, a renewed vision of giftedness. Currently, the study of talent goes beyond abilities and embraces a wider audience in which it is not only about understanding the "nature" of individuals, but how to create productive and satisfying life paths that are beneficial for the individual and society. The key lies in understanding how to advance potential through trajectories that take into account how and why some individuals reach eminence as a consequence of endogenous and exogenous factors and

the interaction between both (Dai, 2018). Second, the novelty of the STEM education movement, which is still in the initial stage of its development (Martín-Páez et al., 2019).

Although the STEM trajectory has become of utmost interest for the advancement and prosperity of nations, commitment to research in this field has not been equally assumed worldwide (Figure 3).

FIGURE 3. Distribution of STEM talent research worldwide (own elaboration based on displayr)
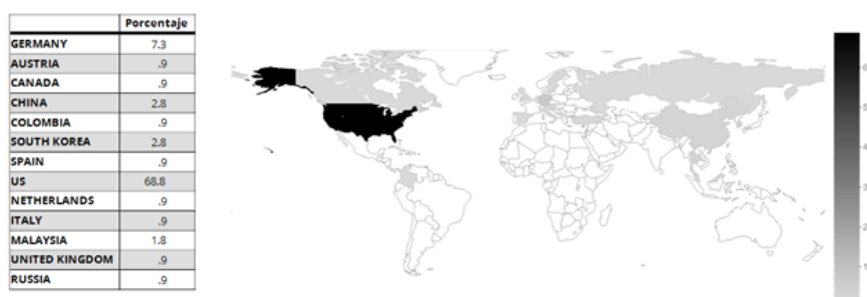
The US is home to almost three-quarters of the total scientific output. The American continent is at the forefront of scientific output with the US, Canada, and Colombia. Regarding Europe, except for Germany, few countries conduct research in this field and those who do it are still shy, like Spain which to date has only published one study. However, it is a European priority to attract talent to science and technology as indicated in the action plan for gifted students of the Lisbon strategy (Hausamann, 2012), following the work of the *European Cooperation in Science and Technology* (COST, 2007).

Finally, the Asian continent appears in third place with a publication percentage slightly lower than the European one.

Regarding educational stages, it is during compulsory education when the foundations of competence are laid, driving the trajectory of talented STEM individuals (Subotnik et al., 2011). Figure 4 represents the interest given to the different educational stages.

FIGURE 4. STEM talent research by educational stages (own elaboration)
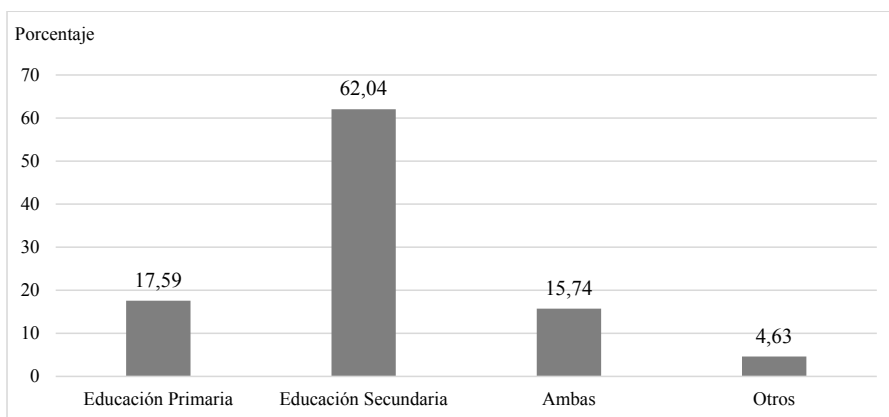
In terms of the direct or indirect population of educational interventions, the majority of the studies focus on compulsory secondary education (known as ESO in Spain). A total of 62.04% of the articles address only this stage and, in addition, 15.74% include both secondary and primary education. Primary education is only included in 17.59% of the total. Finally, 4.63% cover broader developmental stages (from early childhood education to university or adulthood).

Therefore, it is necessary to carry out in-depth research of STEM talent education during primary education, to identify the skills and guidance that talented students need at this stage, given that it is in this period when STEM talent competences are developed. In this sense, early STEM experiences are essential (Cannady et al., 2014) and it is necessary to train students in a variety of skills from each specific talent domain, so that they are able to act efficiently and be guided towards vocational options in said domain (Preckel et al., 2020).

Regarding the research of the other objectives, they have received unequal interest (Figure 5).

FIGURE 5. Attention paid to the research objectives (own elaboration)
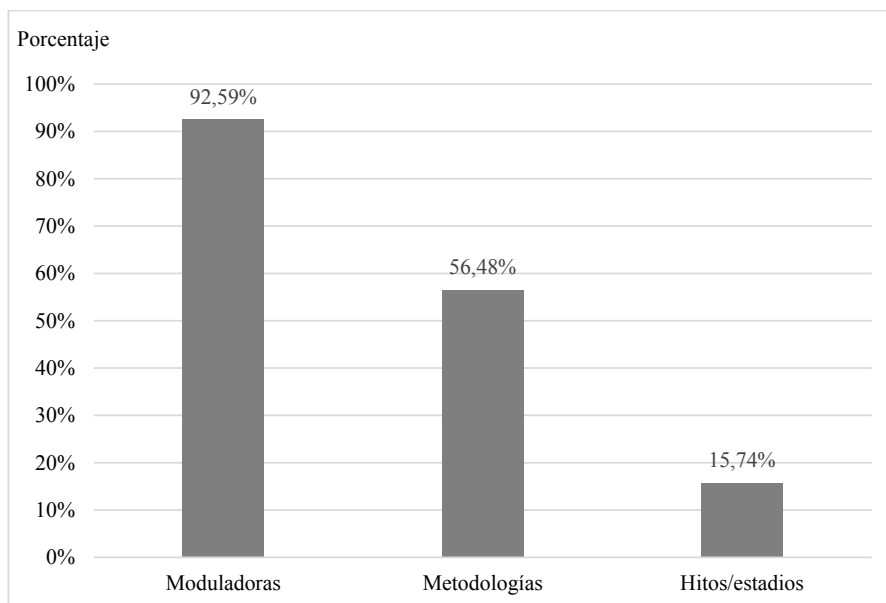
The variables that influence the STEM talent trajectory can be found in the vast majority of the scientific publications (92.59%). More than half (56.48%) study methodologies for promoting STEM talent, and a small percentage (15.75%) focus on the milestones and stages that students go through during compulsory education.

The detailed results regarding each objective topic are presented below. These results are presented as percentages over each subtotal.

Modulating variables in the development of STEM talent in compulsory education

In all talent trajectories, the individual's dispositional variables and the context opportunities both intervene. In addition, both groups of variables interact with each other (Dai, 2021; Subotnik et al., 2021). Regarding STEM talent, these variables are found in N=100 articles (92.59%) and are grouped into: dispositional and contextual. Of all the publications

addressing modulating variables, dispositional variables are found in 87% and contextual variables in 90%. In addition, 75% of the studies highlight the existence of relationships between both sets of variables, so that the combination of both groups of factors also contributes to progress in the STEM trajectory of students.

TABLE 2. Variables that modulate the trajectory of STEM talent in compulsory education (own elaboration)

Variable Groups	Variable	Percentage
DISPOSITIONAL VARIABLES (87%)	Genes	1%
	Cognitive variables	38%
	Psychosocial variables	65%
	Sociodemographic variables	51%
CONTEXTUAL VARIABLES (90%)	Formal education	63%
	Non-formal education	41%
	Others	12%
INTERACTION (75%)	Yes	75%

Dispositional variables

According to the research, among the characteristics of students with STEM talent we find genetic disposition (1%), cognitive variables (38%), psychosocial variables (65%), and sociodemographic variables (51%), with most studies reporting more than one of these characteristics in their subjects.

– Genetics and cognitive variables: genetics and, in a substantially higher percentage, cognitive variables emerge as predictors of STEM talent. They contribute to favoring STEM talent together with polygenic scores, high performance/competence, especially in math and science, abilities/skills, especially visuospatial and mathematical reasoning, prior knowledge, interdisciplinary thinking, and the individual's learning resources. Among these cognitive variables, the greatest weight is given to mathematical (Lubinski et al., 2014) and visuospatial abilities (Lakin and Wai, 2020; Sisman et al., 2020) together with academic performance. Regarding talent trajectory, abilities must be transformed into STEM talent competence, and this competence into expertise (Subotnik, et al., 2010), so assessing performance becomes important, especially in terms of national assessments of curricular competence in math and science.

– Psychosocial variables (non-cognitive): those that arouse the greatest attention in research. Within the psychosocial variables, those that favor the STEM trajectory are: STEM interests (69.23%), STEM attitudes (18.46%), motivation (13.85%) and perception of efficacy/competence in STEM (13.85%). Factors that are represented less include self-regulation, commitment to the task, knowledge about engineering (usefulness and importance), persistence in STEM itineraries, expectations of success (for example, graduation), self-concept, locus of control, emotions, personality, creativity, learning resources, feeling social and emotional support, leadership, identity, security and definition of one's own goals, good interpersonal relationships, tacit knowledge of the field, working hard rather than believing in abilities (*growth mindset*), and the perception of being able to combine scientific work with the family in adult life (in women). Negative-risk behaviors and behavior problems and anxiety towards mathematics have a negative effect. Unlike cognitive variables (more difficult to modify), these variables are malleable and need to be deliberately promoted, as they are a critical factor for staying on the trajectory course (Olszewski-Kubilius et al., 2015, 2016). STEM talent educational interventions must focus on this set of variables to promote a successful STEM talent trajectory.

– Finally, the sociodemographic variables highlight a set of characteristics that limit the STEM talent trajectory. Among them,

gender is the most significant variable (60.78%). The number of women who access STEM university studies has been decreasing over the last 20 years (López-Iñesta et al., 2020), despite female adolescents performing the same or even better than their peers in terms of science, mathematics, and literacy (Gagnon and Sandoval, 2019). For them and for other disadvantaged groups, staying on the STEM path becomes a personal and social challenge.

– Other characteristics that hinder the advancement of STEM talent are in this order: race/cultural diversity (29.41%), with certain races and cultures having greater opportunities (for example, white and native people); socioeconomic status (23.53%), with fewer resources come fewer opportunities; age (11.76%), primary education provides fewer options; rural/urban environment (7.84%), with urban environments offering a wider range of services and resources. In addition, other variables in a lower percentage that hinder the trajectory are: belonging to minority or disadvantaged groups, students at risk of dropping out of the educational system, being twice exceptional (high ability and disability), certain types of family environment and, the profession and educational level of their parents in non-STEM fields. The research seeks to identify the mechanisms that contribute to closing these gaps, for example, with educational programs that provide equal opportunities (Olszewski-Kubilius et al., 2017) or experiences that contribute to overcoming the barriers from the family and school context (Burt y Johnson, 2018).

Contextual variables

These variables refer to the opportunities for developing talent in specific settings and external to each individual. The context variables have been organized into three categories: formal education (63%), non-formal education (41%), and other contexts (12%). Opportunities provided to students on the talent trajectory from the educational system are crucial, but so are all those non-formal educational opportunities within their reach.

In the first place, formal education is the most studied context, and it includes:

– *Teachers*: teacher training (lifelong learning, sustained professional development, institutional support for training), collaboration between educational centers, universities, and STEM professionals, sharing experiences among teachers, high qualification, perception of their competence, and active involvement in the teaching process all contribute favorably to the advancement of the STEM talent trajectory.

– *Methodologies*: described in the following section.

– *Type of center*: the opportunities offered by the different types of centers are contrasted according to their rural/urban environment, the role of STEM boarding schools in the US, and the results of public schools, Catholic or *homeschooling,* and specialized STEM schools as opposed to the traditional ones.

– *Material resources of the center*: talent is encouraged by having STEM material resources, such as laboratories either at the center itself or external.

– *Attention to diversity*: students with STEM talent need to have the possibility of attending advanced courses (mathematics and science, especially) and extracurricular activities, mentoring, differentiation, acceleration, and enrichment.

– *Curriculum*: on the one hand, the advancement of STEM talent is favored by bringing STEM interests into the curriculum at an early age, offering an advanced and/or affective curriculum, access to engineering content and integration of STEM content, intense exposure to mathematics and science content in primary and specialized content in secondary school, perceiving the usefulness of the subjects, visibility of STEM role models in the classroom, different groupings, tacit knowledge of the STEM disciplines, use of technology, the possibility of showcasing classroom projects to the public, interpersonal relationships in the classroom, feedback to students and recognition of achievements, STEM learning environment, guidance, institutional support for the STEM curriculum, and high-quality lesson plans. On the other hand, disruptions in the classroom are negatively related, as they cause anger and boredom.

The differences between the teaching staff, the methodologies that are implemented in the classroom, the type of center, its resources, and the access it has to other resources, attention to diversity for students with STEM talent, and the curriculum that is developed, translate into differences in opportunities for the advancement of STEM talent.

Second, non-formal education can fill many of the shortcomings of formal education, highlighting:

– *Extracurricular activities (92.68%)*: to bring content and skills that are not accessible in formal education (delve into specific interests, learn about new fields, interact with peers who share interests...). In addition, these activities are critical in subjects with sociodemographic characteristics that hinder the STEM trajectory (Subotnik et al., 2019) such as students residing in rural settings (Ihrig et al., 2018) or the female gender (Holmes et al., 2012). Race and offering interests from non-formal education are two factors positively and significantly related to success in STEM (Steenbergen-Hu and Olszewski-Kubilius, 2017).
– *Family and equals*: family is fundamental in promoting early STEM interests and providing support (Burt and Johnson, 2018; Garriot et al., 2014; Steenbergen-Hu and Olszewski-Kubilius, 2017), and so is the support of peers with whom interests are shared (Subotnik y Rickoff, 2010).

Despite this classification of the context, formal and non-formal education should not be separated. Formal education offers some opportunities and non-formal education others, with each of them bringing advantages and disadvantages to the advancement of STEM talent (Olszewski-Kubilius, 2009). Zeng, Zhang, and Wang (2019) suggest building bridges between the two for the development of this talent.

Macro context variables appear subtly and include: educational capital, economic resources of the country, educational policies (scholarships, bridges between the different educational levels and between formal and non-formal education), linking talent education with the objectives of the society, analysis in each society of the impact that STEM talent education has on the incorporation into STEM professions and on the number of people reaching STEM eminence, state of STEM research in the country, population health and survival (life expectation) in less developed countries, national standardization of the curriculum, recognition of

exceptional achievements in students with STEM talent (national awards), cultural value given to the STEM field (norms and values associated with STEM professions), and gender role models and political empowerment of women.

In this way, the STEM talent trajectory is not only affected by the characteristics of the individual and their close educational contexts. Talent has to be understood in the broader context of a culture that values specific lines of human development and transforms it in the course of individual development. Individual and culture are not two separate entities, but are constituents of each other (Dai, 2019). Individual's personal and environmental resources and the access they have to these are associated with high abilities, with the interaction between endogenous and exogenous forces capturing the understanding of giftedness from a systemic perspective (Ziegler et al., 2019).

To summarize, dispositional variables interact with the opportunities offered by the context, they form trajectories that can favor or limit the advancement of talent and the combination between both types of variables appears repeatedly in research (75%). Therefore, STEM talent education needs to be understood from a systemic and dynamic lens characterized by complexity and the interaction between different sets of factors.

Methodologies to promote **STEM** talent in compulsory education

The methodologies that promote STEM talent during compulsory education have been grouped into thirteen categories, although more than half of the publications (64%) opt to address more than one.

The findings place independent/autonomous learning in the first position (26.23%). This methodology allows curricular differentiation for gifted students, given that by delving into and advancing in STEM subjects, thinking and problem-solving skills can be fostered. Independent learning is one of the most frequently recommended methodologies for gifted students and included in most manuals for differentiation and individualization. In addition, it is preferred by the most capable students (Yu and Jen, 2020).

In addition to independent learning, project-based learning is confirmed as another one of the most relevant methodologies for the

advancement of STEM talent also with 26.23%. They are followed in percentage by problem-based learning (18.03%), inquiry-based learning and the engineering design process (16.39% each), and experiments/demonstrations (14.75%).

This set of cited methodologies, the *hands-on* methodologies, are the most widely implemented for the advancement of STEM talent during compulsory education. They allow the integration of STEM disciplines by applying practices of scientific inquiry, mathematical logic, and problem-solving skills, trial and error, creativity, and visualization skills for students who collaborate, design, prototype, invent, optimize, and document unique product or project designs. Along with them, the *maker* approach favors authentic teaching-learning experiences (Banks-Hunt et al., 2016). In addition, all of them contribute to solving real-life problems while integrating the STEM disciplines.

Visits to laboratories (Itzek-Greulich et al., 2015), attending round tables, and conferences (Holmes et al., 2012) improve STEM learning, bring knowledge and skills closer to those who otherwise do not have access and offer guidance towards STEM vocations.

Finally, mentoring (14.75%), role models (8.2%), as well as other sets of methodologies (42.62%) with a wide range of techniques such as the use of narratives and stories from successful STEM professionals, gamification, learning based on video games or bibliotherapy and cinematherapy, among others, offer important benefits. The findings suggest that these methodologies not only favor students in general, but specifically benefit vulnerable groups in the STEM talent trajectory due to their sociodemographic characteristics (women, low socioeconomic status, race ...). It is worth noting the scarce use of traditional methodologies based on lectures (3.28%) which are presented together with other methodologies.

Milestones/stages of STEM talent development in compulsory education

Of the various topics of the research objectives, it is the one that receives the least attention. In terms of publication output within the topic, milestones are studied in 76.47% and stages in 23.53%, the second hardly appears given the novelty of the subject. Models of talent development and STEM education are recent topics in research.

Among the milestones, indicators are defined based on STEM talent competence (46.15%), especially mathematics, but also on computational talent and engineering design, or programming skills, recognitions (both in academic achievements, such as awards or winning tournaments, 30.77%), academic performance on state tests (30.77%), completion of advanced courses (15.78%) in the countries that offer them, and evidence of creativity (7.69%).

The few milestones are mostly related to the processes of identifying students with high abilities or for access to programs in formal or non-formal education, rather than as indicators of progress in the stages they go through in the STEM talent trajectory. Skills and, above all, competence and performance results are usually taken as a reference. The rest of the indicators, such as obtaining prizes or recognitions in STEM contests or tournaments, evidence of creativity and participation in advanced courses, are not presented in all educational systems and when they do occur, they are not available to all students.

The stages are based on Bloom's taxonomy (1985) and earlier research (Subotnik et al., 2011; Subotnik and Jarvin, 2005). Three moments are proposed: in the first stage, people need to be guided to "fall in love" with a topic, idea, or discipline. The second involves teaching the skills, knowledge, and values of the domain. In the third, talented people apply their passion and technical expertise to create a unique style and explore new problems. In the first stage, skills/abilities are transformed into competences and then competences into expertise, the psychosocial abilities becoming essential in the transitions. Regarding STEM talent, suggestions are offered according to age: in 3rd and 4th grade, non-formal education experiences must stimulate STEM enjoyment, promote confidence in spaces such as laboratories, ensure literacy, and develop solid basic mathematical skills. By 6th grade, students should participate in advanced courses and in 8th and 9th grade, curricular gaps must be covered such as significant laboratory practice, "leveling the ground", and coordinating with families.

Recently, Preckel et al. (2020) proposed the *Talent Development in Achievement Domains* (TAD) approach specifying the model of Subotnik et al. (2011). The talent trajectory crosses four moments: potential (individual constellations of psychological factors); competence (related and systematically developed skills); expertise (high level of performance sustained over time) and, transformational achievements (high level of

creative achievement that breaks the limits of the domain or sets new questions). The TAD approach offers a foundation to understand the sequence and empirical evidence regarding the increase in the level of specialization and the relationships between the predictors and indicators that favor the talent trajectory; through a set of steps in which initial skills culminate in transformational achievements upon completion. Despite this, more efforts are still needed to identify milestones and stages in STEM talent.

Conclusions, implications, limitations, and future lines

In gifted education, the "21st century talent models" call for an evolutionary and renewed approach focused on specific domains. Among the talent domains, STEM acquires substantial relevance today, although it is still under study.

This review is a starting point to understand the trajectory of STEM talent in compulsory education outlined in these conclusions:

– The results suggest a growing interest in STEM talent research since the late second decade of this century. Following North American leadership, research is distributed heterogeneously at an international level and in terms of the educational stages it addresses (focusing on secondary education).

– Among dispositional *variables*, cognitive variables are seen as predictors of STEM talent, although by themselves they do not optimize the successful completion of the STEM talent trajectory. In the considered body of research, psychosocial variables acquire much greater relevance than the previous ones. This is consistent with current conceptions of talent development that understand the psychosocial as a more critical element than the purely aptitude-cognitive when progressing through the different stages of said development. Regarding the sociodemographic variables, gender is the most decisive because it concentrates the interest of the research. In addition, a set of characteristics warn of vulnerability in some groups of students. Finally, regarding the contextual variables, they are presented in the form of opportunities for the advancement of STEM talent from formal education, and in a high percentage from non-formal education. It seems that, at

least until now, the development of STEM talent in compulsory education requires complementing formal contexts with non-formal experiences, and even the combination of both. The family also appears as an educational agent that favors the trajectory of STEM talent, especially for some student profiles.

– An overwhelming presence of *hands-on methodologies* is reported for the advancement of STEM talent: active, practical, focused on problem solving, and that allow student autonomy in combination with peer support and expert mentorship. There is a clear relationship between STEM talent education and a certain methodological style, which is also possibly associated with the high presence of non-formal learning (less rigid) in STEM talent education, especially with students who present certain sociodemographic characteristics.

– *Milestones and/or stages* of STEM talent development are the topics with the most palpable research gap, and to which we will dedicate our future efforts. The stages of development of STEM talent in compulsory education have not yet been clearly established, nor the milestones that mark the passage from one to another, despite the interest it arouses to cultivate STEM talent in compulsory education.

To summarize, some guidelines for training STEM talent in the educational system can be suggested. They are based on the premise of the interaction between personal characteristics and although they are presented in a segmented way, they need to be understood from a systematic, holistic, evolutionary, ecological, and dynamic vision:

– Observe the cognitive characteristics of students that predict success in the STEM talent trajectory. High visuospatial skills, high mathematical reasoning ability, and high proficiency in STEM talent stand out in the early years of primary education.

– Deliberately and systematically promote the psychosocial variables that favor the smooth course of the STEM talent trajectory. A top priority while training this talent should be to bring together STEM interests and perseverance in these vocational trajectories, favorable STEM attitudes, motivation towards the field and commitment to it, and a perception of adjusted competence.

– Carefully monitor the most disadvantaged students with STEM talent, both to detect their potential and to offer specific educational

interventions applying the principle of equity. More specifically, the most vulnerable students in STEM are female students, racial and cultural minorities, students with low socioeconomic status, twice exceptional students, individuals at risk of dropping out of the educational system, unstructured family environments, or parents without studies or jobs in STEM fields.

– Provide learning experiences from educational centers that advance the trajectory of STEM talent. The training of teachers throughout their lives and in contact with other teachers, universities, and STEM professionals, knowledge of the most pertinent methodologies to implement in the classroom, specialized resources (such as laboratories or access to external laboratories), attention to diversity programs with differentiated educational responses that allow the most capable students to specialize, and a curriculum with a range of sufficiently challenging opportunities all contribute to the advancement of STEM talent.

– Assess the available resources and opportunities of the educational center and the families to advance talent through an analysis of the immediate context. Opportunities from each setting do not only contribute to the development of psychosocial skills, but can compensate for both personal and contextual shortcomings, both critical issues for advancing the STEM talent trajectory. This implies the participation of the family and identifying services and resources from non-formal education in terms of STEM extracurriculars. It is necessary to build bridges between formal and non-formal education.

– Offer different types of methodologies to enable the curricular differentiation needed by gifted students, especially *hands-on* and learning in real STEM contexts. In addition, for each student, depending on their sociodemographic characteristics, some methodologies may be more appropriate, such as mentoring and role models for female students.

Despite having these guidelines for STEM talent education in compulsory education, challenges remain both in this research and in the field of study in general.

First, some limitations that emerge from this research are outlined. Given that the aim has been to collect as many studies as possible, including qualitative research, the advantage of amassing a large body

of knowledge translates into the limitation of not being able to calculate the size of the effect of the interventions. Furthermore, the guidelines followed in this research suggest the convenience of reviewing the entire process by at least two researchers and, in this work, the classification and coding was carried out by the first researcher, with the second and third researchers only reviewing a percentage of the included studies. However, the development and communication of the protocol of this review allows its replicability for the advancement of research, as proposed by the guidelines that guide this review.

Second and as a future line of research, we plan to continue in this field of research and specify a model for the development of STEM talent in compulsory education. The "talent models of the 21st century" call for a systemic approach, loaded with the interaction of different endogenous and exogenous variables/forces, dynamic, evolutionary, and renewed of the specific talent domains. Within this framework, the STEM talent trajectory variables and the most appropriate methodologies to favor it have been identified. Despite this, based on the conclusions collected, it is necessary to delve into the milestones and stages that occur during compulsory education, in order to predict a successful STEM trajectory and delve into the educational interventions that favor it.

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Educational trajectories, traceability, and self-perception of grades in post-compulsory transitions[1]

Itinerarios educativos, trazabilidad y autopercepción de notas en las transiciones postobligatorias

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Abstract

The aim of this article is to describe and analyze the continuities and ruptures in students' educational trajectories in the transition to post-compulsory education. The incidence of social inequalities and the mediation of the self-perception of school grades in their educational choices are investigated. Using a path analysis model, we analyze data from a follow-up panel of a cohort of young Barcelona students born in 1998. The final sample is 868 young people, out of the initial 2,056, given the attrition. The sample is stratified according to the ownership of the schools (private/public) and the social complexity of the school context. The results show that "non-traditional" educational trajectories are increasingly common among students, with a greater presence of discontinuities, ruptures, and changes of studies in vocational training itineraries and second chance pathways. They also evidence the dichotomy between the de-standardization

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of young people's trajectories and the rigidities of the educational system and the unequal incidence of social origin and self-perceived grades on educational choices. This places the discussion about results in the sphere of academic and vocational guidance policies and the role of educational agents, particularly secondary schools. The results also highlight the relevance of incorporating longitudinal analysis and its traceability dimension into the study of post-compulsory transitions.

Keywords: Secondary education, dropout, social inequality, longitudinal studies. (Self-perception)

Resumen

El presente artículo tiene por objetivo describir y analizar las continuidades y rupturas en los itinerarios formativos de los jóvenes en sus transiciones tras finalizar de la enseñanza secundaria obligatoria. Se ha analizado la incidencia de las desigualdades sociales y la mediación de la autopercepción de las notas en sus elecciones educativas. A partir de un modelo de *Path analysis* se han explotado los datos de un panel de seguimiento, de una cohorte de jóvenes de la ciudad de Barcelona nacidos en 1998. La muestra final fue de 868 jóvenes, sobre una muestra inicial de 2056, dada la atrición de la misma. La muestra fue estratificada en función de la titularidad de los centros) y la complejidad social del entorno. Los resultados muestran que las trayectorias educativas "no tradicionales" son cada vez más comunes entre los estudiantes, con una mayor presencia de discontinuidades, rupturas y cambios de estudios en los itinerarios de formación profesional y en las vías de segunda oportunidad. También ilustran el dilema existente entre la des- estandarización de los itinerarios de los/las jóvenes y las rigideces del sistema educativo y la desigual incidencia del origen social y la autopercepción de notas sobre las elecciones educativas. Ello sitúa la discusión de los resultados en el plano de las políticas de orientación académica y profesional y en el papel de los agentes educativos, en particular de los centros de secundaria. Los resultados ponen también de manifiesto la relevancia de incorporar el análisis longitudinal y su dimensión de trazabilidad en el estudio de las transiciones postobligatorias

Palabras clave: Educación secundaria; abandono escolar; desigualdad social; estudio longitudinal. (auto) percepción

Introduction

The transition from compulsory to post-compulsory education is a critical event in the life course of young people and in the study of the inequality of educational opportunities (Jackson, 2013; Martínez, 2007; Triventi et al., 2016). The transition to upper secondary education is an advantageous decision point for the analysis of trajectories and social inequalities (Breen & Goldthorpe, 1997; Gambetta, 1987; Mare, 1980). These decisions largely shape young people's professional trajectories and the societal position hey will occupy in the future. The "choice" made by students and/or their families is not made in a vacuum but is rather a decision born of a complex process in which social inequalities operate with an unequal impact on the results obtained and on students' choices. When analysing transitions, it is especially important to consider the meeting point of students' educational opportunities and decisions, where in educational trajectories are the expression of an unequal social space in which choices are mediated by social origin. This is partly due to the inequality of educational performance due to primary effects (PE), or more precisely the influence of social origin on unequal academic success, a widely studied phenomenon in the sociology of education from the theories of cultural reproduction (Bourdieu & Passeron, 1981). Many studies have shown that there is a greater representation of young people from humble socioeconomic backgrounds and with low cultural capital in dropout trajectories (García, Casal, Merino, & Sánchez-Gelabert, 2013; Julià, 2018; Valdés, 2019). Other analyses point to the diversity and vulnerability of young people from families with low economic and cultural capital and of immigrant origin and their greater likelihood of developing dropout or intermediate vocational training trajectories (Olmos, Mas, & Salvà, 2020). While these variables are fundamental to explain the inequality of educational performance, they are not sufficient to explain the choices in the transition to upper secondary education (Jackson, 2013) since the influence of social class also operates as a secondary effect (SE) in the decision-making processes.

Following Boudon (1974), choices depend, on the one hand, on effects of social origin on students' performance (primary effects), and, on the other hand, on secondary effects influencing the cost-risk-benefit calculation (Erikson & Jonsson, 1996) an individual makes beyond their objective capacities. SEs include unequal individual and family

aspirations and expectations (socially constructed), with the perception of risk and success of a specific educational option and the economic and opportunity costs of each (Boudon, 1974; Breen & Goldthorpe, 1997). These effects have been widely studied from the rational choice theory paradigm, in its sociological version, (Boudon, 1983) and in particular from the educational decisions model (Breen & Goldthorpe, 1997; Gambetta, 1987).

We include self-perception of grades in its SE dimension, following studies like those of Sullivan (2001) and Torrents (2016), who identify the effects of social origin on the over- and under-estimation of educational abilities. In line with Torrents (2016), the social origin bias in the self-perception of grades confers the SE dimension. Following the analytical DBO scheme (Desires, Beliefs, and Opportunities), self-perception of grades is a factor that forms part of students' beliefs, and as such can have an obvious effect on educational choices by indirectly defining the perceived chances of success in each educational option. The analysis model proposed aims to contribute with new evidence of the relationship between social origin and educational choices, taking self-perception of ability as proxy for probability of perceived success (secondary effect), which mediates in the transitions to post-compulsory education.

Pathways, trajectories, and traceability

Since the last decades of the twentieth century (Casal, García, Merino, & Quesada, 2006; Serracant, 2015), we have been witnessing increasing diversification in terms of young people's trajectories, in part due to the educational expansion that took place in Spain in the 1980s and 1990s, giving rise to an increased social heterogeneity of students and pathways.

The ongoing educational reforms and counter reforms starting in the 1980s (LOGSE, 1990; LOCE, 2002; LOE, 2006; LOMCE, 2013 y LOMLOE, 2020), have also intervened in pathway diversity, especially since the LOE (2006) was approved, introducing forms of diversification in the last year of lower secondary school (directed towards vocational training or baccalaureate) and extended in subsequent reforms such as LOMCE. This period also witnessed the official regulation of tests and courses, making access to intermediate vocational training, leading on to higher vocational training (LOE, 2006), more flexible while simultaneously making post-

compulsory transitions more complex, with "non-traditional" educational trajectories now increasingly commonplace among students (Milesi, 2010). These processes have contributed to the growing individualization and diversification of trajectories, reducing the presence of the former linear pathways and consolidating the new central role played by the ways in which young people conduct their transitions and the effects of the inequality of educational opportunities on post-compulsory education (Denice, 2019; Valdés, 2019).

The trajectories constructed by young people from the pathways established by education systems need to be distinguished both conceptually and analytically. The secondary education pathways available are a product of curricular and normative design, or in other words of the organisation of the education system into levels with access and connectivity regulations between them. Contrarily, educational trajectories have a basic biographical component in the sense that they are the outcome of the combined educational decisions made by students in a social and normative context. While the educational pathways are a structuring element, the analysis of young people's trajectories has a dynamic and agentic dimension. They are social constructs based on an individual's educational decisions, expressing a complex relationship between structure and agency among the structural determinants of inequality and individuals' margins of freedom in decision making.

Educational inequality, however, does not only *crystallise* in the educational levels reached by young people, but also in different process indicators from which their trajectories are defined, or in other words *educational traceability*. Traceability defines educational trajectories depending on the ways in which young people make the transition to post-compulsory education. Introducing traceability into the analysis of educational itineraries is essential to detect qualitative differences in post-compulsory transitions (Lucas, 2001).

Studies like the one by Milesi (2010) show that deviations from a traditional trajectory (linear) are very usual and occur more frequently among the most socioeconomically and academically challenged students. The possible impact of the ways of making the transition on the final grades obtained should also be considered. Some research has analysed students' experiences of repeating a year as a factor that impacts on academic performance, demonstrating that students who have repeated a year are more likely to have disastrous results in the PISA tests (Calero

et al., 2010). Other studies identify problems of attitude and school disengagement among students who repeat a year (Méndez & Cerezo, 2017). Ikeda and García (2014) also point out an effect of social origin on school performance in countries where there are more repeat students.

Other indicators that allow us to measure educational traceability are interruptions and discontinuities. Studies like the one by Andrews (2018) show the effects of these trajectories on engagement (emotional, behavioural, and cognitive) and dropout. The results reveal a lower level of involvement among students with discontinuity and those held back a year, in addition to higher dropout rates than among students with linear pathways in the case of upper secondary education (Bozick & DeLuca, 2005; Milesi, 2010).

González-Rodríguez (2019), among others, report the incidence of individual variables, associated with the behaviour and family variables regarding dropout, while other studies point to a school and teacher expectations effect (Tarabini, 2016). Furthermore, situations of educational rupture and interruption impact on definitive dropout and are especially important if we consider the low rate of re-entry into the education system and the negative outcomes this predicts for young people's future educational progress (Pfeffer & Goldrick-Rab, 2011).

The longitudinal and biographic perspective allows the identification of the new ways in which educational inequality can operate. The analysis of the traceability of educational trajectories requires a longitudinal and biographical methodology approach.

Method

The objective of this paper is to analyse how self-perception of grades intervenes in educational choices in the transition to post-compulsory education. To this end, the incidence of educational inequalities (students' sociodemographic characteristics) on self-perception of results is analysed and the trajectories characterised according to the unequal presence of linear and "non-linear" trajectories. First, a typology of educational trajectory was developed from a longitudinal perspective, incorporating the final level reached by young people and different dimensions of educational traceability (repetitions, discontinuities, and transfers to other educational options). A *Path Analysis* model was developed based on

this typology to study the incidence of the sociodemographic variables on the trajectories and the mediating effect introduced by students' self-perception of the grades they expected to obtain at the end of the year on this relationship.

DIAGRAM I. Analysis model
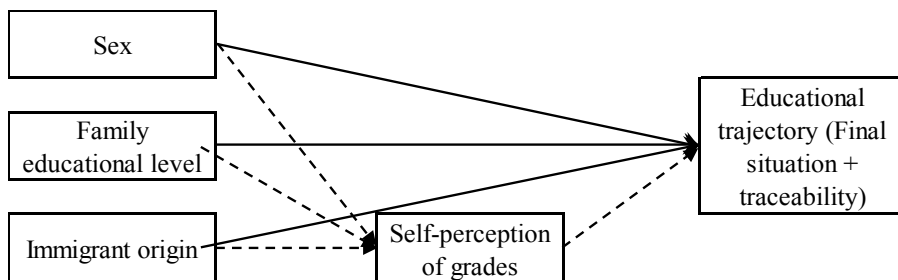
Following this model, four working hypotheses are formed:

1. Linear and non-linear trajectories (repetition, changes of course of study, and discontinuities) have an unequal presence in the final pathways taken by students. More linear trajectories are expected in the academic pathways (baccalaureate) due to a greater presence of young people from families with higher cultural capital (parents with a university education) and the associated academic requirements. Repeating a year will be more present in the intermediate level vocational training pathways due to the percentage of young people who have accumulated some academic difficulties throughout their schooling (García & Sánchez-Gelabert, 2020). Discontinuous trajectories (dropout and return to the education system) will be more present in the pathways shaped by students with a more socioeconomically and academically disadvantages profile, in line with Milesi (2010).

2. Sociodemographic variables like family cultural capital, sex and immigrant origin will affect self-perception of grades. More specifically, it is expected that the young people from families with high cultural capital (a university level education) have a high self-

perception of grades which, irrespective of their objective capacities, can be acting as an aversion to risk mechanism (Breen & Goldthorpe, 1997). Contrarily, sex and immigrant origin will tend to intervene less, although lower self-perception among girls is expected, in line with the findings of Torrents (2016), who report that the underestimation of abilities among advanced students from a lower social background mainly occurs among girls and the native population, as opposed to among those with an immigrant background.

3. The sociodemographic variables and self-perception of grades will have a direct effect on educational itineraries due to the unequal effect of migrant origin, sex, and family cultural capital on educational choices. To this effect, self-perception of grades will also have a direct effect on the itineraries given that these expectations guide the choices made. It will be young people with higher expectations of good grades, those with a higher family educational level, native Spanish students, and women who will have a greater presence in the academic and linear itineraries, and it will be men, students of immigrant origin, students from families with low cultural capital, and those with low expectations in terms of academic results who will have a greater presence in the other itineraries.

4. The combination of sociodemographic variables and self-perception of grades will have a differential impact on the educational trajectories (indirect effects, mediated by self-perception of grades). There will be a greater presence of young people from families with a high educational level in linear post-compulsory itineraries even when self-perception of grades is low, while the students from families with an intermediate or low educational level, or post-compulsory and compulsory, respectively, will have less presence in the linear academic itineraries, even when self-perception of grades is high.

Sample

The data presented is part of a panel study, which itself is part of an international study (ISCY Project[2]), the general objective of which was

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[2] This is a completed study co-directed by the professors Stephen Lamb (CIRES, University of Vitoria, Melbourne) and Eifred Markussen (NIFU, Oslo). More information in https://www.vu.edu.au/centre-

to analyse the educational choices in the post-compulsory transitions of young people who live in urban contexts and the associated inequality phenomena. The sample was decided by each participating team, using a city criterion (urban context) and a cohort criterion (born in 1998), irrespective of the educational level or academic year they were in. In our case, the city of Barcelona was chosen, given the opportunities it provided for the research team, selecting a stratified, two stage sample of 27 schools and 2,056 students (T0) with 95% confidence interval and a sample error of 5%. The sample was structured according to school ownership, state-owned or state-subsidised and privately owned ("concertados"), and the social complexity of the school, based on an index compiled by the Inspector of Education from the Department of Education of the Government of Catalonia.

The project was designed using a panel methodology. In the case of Barcelona, the field work was carried out in four periods (TO, in 2014, which was the first year of surveying, and three subsequent waves: T1 in 2015, T2 in 2016, and T3 in 2017)[3]. The inevitable sample attrition in longitudinal studies of this type reduced the total number of students to 1,794 in the second survey, 1,482 in the third survey, and 868 in the last survey. To correct the effects of attrition we proceeded to weight the database (Inverse Probability Weighting). Based on the first survey (cohort sample), the probability of the non-missing information was calculated using a logistic regression model, in successive waves with the covariables as their possible predictors. The variables shown to be significant were family educational level and expected grades. Based on these three variables, the probability of a "yes" response from each individual (using logistic regression) and the corresponding weight were calculated. Last, we applied the weighting and selected the "yes" response cases in the last wave analysed, obtaining a weighted sample of 1,670 cases (T3).

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for-international-research-on-education-systems-cires/our-research/international-comparisons-of-policy-practice y https://www.nifu.no/projects/international-study-of-city-youth-iscy.

[3] The database of this study was delivered to the CIS and is currently in the process of being published in the ARCE repository. http://www.arces.cis.es/arces.jsp.

Instruments, origin, and analysis

A specific questionnaire was design for the data collection. In a first block of questions (T0), basic sociodemographic information including age, sex, immigrant status, family structure, family cultural capital, parents' employment situation, and previous school trajectory was collected. The second block of questions collected information about student engagement (cognitive, behavioural, and emotional), and the third block focused on academic and professional expectations and choice of studies. The subsequent, briefer questionnaires ((T1, T2 i T3) collected information about the current situation of the student in relation to their studies, work, and other situations. They also collected information about school achievement, reasons for their choice or for dropping out, and their expectations for the following academic year.

The questionnaire was constructed and discussed by the international research teams and tested in different cities. In the case of Barcelona, it was previously piloted in two secondary schools with a similar social composition (130 answers) to validate its internal consistency. An Ethics Research Committee (made up of the national research team, the Barcelona Education Consortium, and the CSASEC authorised the questionnaire, ensuring compliance with the ethical principles concerning human dignity, confidentiality, and non-discrimination. The questionnaires were administered with the involvement and support of the above-mentioned entities, education inspectors, and the 27 participating centres.

The method of administering the questionnaire in schools in the first phase of the project (T0) was face-to-face, through an online application. In some cases, the students gave their responses on paper, always with a member of the research team present. In the second wave of the project, most of the questionnaires were administered face-to-face in the schools, except for students that had already left the school, who were interviewed by telephone. In the third wave of the study, only a third of the questionnaires could be administered face-to-face, with the rest completed by telephone interview since most of the students had already left the school. All the questionnaires were administered by telephone in the fourth wave of the project.

Procedure

The analysis was carried out using the path analysis technique based on the statistical software MPlus 8. This type of analysis is used to model the structural relationships between observed variables, allowing the analysis of how one or more variables mediate in the relationships among other variables. Path analysis allows the fit of theoretical models to be evaluated where a set of relationships of dependency among variables are proposed. To this effect, each arrow presents a standardized coefficient which indicates the magnitude and sign of the effect (positive or negative) of a variable on another endogenous variable. In other words, these coefficients are partial regression coefficients, representing the effect of one variable on another while controlling the rest of the variables. To interpret the coefficients of the model, βs > .05 is considered a small effect, βs > .10 a moderate effect, and βs > .25 a large effect (Keith, 2015). Furthermore, the "Weighted Least Squares with Robust Means and Variances" (WLSMV) method was used to estimate the model because it is a suitable method for dichotomous and categorical dependent variables.

This type of analysis allowed the entire theoretical model to be analysed, incorporating the six resultant trajectories as dependent variables, and controlling the regressions by the sociodemographic variables. Furthermore, it allowed the analysis of the indirect effects of the sociodemographic variables on the educational pathways, mediated by the self-perception of grades. In other words, we were able to analyse whether the fact of having a high or low self-perception of grades modified the inequalities when they occurred according to the social profile of the students in the choice of studies. Our aim was to produce a model that related the variables sex, generation of immigration, family educational level, and self-perception of grades in 4th ESO to the later educational pathways.

Independent variables
The independent variables considered in the analysis are shown in Table 1 below.

TABLE I. Values of the independent variables

Variable	Response options	N (%)
Family educational level[4]	Compulsory education Post-compulsory education University education	667 (33.4 %) 516 (25.8%) 816 (40.8%)
Sex	Men Women	1,087 (52.9%) 969 (47.1%)
Immigrant origin	Born in Spain from native parents	1,470 (76.7%)
	Born in Spain from foreign parents	86 (4.5%)
	Arrived aged11 or under	260 (13.6%)
	Arrived over age	100 (5.2%)
Perception of Grades	Very good grades	314 (15.4%)
	Good results	749 (36.7%)
	I will pass	729 (35.8%)
	Bad grades	208 (10.2%)
	Very bad grades – lots of fails	39 (1.9%)

Following the analytical scheme proposed by Hedström (2005), we considered the self-perception of expected grades at the end of ESO as a factor that would form part of the students' beliefs, potentially having a clear effect on educational choices by indirectly defining the perceived probability of success for each educational option. The following question was used in the survey: "How do you think your schooling will go this year", with the following response options: "I think I will get very good grades, A's and B's"; "I think I will get good grades, B's and C's"; "I think I will pass"; I think I will get bad grades, including some fails"; "I think I will get very bad grades, including a lot of fails". This variable expresses the different expectations of success among the students, depending on their appraisal of previous academic performance. A correlation analysis was carried out to check for possible self-appraisal bias, using the question, "How do you think your schooling will go this year" from the first panel survey in 2015 and the grades they finally obtained in the 2016 survey. A high correlation between the two was demonstrated. To this effect, despite the element of subjectivity, self-perception of grades was

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[4] Maximum parental educational level.

incorporated as "proxy" for the perception of the probability of success and its mediating effect on the educational choices made. The mediation of self-perception on choices is analysed for the main sociodemographic variables, i.e., family educational level, immigrant origin, and gender.

Dependent variable: educational trajectories

A sequences analysis was performed to construct the educational trajectories over the three years analysed and to identify their traceability. This analysis showed a high complexity (more than 130 itineraries were identified), which was simplified by means of a cluster analysis that introduced the education situation at the end of the period and the events related to educational traceability (repetition, reorientations, and discontinuities (dropouts and re-entries into the education system). To do so, the Euclidean distance to the square was used as a measure of similarity and the Ward's hierarchical clustering method, and six types of grades were selected based on the dendrogram, conserving the groups that maintained a strong internal homogeneity. The typology resulting from the hierarchical cluster is described in the results section that follows.

Results

Educational trajectories and traceability

The cluster analysis identified six trajectories resulting from the conjugation of educational level and traceability (Table II). There was one clearly linear trajectory, Linear Academic; two itineraries predominated by repetition, Academic with Repetition and Intermediate Level Vocational (CFGM) with Repetition; one Higher Vocational Training (CFGS), characterised by option changes resulting largely from re-orientation processes; and two vulnerable educational itineraries, Dropout after lower secondary education (ESO), and Second chance Opportunities with discontinuity").[5]

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[5] Second chance opportunities are understood as the educational programmes directed at people who have not successfully completed obligatory secondary education, aimed at obtaining credentials, schooling certificates and professional skills acquisition.

TABLE II. Educational itinerary and traceability

Educational Itineraries	n	%
Itinerary. 1. CFGM with predominance of repetition	258	14.2
Itinerary 2. Linear Academic	1032	57.0
Itinerary 3. Second chance opportunities with discontinuities	121	6.7
Itinerary 4. Dropout after ESO	79	4.4
Itinerary 5. CFGS with predominance of re-orientation	188	10.4
Itinerary 6. Academic with repetition	134	7.4
Total	**1812**	**100**

As Table 2 shows, the linear academic itinerary (ESO-Baccalaureate-University) is the one that presents the highest percentage, including more than half the young people in the sample (57%). To this we can add a small percentage of young people (7.4%) that also describe an academic itinerary, but with repetition.

The next most important itinerary in terms of percentages of the total were CFGM with predominance of repetition and CFGS with predominance of orientation. The first (14.2%) brings together students that had gone from compulsory (or lower) secondary education to CFGM intermediate level vocational training, with the presence of repetition particularly relevant, while the second (10.4%) brings together young people with diverse access pathways (baccalaureate, CFGM, or the tests and courses to access this level).

Last, the most educationally vulnerable itineraries were the second chance itineraries (6.7%), which included young people in adult education centres who take tests and courses to access vocational training (second chance with discontinuity), and the school dropout itinerary (4.4%), characterised by multiple experiences of repetition or by educational discontinuity that culminates in dropout.

In line, therefore, with the first hypothesis, these results evidence the unequal presence of repetition, changes of option, and discontinuities in the final itinerary reached, and the strong presence of non-linear itineraries.

Characterisation of the educational itineraries

The characterisation of the different itineraries (Diagram II) was carried out based on the theoretical model. In the evaluation of the fit of the model it was considered that the goodness of fit was adequate if the coefficient CFI and TLI was greater than .90 (Byrne, 2001) and if the coefficient RMSEA was less than .08 (Kline, 1998). To this effect, it was observed that the parameters CFI and TLI were greater than .95 (CFI = .974; TLI = .965) and the parameter RMSEA was less than .05 (RMSEA = .046), confirming that the final fit of the model was good.

Regarding the second hypothesis, the results showed that students' perception of the grades they would obtain at the end of ESO has a direct relation with the sociodemographic variables analysed (sex, family educational level, and generation of immigration). The results shown in Diagram II can be interpreted as the influence of self-perception of grades and the sociodemographic variables on the final itineraries.

DIAGRAM II. Influence of sociodemographic variables and self-perception of grades on itineraries
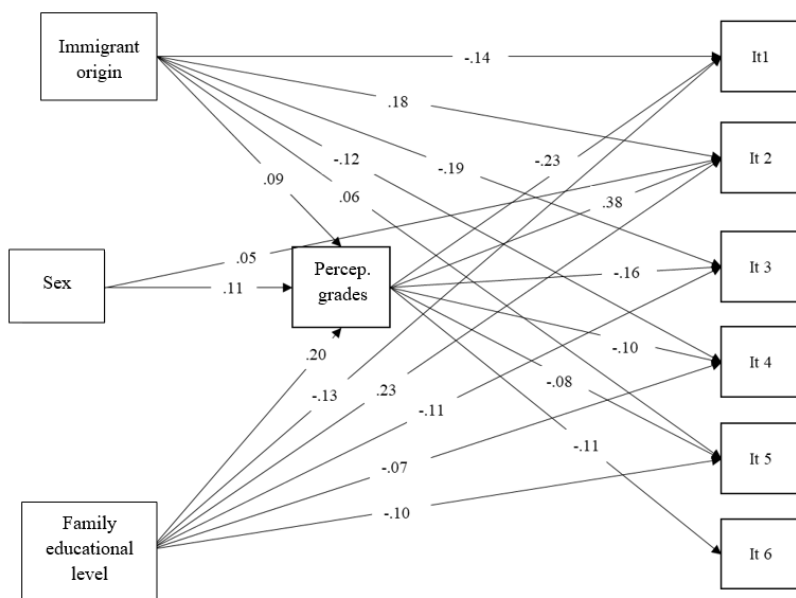
Bearing in mind the hypothesis formulated, the results show how family educational level is the variable that intervenes most in the final itineraries. The young people from families with a high family educational level presented a significant positive correlation (.23) in the linear academic itinerary and a negative correlation in the other itineraries. The same applied to the young people from native Spanish families in the linear academic (.18) and the CFGS (.06) itineraries, and a negative correlation in the rest. Meanwhile, sex (woman) only presents a positive correlation (.05) in the linear academic itinerary and a negative correlation in the rest.

Regarding self-perception of good grades, the young people from families with a university education stand out (.20), with the girls above the boys (.11) and the native Spanish population (.09), in the order shown.

The incidence of the sociodemographic variables and self-perception of grades on the itineraries (direct effects).

The results obtained allowed us to show the direct effects of the sociodemographic variables and the self-perception of grades on the itineraries. Regarding the CFGM itinerary with a predominance of repetition, the young people whose parents had finished compulsory or post-compulsory education presented a stronger relationship and a higher probability of being in this professional itinerary, with a strong (.30) and a moderate (.14) relationship, respectively. Meanwhile, the young people of native Spanish origin had a lower probability of being in this itinerary, given that a strong negative relationship was observed (-.29), and likewise for the young people with a high self-perception of grades (-.23)

Regarding the second itinerary, linear academic, the young people of native Spanish origin, those from families with a university education, and the young people that expect to get good grades had a greater probability of being in this itinerary, which as already pointed out was characterised by linearity.

The third itinerary (second chance with discontinuity), characterised by dropping out of and re-entering the education system, had a strong relationship (.26) with the young people whose families had a compulsory

education, while the young native Spanish people and those that had a perception of good grades presented a lower probability of being in this itinerary given the negative sign of the coefficient (-.41 and -.16, respectively). The young native Spanish people were the group that was most distant from itineraries of this type, with a very high coefficient. Similar results were observed in the dropout after ESO itinerary.

The young people of native Spanish origin stood out in the CFGS with experiences of reorientation itinerary, with a moderate coefficient (.16), those with a post-compulsory family educational level, with a high coefficient (.27), and those with a compulsory educational level, with a moderate coefficient (.19). Last, in the academic with repetition itinerary, the only observation was how self-perception of grades (low) had a direct relationship with this itinerary.

The differential impact of self-perception of grades according to the sociodemographic variables on the itineraries (indirect effects)

Regarding hypothesis 4, the joint impact of the sociodemographic variables and self-perception of grades on the educational itineraries described was analysed (Table IV). This represents the differential impact or the unequal mediation of self-perception of grades on the itineraries depending on the family educational level, sex, and immigrant origin of the students.

The results showed that like for the CFGM with predominance of repetition itineraries, young men had a higher probability of being in this itinerary even when they had a perception of good grades. The same applied to the young people of immigrant origin and those from families with a low (compulsory) and a medium (post-compulsory) educational level. To this effect, the perception of grades would not play a decisive role in the educational transitions of these students.

Unlike the previous itinerary described, the linear academic itinerary was more probable among young people of native Spanish origin and women, as opposed to young people of immigrant origin with good grades and men with good grades. This itinerary was less probable in the case of young people whose parents had a low educational level, even when self-perception of grades was high. These results can be interpreted as a consequence of an unequal effect of economic costs and

young people's opportunities depending on their social condition, and of an unequal perception of the risk (difficulty) associated with a longer academic itinerary. There was the "ceiling effect" of the social groups with more cultural capital at play, given the greater academic requirements involved in maintaining their social position (Boudon, 1974; Breen & Goldthorpe, 1997).

In the second chance with discontinuities itinerary, the students with the highest probabilities were the young people from families with a compulsory educational level or of immigrant origin, even when they had a self-perception of good grades. Notably, sex was a determinant factor in this itinerary. When all social conditions and grades were equal, the girls were underrepresented in the second chance options. The characteristics in terms of traceability were dropping out of and re-entering the education system.

The dropout after ESO itinerary had important parallels with the previous itinerary. The young people of immigrant origin, men, and the students from families with a compulsory level education presented higher probabilities of being in this itinerary, even when they had a self-perception of good grades. This did not occur, as we have already seen, with young people whose parents had a medium level or university education.

In the CFGS with predominance of reorientation and the academic with repetition itineraries, self-perception of good grades also had an unequal impact. In these two itineraries, there was a greater presence of young people from families with a low cultural capital, men, and students of immigrant origin, even when they had a self-perception of good grades.

Conclusions and discussion

The results presented contribute with some relevant information, both in terms of the relationships of the model and the main characteristics of each itinerary, and in terms of their contribution to the debate about education and transition policies, and particularly those directed at students who are socially vulnerable to dropout. We want to highlight four contributions to the scientific and political debate.

First, following Milesi (2010), the results show how the "non-traditional" educational trajectories are becoming increasingly common among students. This "de-standardisation" of trajectories in post-compulsory transitions is unequally distributed among the academic and professional trajectories, affecting the latter more profoundly, and among the "second chance" pathways. Students' academic difficulties is one of the factors that explain the presence of non-linear trajectories, although it is not the only one since the sociodemographic variables also intervene. The question arises as to whether and to what degree the "non-linear" trajectories are failed trajectories, or whether they are choices that respond to a practical rationality. The non-linearity of the post-compulsory transitions requires specific study to identify the factors that condition these trajectories, and to see if they are also associated with a low quality of academic and professional guidance, with the economic and opportunity costs of the choices, or with critical events that impact on the biographies of the young people. These "non-linear" trajectories clash with the rigid organisational and curricular norms and period of learning set out by the education system, paving the way to the debate on the subjectivity of educational policies. As Ulrich Beck states, "to give reflexive modernisation shape, the institutions need to provide opportunities – spaces and resources- that allow the individual to learn, act, and take decisions. This implies going beyond the normative planes and their rational of causality" (Beck, 1992).

Second, the results evidence the unequal interaction of the relationship between social origin and self-perception of grades in terms of the educational decisions made in post-compulsory transitions, concurring with other studies (Bernardi & Cebolla, 2014). The relationship between family educational level and the educational itineraries reached are unequally mediated by self-perception of grades: there is a greater presence of offspring of families with higher educational levels (parents with a university education) in the academic itinerary when grades are lower (compensation effect mediating capital reconversion strategies), while students from families with a medium and low level education, post-compulsory and compulsory, respectively, have less probabilities, even when self-perception of grades is high. Even when they have good grades, young people of immigrant origin have less presence in the academic itinerary. These results have important implications for educational guidance policies and practices in high schools, where the

expectations of young people from families with low capital cultural and of immigrant origin could be raised with the aim of achieving good school results.

A possible effect of unequal perception of risk (economic and/or academic) was also identified among the young male students of immigrant origin and those with low family cultural capital with a self-perception of good grades, who "do not dare" to choose the university option. This dissonance could be explained by factors associated with the increased costs of a university education (direct, indirect, the opportunity costs associated with immediate loss of income and time), inaccurate information received, or a strategy to minimise the perceived risk by pursuing higher vocational education in the decision to obtain a higher vocational training qualification.

The academic with repetition itinerary, which as discussed is characterised by self-perception of low grades, can be interpreted as the result of the social value of the academic trajectory, particularly among young people from families with higher level vocational qualifications or a university education, giving way to possible inertia and compensation effects, as discussed previously. Other inequality processes were also observed in the most vulnerable itineraries regarding the relationship between the sociodemographic variables and self-perception of grades, representing important challenges for educational policy in terms of improving the success rate (in both the first- and second chance options by diversifying the offer, personalised support, etc.), and for grants policies, which is especially pertinent for the young people who would like to stay in the education system (self-perception of high grades) but end up dropping out or are "relegated" to the less socially prestigious vocational training trajectories. In brief, there is a need to advance towards comprehensive transition policies, especially regarding education and training policies, and support and guidance policies.

Third, the results show how the academic itineraries predominate over the vocational ones, with a clear gender bias. This inequality is also evident in terms of girls' reduced opportunities in the second chance trajectories, which could be interpreted as a consequence of their reduced presence in these itineraries, which furthermore have a very "masculinised" offer. This generates greater polarisation between the girls that take a dropout trajectory, which is often associated with

the premature assumption of gender roles, and those that develop long academic itineraries.

Fourth, the results reflect the importance of incorporating longitudinal analysis and its traceability dimension into the study of post-compulsory transitions, allowing the dialectical analysis of the relationships between structure and agency, and shedding more light on the trajectories and the possible effects of the accumulation of inequalities. The high presence of non-linear trajectories points to the need to continue investigating biographical events and school experiences, and their incidence on the pathways and their traceability.

Educational traceability thus becomes an important element in the analysis of educational pathways and transitions and the associated inequality phenomena since sociodemographic variables not only impact on the level of studies young people reach, but they also influence the ways in which they make the transition to post-compulsory education. In this regard, it is important to complement the analysis with a qualitative methodological approach that enables us to investigate in greater depth the reasons for dropout and re-entry into the education system. One of the main difficulties of this study was the weighting of the sample to avoid the usual attrition in panel studies. For this reason and given the high economic cost and substantial effort involved in studies of this kind, keeping annual student records from the year they start in the system, containing personal, academic, and sociodemographic information, is recommended to be able to follow and analyse their educational trajectories throughout their schooling as has been done in some CCAA. This would provide us with an information observatory about educational transitions, the examination of which would provide an evidential basis for new careers guidance and educational policies.

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Appendices

1. Influence of sociodemographic variables and self-perception of grades on pathways (direct effects)

	DIRECT EFFECTS			
	Estimate	S.E.	Est./S.E.	P-Value
Pathway 1. CFGM with predominance of repetition				
Man > Pathway 1. CFGM with repetition	**Ref.**			
Woman > Pathway 1. CFGM with repetition	-.08	.05	-1.79	.079
Immigrant origin > Pathway 1. CFGM with repetition	**Ref.**			
Native Spanish > Pathway 1. CFGM with repetition	-.29	.05	-6.31	**.00*****
University level education > Pathway 1. CFGM with repetition	**Ref.**			
Compulsory education > Pathway 1. CFGM with repetition	.30	.06	5.38	**.00*****
Est. post-compulsory > Pathway 1. CFGM with repetition	.14	.06	2.19	**.03***
Self-percep. good grades > Pathway 1. CFGM with repetition	-.23	.03	-8.88	**.00*****
Pathway 2. Linear academic				
Man > Pathway 2. Linear academic	**Ref.**			
Woman > Pathway 2. Linear academic	.11	.04	2.80	**.005****
Immigrant origin > Pathway 2. Linear academic	**Ref.**			
Native Spanish > Pathway 2. Linear academic	.40	.056	7.13	**.00*****
University level education > Pathway 2. Linear academic	**Ref.**			
Compulsory education > Pathway 2. Linear academic	-.48	.066	-7.38	**.00*****
Post-compulsory education > Pathway 2. Linear academic	-.32	.058	-5.49	**.00*****
Self-percep. good grades > Pathway 2. Linear academic	.38	.036	10.63	**.00*****
Pathway 3. Second chance with discontinuity				
Man > Pathway 3. Second chance with discontinuities	**Ref.**			
Woman > Pathway 3. Second chance with discontinuities	-.01	.05	-.28	.78
Immigrant origin > Pathway 3. Second chance with discontinuities	**Ref.**			
Native Spanish > Pathway 3. Second chance with discontinuities	-.41	.05	-9.04	**.00*****
University level education > Pathway 3. Second chance with discontinuities	**Ref.**			
Compulsory education > Pathway 3. Second chance with discontinuities	.26	.07	3.80	**.00*****

Post-compulsory education > Pathway 3. Second chance with discontinuities	.10	.08	1.27	.20
Self-percep. good grades > Pathway 3. Second chance with discontinuities	-.16	.02	-7.43	**.00*****
Pathway 4. Dropout after ESO				
Man > Pathway 4. Dropout after ESO	**Ref.**			
Woman > Pathway 4. Dropout after ESO	-.03	.05	-.73	.46
Immigrant origin > Pathway 4. Dropout after ESO	**Ref.**			
Native Spanish > Pathway 4. Dropout after ESO	-.27	.05	-5.63	**.00*****
University level education > Pathway 4. Dropout after ESO	**Ref.**			
Compulsory education > Pathway 4. Dropout after ESO	.18	.06	2.81	**.005****
Post-compulsory education > Pathway 4. Dropout after ESO	.06	.07	.85	.395
Self-percep. good grades > Pathway 4. Dropout after ESO	-.09	.02	-3.70	**.00*****
Pathway 5. CFGS with predominance of reorientation				
Man > Pathway 5. CFGS with reorientation	**Ref.**			
Woman > Pathway 5. CFGS with reorientation	-.01	.05	-.14	.89
Immigrant origin > Pathway 5. CFGS with reorientation	**Ref.**			
Native Spanish > Pathway 5. CFGS with reorientation	.16	.06	2.84	**.005****
University level education > Pathway 5. CFGS with reorientation	**Ref.**			
Compulsory education > Pathway 5. CFGS with reorientation	.19	.06	3.20	**.001****
Post-compulsory education > Pathway 5. CFGS with reorientation	.27	.06	4.43	**.00*****
Self-percep. good grades > Pathway 5. CFGS with reorientation	-.08	.03	-2.71	**.007****
Pathway 6. Academic with repetition				
Man > Pathway 6. Academic with repetition	**Ref.**			
Woman > Pathway 6. Academic with repetition	-.07	.05	-1.4	.16
Immigrant origin > Pathway 6. Academic with repetition	**Ref.**			
Native Spanish > Pathway 6. Academic with repetition	.04	.05	.78	.43
University level education > Pathway 6. Academic with repetition	**Ref.**			
Compulsory education > Pathway 6. Academic with repetition	-.07	.06	-1.27	.21
Est. post-compulsory > Pathway 6. Academic with repetition	.004	.06	.06	.95
Self-percep. good grades > Pathway 6. Academic with repetition	-.11	.03	-3.190	**.001*****
Self-perception of grades				
Man > Self-percep. good grades	**Ref.**			

Woman > Self-percep. good grades	.21	.05	4.42	**.00***
Immigrant origin > Self-percep. good grades	**Ref.**			
Native Spanish > Self-percep. good grades	.20	.05	3.67	**.00***
University level education > Self-percep. good grades	**Ref.**			
Compulsory education > Self-percep. good grades	-.42	.06	-7.49	**.00***
Est. post-compulsory > Self-percep. good grades	-.28	.06	-4.53	**.00***

2. Influence of the sociodemographic variables and self-perception of grades on pathways (indirect effects)

	INDIRECT EFFECTS			
	Estimat	S.E.	Est./S.E.	P-Value
Pathway 1. CFGM with predominance of repetition				
Woman > Self-percep. good grades > Pathway 1. CFGM with repetition	-.05	.01	-3.96	**.00***
Native Spanish > Self-percep. good grades > Pathway 1. CFGM with repetition	-.05	.01	-3.39	**.001**
Compulsory education > Self-percep. good grades > Pathway 1. CFGM with repetition	.10	.02	5.73	**.00***
Post-compulsory education > Self-percep. good grades > Pathway 1. CFGM with repetition	.06	.02	4.04	**.00***
Pathway 2. Linear academic				
Woman > Self-percep. good grades > Pathway 2. Linear academic	.08	.02	4.10	**.00***
Native Spanish > Self-percep. good grades > Pathway 2. Linear academic	.08	.02	3.45	**.001**
Compulsory education > Self-percep. good grades > Pathway 2. Linear academic	-.16	.03	-6.09	**.00***
Post-compulsory education > Self-percep. good grades > Pathway 2. Linear academic	-.11	.03	-4.20	**.00***
Pathway 3. Second chance with discontinuities				
Woman > Self-percep. good grades > Pathway 3. Second chance with discontinuities	-.04	.01	-3.80	**.00***
Native Spanish >Self-percep. good grades>Pathway 3.Second chance with discontinuities	-.03	.01	-3.29	**.001**
Compulsory education >Self-percep. good grades> Pathway3. Second chance with discontinuities	.07	.01	5.23	**.00***

Post-compulsory education > Self-percep. good grades > Pathway 3. Second chance with discontinuities	.05	.01	3.85	**.00***
Pathway 4. Dropout after ESO				
Woman > Self-percep. good grades > Pathway 4. Dropout after ESO	-.02	.01	-2.83	**.005**
Native Spanish > Self-percep. good grades > Pathway 4. Dropout after ESO	-.02	.01	-2.62	**.009**
Compulsory education > Self-percep. good grades > Pathway 4. Dropout after ESO	.04	.01	3.33	**.001**
Est. Post-compulsory > Self-percep. good grades >Pathway 4. Dropout after ESO	.03	.01	2.86	**.004**
Pathway 5. CFGS with predominance of reorientation				
Woman > Self-percep. good grades > Pathway 5. CFGS with reorientation	-.02	.01	-2.32	**.02**
Native Spanish > Self-percep. good grades > Pathway 5. CFGS with reorientation	-.02	.01	-2.20	**.03**
Compulsory education > Self-percep. good grades > Pathway 5. CFGS with reorientation	.03	.01	2.54	**.01**
Post-compulsory education >Self-percep. good grades >Pathway 5. CFGS with reorientation	.02	.01	2.32	**.02**
Pathway 6. Academic with repetition				
Woman > Self-percep. good grades > Pathway 6. Academic with repetition	-.021	.01	-2.58	**.010**
Native Spanish > Self-percep. good grades > Pathway 6. Academic with repetition	-.020	.01	-2.37	**.018**
Compulsory education >Self-percep. good grades > Pathway 6. Academic with repetition	.041	.014	2.93	**.003**
Post-compulsory education > Self-percep. good grades > Pathway 6. Academic with repetition	.027	.010	2.60	**.009**

Family Functioning and Academic Self-Efficacy: The Mediating Effect of Emotion Regulation

Funcionamiento Familiar y Autoeficacia Académica: Efecto Mediador de la Regulación Emocional

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Abstract

Family functioning can have an impact on the processes of emotion regulation, which in turn impact students' perception and judgment of their own skills. In order to analyze this, the mediating effect of emotion regulation strategies on the relation between family functioning and academic self-efficacy in Mexican students was examined for the first time. This research had a quantitative and cross-sectional correlational design, and it included 729 Mexican high-school teenagers. Results showed that the model had an adequate fit, confirming that family cohesion, flexibility, and communication have an indirect impact on academic self-efficacy –composed of participants' academic confidence, effort, and understanding, through emotion regulation, namely through reappraisal and mindfulness strategies. Thus, it was possible to acquire a more accurate understanding of how emotion control impacts the processes involved in academic self-efficacy. The results suggest that those students who, concerning their daily activities, can be aware of internal processes and external aspects surrounding them, and who are also capable of changing the meaning of an emotional experience, will be able to reappraise their school activities according to their own goals, reappraise situations involving a problem they feel they cannot solve in the best way, or reappraise the feelings they experience when

performing academic activities. In conclusion, the pioneering nature of this research confirmed that emotion regulation strategies mediated the relation between family functioning and academic self-efficacy, by helping to explain the association between emotion regulation strategies and the perception of Mexican teenage students of their confidence in the development of their academic activities, the effort they make to accomplish them, and their understanding of those activities.

Resumen

Las implicaciones vinculadas al empleo durante los estudios representan un tema de investigación que debe ser valorado rigurosamente con el fin de encontrar la fórmula más adecuada para que los estudiantes universitarios tengan una inserción laboral exitosa una vez acaben su formación. Por ello, el principal objetivo de este artículo es encontrar el efecto de estar empleado durante los estudios, diferenciando la naturaleza del empleo, sobre el éxito de los egresados universitarios en su inserción al mercado de trabajo. Se realizan varios modelos *probit* con corrección de selección con el fin de valorar los efectos concernientes a la citada relación. Como variables dependientes, se utilizan cuatro indicadores que recogen la calidad del empleo a partir de la estabilidad, la adecuación y la remuneración del mismo. La variable explicativa de interés, el trabajo durante los estudios, se clasificará atendiendo al tipo de jornada y su relación con la formación del egresado. Con el fin de tener una visión más amplia, se estudia tanto el primer empleo tras terminar la universidad, como el empleo que tienen los individuos en el momento de realización de la encuesta. Los datos utilizados para realizar estos modelos proceden de la Encuesta de Inserción Laboral de Titulados Universitarios (EILU), elaborada por el Instituto Nacional de Estadística. Los principales resultados muestran un efecto positivo del empleo estudiantil a jornada completa sobre la probabilidad de tener un trabajo estable y mejor remunerado. Por otro lado, la conexión del trabajo estudiantil con el área de estudios del egresado supondrá una menor probabilidad de estar sobrecualificado, así como una mayor probabilidad de situarse en los quintiles más altos de base de cotización. Por último, se encuentra que la magnitud de los efectos es menor en el momento que se realiza la encuesta si se compara con el primer trabajo.

Palabras clave: Inserción laboral, universitarios, calidad del empleo, educación superior, trabajo estudiantil.

Introduction

Family functioning and the emotion regulation processes that develop from family relationships are two essential factors for analyzing school performance, particularly academic self-efficacy. Having a deep understanding of the reasons behind remarkable differences in students' academic self-efficacy has always been a concern for researchers and educational institutions. Several investigations have sought to find the impact of family functioning and emotion regulation on the lives of students in and out of their classrooms (e.g., Adeniji, Akindele-Oscar & Mabekoje, 2020; Ki, 2020; Llorca, Richaud & Malonda, 2017; Pinquart & Kauser, 2018); however, there are still questions that need to be answered.

Among the models that have been created to analyze family functioning, the one proposed by Olson, Sprenkle and Russell stands out. They developed the Circumplex Model with the objective of studying the impact of family cohesion, flexibility, and communication. According to Olson, Sprenkle and Russell (1979), Cohesion is defined as the emotional ties established among family members. Flexibility refers to the ability a family has to make a series of changes concerning the leadership, roles, and rules established within the family system. As for Communication, in the Circumplex Model it refers to the positive communication skills employed within the family environment. This Model has been used to explain the impact of family functioning on academic self-efficacy. Specifically, findings have documented that family communication has a direct impact on increasing academic self-efficacy (Hashemi, Kooshesh, & Eskandari, 2015). For example, a study that included Caribbean high school students found that living in a family environment with high levels of cohesion and flexibility had a positive impact on students' beliefs of academic self-efficacy (Stubbs & Maynard, 2017).

Family functioning is a particularly important predictor not only of academic self-efficacy, but also of the process of emotion regulation in students. Family members are determinants of the emotion regulation process of adolescents. According to the model proposed by Thompson (1994), emotion regulation consists of a series of extrinsic and intrinsic processes by which people monitor, evaluate, and modify their emotional reactions, particularly the temporal characteristics and intensity of these reactions, to achieve their goals. Usually, the process of emotion regulation is a conscious one, performed with a specific intention.

However, it can also occur unconsciously, without a clearly identified purpose (Braunstein, Gross, & Ochsner, 2017). The study of emotion regulation has led to the analysis of two types of emotion regulation strategies: Adaptive and maladaptive. In this research, we will focus on the adaptive strategies, which have been associated to long-term effects directly impacting mental and physical health. In addition to mitigating the consequences of negative emotions, adaptive strategies are a key factor in achieving academic success and good social functioning (Gross, 2013). These strategies have a cognitive and a behavioral component that enables the interaction between emotional information and cognitive control. Outstanding adaptive strategies include reappraisal, mindfulness, attention, problem solving, positive re-focusing and direct request (Hu, Zhang, Wang, Mistry, Ran, & Wang, 2014; Schäfer, Naumann, Holmes, Tuschen-Caffier, & Samson, 2017). In line with the objective of this research, we were interested in analyzing the effects of reappraisal, acceptance, and mindfulness. The reappraisal strategy has been widely studied and is considered a key element of emotion regulation. Through reappraisal, people give new meaning to emotional events in such a way that they can modify their understanding of those events (McRae, Ciesielski, & Gross, 2012). Acceptance refers to approving thoughts about what has happened and what has been experienced (Garnefski, Kraaij, & Spinhoven, 2002). Finally, Mindfulness allows paying attention to the experiences occurring at the present moment, accepting them as they are and avoiding an evaluation of them (Brown & Ryan, 2003).

As a result of the years of interaction within the family, parents are usually the primary instructors of emotion regulation processes for their children. Specifically, it has been identified that children with negative emotional responsiveness come from family environments characterized not only by serious communication gaps and low cohesion, but also by a lack of support among family members and the inability to counteract mental dysfunction at home (Rabinowitz, Osigwe, Drabick, & Reynolds, 2016).

In contrast, very few studies have documented the significant impact of emotion regulation processes learned within the family on academic self-efficacy. For example, frequently experiencing positive emotions has an impact on students' cognitive and behavioral processes, as well as on their academic commitment (Putwain, Sander, & Larkin, 2013). Likewise, positive emotions such as hope, joy, and pride are essential for students

not only to be interested in and strive for academic activities, but also to become academically self-efficient, thus ensuring academic success (Pekrun, Goetz, Perry, Kramer, Hochstadt, & Molfenter, 2004).

Scientific literature has identified that those students most committed to their academic performance and thus those who get better grades, who participate actively, study persistently for and put effort in their different courses, tend to show high levels of academic self-efficacy (Alyami et al., 2017; Caraway, Tucker, Reinke, & Hall, 2003). This type of self-efficacy refers to the confidence students have in their own skills. Confidence not only allows students to perform their academic activities satisfactorily, but also acts as a motivational force in their learning process (Bandura, Freeman, & Lightsey, 1999). In particular, academic self-efficacy is based on the perception and judgment each student has of their own abilities – which do not necessarily match their real skills, and therefore determines their control over their own learning process and consequently their academic performance (Liu, Gao, & Ping, 2019). That is why academic self-efficacy has been a constant benchmark for evaluating academic success (Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011).

While the effects of family functioning, emotion regulation, and academic self-efficacy have been thoroughly investigated, our search in the literature did not lead to a study proposing a model of mediation between these three constructs. In order to fill this gap in the scientific literature, the objective of this research was to examine the mediating effect of emotion regulation strategies on the relation between family functioning and academic self-efficacy. A second objective was to analyze the relation between family functioning and emotion regulation strategies, as well as between emotion regulation strategies and academic self-efficacy. On this basis, we hypothesized that: H1) Emotion regulation strategies might mediate the relation between family functioning and academic self-efficacy, and they might help explain the relation between emotion regulation strategies and the perception of confidence in task performance, the effort put in task conduction, and the understanding of the task among Mexican adolescents. H2) When there is more flexibility, cohesion and communication among family members, there might be a greater use of adaptive emotion regulation strategies –mindfulness, reappraisal, and acceptance. H3) If the use of adaptive emotion regulation strategies increases, there would be a higher level of academic self-efficacy among the Mexican students participating in this study.

Method

This research has a cross-sectional and quantitative correlational design which was carried out in central Mexico.

Sample

This research was carried out with the participation of 729 adolescents (52.26% are women and 47.74% are men). The type of sampling used was a convenience sampling (a non-probabilistic approach) and came from seven high schools located in the State of Mexico. Four of them are public and three are private. At the time of data collection, the participants were studying one of the six semesters that make up the high school level in Mexico. On average, the participants were 15.93 years old (SD = 1.38) with values that ranged from 14 to 21 years. Most of the participants (78.46%) mentioned living at home with both parents, 17.42% lived with one of the two parents and 4.12% did not live with their parents. Regarding the proportion of students per semester, 34.01% were studying the second semester, 37.17% were in the fourth semester and 28.82% were studying the last semester. There were no exclusion criteria, and no financial compensation was offered for their participation.

Instruments

Family functioning was measured with the Family Adaptability and Cohesion Evaluation Scale (FACES IV) developed by Olson (2010). The scale includes 42 items divided into six scales: balanced cohesion and balanced flexibility, disengaged and enmeshed cohesion, and rigid and chaotic flexibility. It also includes two other subscales (Family Communication Scale and Family Satisfaction Scale). For this study, the dimensions of Balanced Cohesion and Balanced Flexibility were applied (which evaluate the functional/moderate aspects of these two dimensions), as well as Family Communication subscale. Cohesion measures the emotional bond that occurs between family members. Flexibility refers to the ability of the family in general to carry out processes of change to the interior

and exterior of the family. The Communication dimension measures the capacity of the members of the family to listen to each other, express their ideas and experiences, as well as the respect they have for listening the opinions of others. The participants evaluate the level of agreement they have with each of the statements on a 5-point Likert type scale ranging from 1 (totally disagree) to 5 (totally agree). In this research, the Spanish version proposed by Rivero, Martínez-Pampliega and Olson (2010) was used. The reliability of the scale in its dimensions has ranged between .77 and .89 (Olson, Gorall, & Tiesel, 2006). The validity of the scale has shown adequate properties (χ^2 = 2,058.76, df = 804, p <.001; IFI = .97, CFI = .97, RMSEA = .058) (Olson, 2011).

The emotion regulation construct was measured using the scales of three instruments.

The Mindful Attention Awareness Scale-Adolescents [MAAS-A] developed by Brown, Ryan, Loverich, Biegel and West (2011) was used to measure the mindfulness emotional regulation strategy. This instrument is unidimensional in nature and includes 14 items. The objective of the scale is to assess the awareness and attention capacity that adolescents have regarding the events they experience daily. The response options are offered in a Likert-type format ranging from 1 (almost never) and 6 (almost always). In this research, the Spanish version of the MAAS-S proposed by Calvete, Sampedro and Orue (2014) was selected. Because the wording of the items indicates the absence of mindfulness, these were inversely coded in such a way that higher scores show a higher level of mindfulness. The psychometric properties of the scale both and in its original version as in this adaptation have been very adequate. An internal consistency has been reported oscillating between α = .82 and α = .84. Likewise, the unidimensional structure of the scale explained 32.5% of the variance (Brown et al., 2011).

Regarding the Reappraisal emotional regulation strategy, to measure this variable the Emotion Regulation Questionnaire [ERQ] constructed by Gross and John (2003) was used. This instrument contains 10 items distributed in two dimensions (Cognitive Reappraisal and Expressive Suppression). In this research only the Cognitive Reappraisal dimension was included which measures the ability to give positive meaning to those experiences that have negative emotions. Participants answered the six questions that this dimension contains using a Likert-type format of seven options ranging from 1 (Totally disagree) to 7 (Totally

agree). For the present study, the Spanish version proposed by Cabello, Salguero, Fernández-Berrocal and Gross (2013) was used. In the analysis of its psychometric properties, a Cronbach's alpha for the Reappraisal dimension of .79 was found. Item-total correlations ranged from .41 to .62. Likewise, the test-retest reliability with an interval period of 3 months was .64 (Cabello et al., 2013).

With the purpose of measuring the Acceptance variable, the Cognitive Emotion Regulation Questionnaire (CERQ) designed by Garnefski, Kraaij and Spinhoven (2001) was selected. This is one of the most used instruments to measure emotion regulation strategies, which was built with the aim of analyzing not only the general cognitive style, but also the type of emotion strategy used to manage an emotional situation. With a total of 36 items divided into nine factors (Acceptance, Positive Focusing, Positive Reappraisal, Putting in Perspective, Focusing on Plans, Self-blame, Rumination, Blaming Others and Catastrophizing) this scale examines maladaptive and adaptive emotion regulation strategies. For the purposes of this research, only the Acceptance dimension was included. Through this dimension, it is measured how people are able to accept any unpleasant event they have experienced. The Spanish version developed by Domínguez-Sánchez, Lasa-Aristu, Amor and Holgado-Tello (2013) was used in this research. To respond to this scale, five response options are presented in a Likert-type format that ranges from 1 (almost never) to 5 (almost always). Adequate indices have been found in the several studies that have analyzed its psychometric properties. For internal consistency, Cronbach's alphas have ranged between .68 and .93. Likewise, the CERQ has obtained good indicators of convergent and discriminant validity (Garnefski & Kraaij, 2007).

Academic self-efficacy was measured using the School Self-efficacy Scale (ACAES) created by Galleguillos-Herrera and Olmedo-Moreno (2019). The scale assesses the perceptions of students regarding the abilities they possess to achieve their academic activities. The scale consists of 18 items grouped in 3 dimensions. The first one called Confidence in task performance measures the own perception with respect to the capacity that one possesses to carry out adequately the school activities. The second dimension, Effort put in task conduction, analyzes the perception of the effort required to achieve academic goals. The last dimension, Understanding of the task, measures the perception that one has regarding the understanding of what each of the academic activities

implies in order to plan school performance. The scale is answered in a Likert-type format with 5 options ranging from 1 (I can never) to 5 (I can always). In its original version, the scale explained 57.04% of the variance and it has a Cronbach's Alpha of 0.917 for the total scale (Galleguillos-Herrera & Olmedo-Moreno, 2019).

Procedure

Participants were recruited from seven high schools located in Mexico's central region. Four of them were public and three private schools. After been granted the respective authorization from the management of each of these high schools, the groups involved in the investigation were considered. Since this was a non-probability convenience sampling, the coordinator or counselor at each institution was contacted, and they indicated which groups were available to participate, depending on their schedule and activities. Each group had 20-45 students. The students who were present when data was collected received general information about the research –its objectives, their rights as participants, the process to preserve the anonymity and confidentiality of the data. Once they were given this information, the students who decided to participate voluntarily signed the informed consent and received the questionnaires to be completed. Students received no financial compensation for their participation. On average, it took them 25 minutes to complete all the scales.

Data Analysis

First, several descriptive analyzes were carried out which included the mean and standard deviation, as well as bivariate correlation analysis between the study variables. Subsequently, a structural equation model was designed which included three latent variables. The first of them is Family Functioning which includes three indicators: Cohesion, Flexibility and Communication. In turn, the latent variable of Emotional Regulation included the indicators of Mindfulness, Reappraisal and Acceptance. Likewise, the latent variable of Academic Self-efficacy includes three indicators: Confidence in task performance, Effort put in task conduction,

and Understanding of the task. The analysis of this model was carried out using the SPSS program version 25.0 and the LISREL program 8.8 (Jöreskog & Sörbom, 1996) using the maximum likelihood procedure. On the other hand, the mediation analysis for this research included the reports that each participant provided concerning the predictors (Cohesion, Flexibility and Communication), the mediation variables (Acceptance, Mindfulness and Reappraisal) and the criterion variables (Confidence in task performance, Effort put in task conduction, and Understanding of the task). In order to test the general fit of the model, various criteria were used: the Comparative Fit Index (CFI), the Tucker-Lewis index (TLI), the Standardized Mean Square Residual (SRMR) and the root mean square error of approximation (RMSEA). The good fit of the model is obtained by finding values equal to or higher than .95 for the CFI and the TLI, as well as values close to .06 for the RMSEA and values less than .08 for the SRMR (Hu & Bentler, 1999; Schumacker & Lomax, 2016).

Results

In order to know the general characteristics of the study participants, Table 1 shows the descriptive information they provided when answering instruments used in this research. The bivariate correlations between the study variables are also included in this table.

TABLE I. Mean, Standard deviation and correlations between study variables

Variables	1	2	3	4	5	6	7	8	9	M	SD
1.Cohesion	--									21.88	3.32
2.Flexibility	.88**	--								15.71	2.58
3.Communication	.70**	.57**	--							33.74	5.76
4.Acceptance	.25**	.33**	.40**	--						8.82	1.01
5.Mindfulness	.13	.29**	.32**	.58**	--					48.60	7.11
6.Reappraisal	.42**	.25**	.28**	.42**	.68**	--				31.67	4.13
7.Confidence	.21**	.30**	.30**	.49**	.50**	.55**	--			30.36	4.81
8.Effort	.15*	.10	.22*	.28**	.24**	.48**	.59**	--		19.18	1.76
9.Understanding	.11	.18*	.33**	.44**	.32**	.27**	.47**	.58**	--	10.08	1.85

*p < 0.05; **p < 0.01

Second, in order to examine the main objective of this research, a measurement model and a structural equation model were analyzed. Regarding the measurement model, it describes the relations between the observed variables and the latent constructs that include each one of them. On the other hand, the structural equation model describes the relation between the latent variables (Tabachnick & Fidell, 2018). The model created for the present research specifies that family functioning is related to emotion regulation and that emotion regulation, in turn, is associated with academic self-efficacy. In the model that was designed, the direct effects of family functioning on academic self-efficacy were not specified because it was hypothesized that family functioning would have indirect effects on academic self-efficacy through the mediating role of emotion regulation. The results revealed that the model showed an adequate fit (X^2/gl = 43/20, CFI = .98, TLI = .95, SRMR = .02, RMSEA = .04). Specifically, the effects of family functioning on emotion regulation were significant (standardized path coefficient = .48; z = 4.28) indicating that high levels of family functioning were related to high levels of emotion regulation. In turn, emotion regulation was significantly associated with academic self-efficacy (standardized path coefficient = .80; z = 5.38), showing that high levels of emotion regulation were related to high levels of academic self-efficacy. Likewise, the indirect effects of family functioning on academic self-efficacy (z = 3.74) were significant, indicating that emotion regulation had a mediating role between the family functioning of the students who participated in this research and their academic self-efficacy.

FIGURE I. Final model of family functioning, emotion regulation and academic self-efficacy.
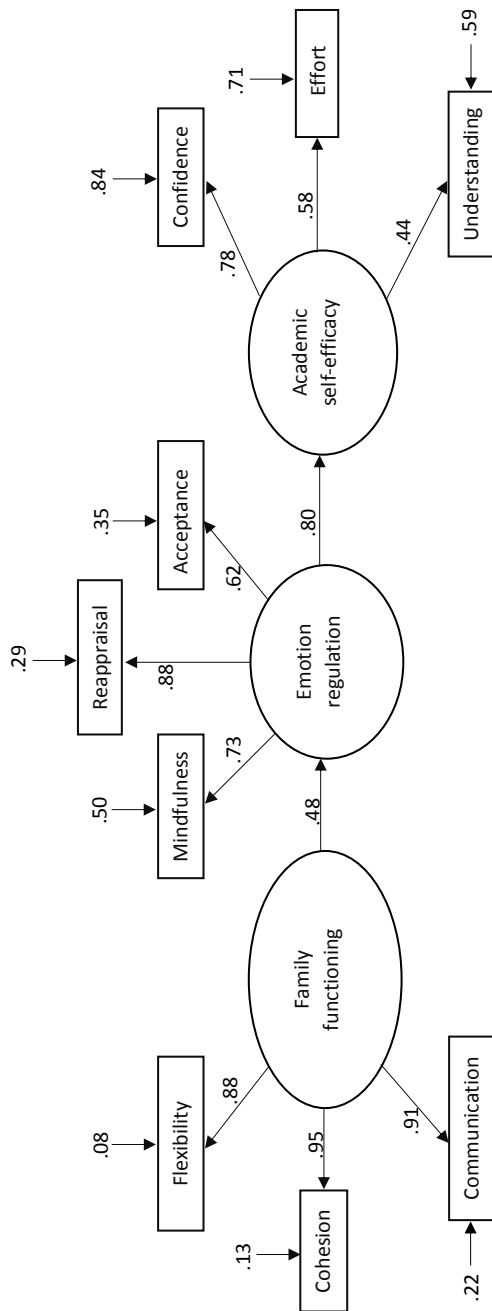
Note: Structural equation model showing the relations between family functioning, emotion regulation and academic self-efficacy. The values are the standardized coefficients. All coefficients are significant at p <.05.

Based on these results, the hypothesized theoretical model suggested that family functioning predicts academic self-efficacy via emotion regulation. Figure 1 shows the standardized path coefficients that were found in the relations between family functioning, emotion regulation, and academic self-efficacy. All coefficients were significant at .05. Based on the values found, it is possible to show that emotion regulation has a mediating function between family functioning and academic self-efficacy. Thus, a high level of family functioning was a significant predictor of the highest indices of emotion regulation, which in turn became a significant predictor of the highest levels of academic self-efficacy.

Discussion

This research examined for the first time a model of mediation between family functioning, emotion regulation, and academic self-efficacy in Mexican students. The most important result of this study confirmed that family cohesion, flexibility and communication have an indirect impact, through emotion regulation, on academic self-efficacy. Specifically, students with high levels of emotion regulation processes showed better academic self-efficacy than those with poor reappraisal, mindfulness, and acceptance. Since there were no studies measuring the mediating effect of emotion regulation strategies between these two constructs, our results are the first ones allowing the elucidation of why family functioning can predict academic self-efficacy through emotion regulation.

With regard to the relation between family environment and emotion regulation, our results suggest that living in a family environment that fosters cohesion, flexibility and communication between family members has important effects on the emotion regulation process of children. Based on the correlation analysis conducted, the results we found support this. Of the nine correlations between each of the three dimensions of family functioning and the three dimensions of emotion regulation included in this research, all were statistically significant, except one. According to the magnitude of the correlations found, the relation between family cohesion and reappraisal ($r = .42$, $p < .01$), and the relation between communication of family members and acceptance ($r = .40$, $p < .01$) stand out. These findings show the strong relation between family functioning

and the emotion regulation strategies that parents raise and develop in their children.

The same results had been previously found in other parts of the world and with different samples. For example, in children and teenagers living in high-risk communities with remarkable high rates of violence, it was found that family flexibility and cohesion functioned as protective factors, allowing youngsters to better regulate their negative emotions, especially those related to anger (Houltberg, Henry, & Morris, 2012). In these circumstances, the ability to adapt to changes and the quality of the ties within the family function as an indispensable mechanism for controlling emotions. Likewise, the mother's ability to regulate her own emotions is one of the main factors directly influencing the building of adequate family cohesion and flexibility (Demby et al., 2017). In turn, a study recently conducted in the Hispanic community living in the United States identified family cohesion as related to the presence of various emotion regulation strategies (Cano et al., 2020). In contrast, when parents have deficiencies in managing their emotions, communication with their children deteriorates significantly, which in turn leads to parents feeling more overwhelmed and stressed by problems, displaying a more hostile treatment, tending to distance themselves, and reducing to a great extent their support and signs of affection towards their children (Li, Bai, Zhang, & Chen, 2018).

In addition to the empirical evidence that we provide by documenting the relation between family functioning and emotion regulation, it is important to note that, according to the Circumplex Model, one of the possible explanations for this outcome would be the creation of emotional ties within the family. Since they are young, children begin to develop the foundations of what will be their own processes of emotion regulation. With their parents and other family members as primary models, children learn a series of strategies that allow them to manage their emotions in different circumstances. Family support throughout childhood and adolescence will be a determining factor in the ability of children to control their emotions, especially when facing situations that involve negative emotions. Likewise, the Circumplex Model also explains the impact of family communication on the development of a functional emotion regulation. The intensity and frequency with which family members can express themselves positively or negatively influences how the family environment that will prevail within a family is built (Fosco &

Grych, 2013). In turn, parents who successfully communicate with their children have the opportunity to transmit and teach them a series of strategies for emotional management.

Just as in the results for the relation between family functioning and emotion regulation, the analysis of the correlations between emotion regulation strategies and factors of academic self-efficacy also showed statistically significant relations between all variables. Overall, it was possible to confirm the decisive impact that the control and management of emotions has on the creation and the development of the academic self-efficacy of the students participating in this study. These findings are in line with others previously found in different parts of the world. For example, in a study conducted in Peru with university students, the results showed that emotion regulation strategies, specifically plan-focusing and acceptance, were significantly related to academic self-efficacy (Domínguez-Lara & Sánchez-Carreño, 2017). Therefore, students who are able to accept unpleasant experiences without judging them and who manage to focus on problem solving by concentrating on their own plans tend to feel more confident about their own academic skills, have a better understanding of their school goals, and strive more to achieve them. In addition, in another research, which included Australian university students, the mindful awareness strategy showed a significant relation with academic self-efficacy (Keye & Pidgeon, 2013). Likewise, a path analysis allowed finding that two other strategies of emotion regulation, in this case mindfulness and positive reappraisal, were also related to academic self-efficacy. Specifically, the mechanisms of aware acting, observation, and description, pertaining to mindfulness, had direct effects on academic self-efficacy, while the absence of reaction had an indirect effect on academic self-efficacy (Hanley, Palejwala, Hanley, Canto, & Garland, 2015).

With regard to the main objective of this research, the results confirmed for the first time the mediating role of emotion regulation in the relation between family functioning and academic self-efficacy. Our analyses showed that family functioning led to academic self-efficacy, primarily through the reappraisal and mindfulness strategies. This finding suggests that family cohesion, flexibility, and communication have an impact on the paths leading to academic self-efficacy through emotion regulation strategies. The analyses conducted in this research led to interesting findings. Firstly, we identified that the emotion

strategy of reappraisal had the most significant effects on the academic confidence, understanding, and efforts of participants. Therefore, those students who, concerning their daily activities, are capable of changing the meaning of an emotional experience, will also be able to reappraise their school activities according to their own goals, reappraise situations involving a problem they feel they cannot solve in the best way, and reappraise the feelings they experience when performing their academic activities. Previous investigations have also documented that reappraisal produces a state of psychological well-being, improves functioning in interpersonal relationships, encourages reinterpretation of events, acts as a protective factor against negative experiences, allows individuals to focus on the situation they are currently experiencing, and changes the emotional effect of the situations and their corresponding personal relevance (e.g., Brockman, Ciarrochi, Parker, & Kashdan, 2017; Dryman & Heimberg, 2018, Livingstone & Isaacowitz, 2018; Zilverstand, Parvaz, & Goldstein, 2017). Applying the reappraisal strategy to the school environment would be an indispensable resource to encourage students to seek for themselves the opportunities and learning resources with which they will achieve their academic goals. Due to the lack of past studies examining the effects of the reappraisal strategy on academic self-efficacy, this research allows us to understand for the first time the importance of giving new meaning to the emotional events that students experience on a daily basis in their school activities.

Likewise, the ability to become aware of our own internal processes – cognitive, emotional, and physiological, as well as of the external elements surrounding us, is a significant factor in our perception of our intellectual abilities. Just as in the present research, previous studies with university students had already identified the direct effects in academic self-efficacy of various aspects inherent in mindfulness, such as observation, aware acting, and the ability to describe one's feelings (Hanley et al., 2015). Based on our results, we can affirm that by becoming aware of the emotional processes they experience in their school activities, students are able to better perceive their school commitments, feel more autonomous and motivated to achieve their goals, have greater control and act proactively taking responsibilities. This suggests that, by internalizing and reflecting on the everyday experiences they go through at school, students develop the different skills inherent in academic self-efficacy.

Finally, the acceptance strategy also had a major impact on students' perception of their own abilities. Our search for investigations examining the effects of acceptance on academic self-efficacy led us to none. Therefore, our results allow us to show for the first time how, through the acceptance strategy, students are able to transform their experiences, which turns into a higher academic self-efficacy. One possible explanation for this would point out that, by admitting negative emotions without pretending to judge or change them, students are not only more competent, persistent, and autonomous, but also more striving and confident about their skills.

One of the limitations of this research is its transversal nature, which does not permit to know how the emotion regulation strategies employed by the participants of this study will evolve when they get to college and whether these strategies will continue to have the same impact on students' academic self-efficacy. A second limitation lies in the predictors of emotion regulation. The design proposed in this research included family functioning as the factor that would directly impact emotional regulation strategies. However, no other factors of importance in the development of emotion management, such as teachers, schoolmates, or friends with whom students have a close link, were included. A third limitation is the lack of comparisons between males and females, or between students in public and private schools.

Conclusions

The pioneering nature of this research confirmed for the first time that emotion regulation strategies mediate the relation between family functioning and academic self-efficacy. Since that was the main objective of this research, a model of structural equations was created to examine the mediating effect of emotion regulation. The results confirmed that this model had an adequate fit, showing that family functioning predicted academic self-efficacy through emotion regulation. As for the secondary objective, which was to analyze the relation between family functioning and emotion regulation strategies, as well as between emotion regulation strategies and academic self-efficacy, the findings showed that the direct effects of family functioning on emotion regulation were significant, indicating that high levels of family functioning are related to high

levels of emotion regulation. Emotion regulation was also directly and significantly correlated to academic self-efficacy. Therefore, these specific results helped explain the relation between emotion regulation strategies and the perception of confidence in task performance, the efforts put in task fulfillment, and the understanding of the task in Mexican adolescents.

With regard to the hypotheses posed, the structural equation model also confirmed that the presence of greater flexibility, cohesion and communication among family members led to a higher use of adaptive emotion regulation strategies –mindfulness, reappraisal, and acceptance. Meanwhile, the increased use of adaptive emotion regulation strategies led to a higher level of academic self-efficacy, specifically in the perception of confidence in task performance, the effort put in the accomplishment of the task and the understanding of the task among the Mexican students who took part in this research.

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The gender gap in STEM Education

La brecha de género en la Educación STEM

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Abstract

Studies on declining attitudes toward science in STEM education, especially among girls, have become an increasingly important topic, given their implications for academic and professional decision-making. Although there is considerable research that indicates that these attitudes begin consolidating themselves in childhood, most of this research focuses on secondary education. The aim of this article is to explore whether the liking for science, perceived usefulness, self-efficacy and professional interest in science display significant gender-based variations at an early age. The study design is non-experimental transversal (ex-post-facto) and it employs a quantitative methodology, with the application of the ACESTEM scale (Martín, 2020) to a sample of 408 students aged 10-14 years. The tests conducted are Pearson correlations between variables, Student's *t*-test to compare boys and girls, and factorial ANOVA to analyse the interaction between gender, stage, and the father's and mother's profession. The results show that boys display more favourable attitudes towards science than girls, but interest in science decreases with increasing age in both groups. Depending on the father and the mother's professions (STEM or non-STEM), we observe that while the father's profession does not differentiate the means in either attitude or its dimensions, the mother's profession produces statistically significant differences. There is a greater negative relationship between self-efficacy and age in girls than in boys; but this is not the case for the other dimensions. These results open up new avenues of research in order to achieve quality education for all.

Key words: STEM, gender, attitudes towards science, self-efficacy, stereotypes, identity, vocational interests.

Resumen

Los estudios sobre el declive de las actitudes hacia la ciencia en la Educación STEM, especialmente de género femenino, se han convertido en una temática de interés creciente por las repercusiones que estas tienen en la toma de decisiones académicas y profesionales. Aunque muchas investigaciones indican que estas actitudes comienzan a construirse en la infancia, la mayoría han focalizado su atención en la educación secundaria. El objetivo de este artículo es explorar si el gusto por la ciencia, la utilidad percibida, la autoeficacia y el interés profesional por la misma, presentan variaciones significativas respecto al género en edades tempranas. El diseño es transversal no experimental (ex post-facto) y la metodología de tipo cuantitativo con la aplicación de la escala ACESTEM (Martín, 2020) a una muestra de 408 estudiantes entre los 10 y los 14 años. Se han realizado correlaciones de Pearson entre las variables, *t* de Student para comparar chicos y chicas y ANOVA factorial para analizar la interacción entre género, etapa y profesión del padre y de la madre. Como resultados destaca que los chicos manifiestan actitudes más favorables hacia la ciencia que las chicas pero en ambos se constata una disminución del interés por la ciencia con la edad. En función de la profesión (STEM o no STEM) del padre y de la madre, observamos que la profesión del padre no diferencia las medias ni en la actitud ni en sus dimensiones, mientras que la profesión de la madre produce diferencias estadísticamente significativas. En las chicas destaca una mayor relación negativa entre la autoeficacia y la edad que la obtenida por los chicos, no ocurre lo mismo en otras dimensiones. Estos resultados abren nuevas vías de investigación con el fin de conseguir una Educación de calidad para todos y para todas.

Palabras clave: STEM, género, actitudes hacia la ciencia, autoeficacia, estereotipos, identidad, vocaciones.

Introduction

STEM Education (acronym for *Science, Technology, Engineering* and *Mathematics*), which is taught through real-world problem solving, is recognised as a learning requirement for all as it promotes the

development of the inquiring, cooperative, creative, reflexive and critical dimensions in citizens (Greca et al., 2021; UNESCO, 2019).

The attraction of STEM Education, linked to concerns regarding a reality where students' interest (especially female students) in science, mathematics and technology is in decline, are the motivations behind this research. Data from different sources point to the existence of a persistent gap in future STEM aspirations between girls and boys, the latter having fewer possibilities of pursuing a career related to STEM Education (Sáinz, 2020). In this regard, during the academic year of 2018-2019 in Spain, of the 24.12% of university students who were in STEM education, the proportion of women (7.66%) was significantly lower than men (16.47%) (Ministry of Universities, 2020). With regard to Vocational Training, the proportion of women is far below that of men (Gamboa et al., 2020), with notable differences by professional families, the female presence being very low in industrial and STEM fields.

Researchers such as Vázquez and Manassero (2015) indicate that the origin of disinterest in STEM Education may be located in negative attitudes towards science and technology, which are acquired throughout one's school life. This has led to research which conducts a specific study of attitudes to science in STEM Education, given the role they play in generating interest and commitment to topics related to science and technology, and because promoting a motivation, liking and attraction for STEM Education may increase the number of students (especially female students) who are likely to consider a future STEM syllabus in both university education and Vocational Training.

Additionally, different studies indicate that aspirations regarding the possible choice of a specific syllabus related to STEM Education consolidate themselves in early childhood and attitudes towards science in STEM Education are formed at an early age (Tai et al., 2006), being hard to change during and after adolescence. For this reason, researchers such as Savinskaya (2017) consider that STEM education must begin even before Primary Education, thus ensuring a positive attitude towards these studies based on gender equality. However, most studies conducted in this area have focused on Secondary Education (above all, from the age of 14 onwards). The importance of our research lies precisely in the fact that this study is conducted on students between the ages of 10 and 14 years.

The research conducted on student gender reveals contradictory results. Some show that boys tend to display more favourable attitudes towards science than girls (Pérez & de Pro, 2018); others highlight more favourable attitudes in girls (Chetcuti & Kioko, 2012), and yet other studies appear to have deviated from these patterns and do not observe significant differences (Toma & Greca, 2018).

Denessen et al. (2015) conclude that girls enjoy science and technology lessons less than boys, the former being more susceptible to teachers' lack of enthusiasm than boys. Studies by López et al. (2021) demonstrate a connection, especially in girls, between the choice of syllabus or STEM studies and high performance in science.

Archer et al. (2020) conclude from the results of the ASPIRES 2 project that gender problems are evident from a young age, more specifically, from the age of 10, and that boys display more solid scientific aspirations than girls, the latter having less possibilities of aspiring to a STEM syllabus, regardless of the fact that a higher percentage of girls rather than boys, consider science to be their favourite subject. In this line, if we consider gender, age and the educational stage, different authors conclude that as the student advances in their education, favourable attitudes towards science reduce drastically (Said et al., 2016), affecting all scientific subjects, but especially physics (Sáinz, 2017).

Sáinz and Müller (2017) find that girls in Secondary Education give greater importance to achieving expressive-communal goals and boys to achieving agentic-instrumental goals. In this regard, the research conducted by Pérez et al. (2018) reveals that girls have more favourable attitudes towards most questions related to environmental aspects, reflecting a greater sense of responsibility, awareness and respect, although these were also positively reflected in boys.

Regarding research on family influence, their daily practices, resources and values, Peterson et al. (2018) show that it plays an important role in promoting the creation of attitudes towards science in STEM Education. More specifically, Avendaño et al. (2020) state that the mother is the most influential figure when it comes to choosing STEM careers, in comparison with fathers, while Holmes et al. (2017) point out that having a father in a STEM profession has a significant effect on the process of choosing STEM studies for both boys and girls.

The conclusions presented by the Ministry of Education and Vocational Training (2019) and the OECD (2018) on the Programme for International

Student Assessment (PISA) with special reference to student attitudes demonstrate that when performance levels in science and mathematics are taken into account, significant variations are revealed. In the OECD, there is a lower proportion of girls than boys at upper levels of performance in science and mathematics, although it is true that in the case of mathematics, these differences have decreased over time, both in the OECD average and in Spain. In the case of sciences, the gender gap in average performance in 2018 is lower than that observed in mathematics and it may be stated that currently girls have a significantly higher average score than boys, whereas in 2015, the reverse was true.

Finally, several studies show that student behaviour and choice may be affected by implicit biases derived from exposure to generalised cultural stereotypes that consider science as a profession more suited to men than women (Kim et al., 2018; Oon et al., 2020), these stereotypes being sustained and displayed by both genders (Blazev et al., 2017). In relation to the above, Cheryan et al. (2017) argue that boys may feel pressurised to choose science as a topic that may be perceived as being stereotypically masculine, while the same may lead girls to abandon this topic as a means to establish their gender identity. In this regard, other factors that attempt to account for the apparent lack of interest in girls with reference to STEM studies are linked to the absence of role models for women, teaching methods that do not reach girls and low feeling of acceptance or decreased family support (UNESCO, 2019).

As we have seen, gender-related differences in attitudes to science are the result of an interconnected and complex reality influenced by socio-cultural, academic and psychological aspects (Cabero & Valencia, 2021; Luis et al., 2020).

The goal of the study is linked to the exploration of whether a liking for science, the perceived usefulness of science, self-efficacy and professional interest in science display significant gender-based differences. Based on this goal, we propose the following research hypotheses:

Hypothesis 1: There are statistically significant differences in attitudes towards science in STEM Education and its dimensions, according to gender.

Hypothesis 2: There is a statistically significant and negative relationship between age and attitude towards science in STEM Education and its dimensions and it differs based on whether it is analysed in the sample of boy or girl students.

Hypothesis 3: There are statistically significant differences in attitude and its dimensions according to gender (male/female), educational stage (primary/secondary), mother and father's profession (STEM/non-STEM) and the different interactions between these factors.

Method

The research was conducted by means of a non-experimental transversal (ex-post-facto) design and a quantitative methodology consistent with the objective and the declared hypotheses. The proposed approach is therefore a quantitative study that enables the analysis of students' attitudes towards science in STEM Education, considering beliefs and perceptions regarding scientific competence (self-efficacy), the perceived usefulness of science and future professional intentions, as well as the affective reactions displayed by male and female children between the ages of 10 and 14 years (5th and 6th year of Primary Education and 1st and 2nd year of Compulsory Secondary Education) onliking and enjoyment of science.

Sample

The sample was constituted by 408 students (210 girls and 198 boys) in the 5th and 6th year of Primary Education, and the 1st and 2nd year of Compulsory Secondary Education from three state-owned ($N = 147$), state-sponsored ($N = 113$) and private ($N = 148$) schools in the Region of Madrid. Their average age was 11.79 years (SD = 1.28, min. = 9 and max. = 16).

If we look at the gender-based distribution of the sample, the number of girls at 210 (51.4%) is somewhat higher than the number of boys at 198 (48.5%). The largest group of students belonged to the 1st year of Compulsory Secondary Education (12 and 13 years old) at 131, and the smallest group was that of the 6th year of Primary Education (11 and 12 years), with a total of 87. In all of them the number of girls exceeded the number of boys, with the exception of the 6th year of Primary Education, (49 boys and 38 girls).

With regard to sample distribution based on the profession of the father and the mother, it was observed that among students whose mothers were STEM professionals[1], 60% of the fathers were also in STEM

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[1] According to the Recommendation of the Commission dated 29 October 2009 on the use of the International Standard Classification of Occupations (ISCO-08), STEM professionals belong to Sub-

professions, while 40% were not. Among students whose mothers were not STEM professionals, 76.5% of the fathers were also not in STEM professions, and 23.5% were STEM professionals.

Instruments

In order to conduct this research, a scale that could measure attitudes towards science in STEM Education (ACESTEM, Martín, 2020) was developed for the ages in question (10 to 14 years). For this, an initial review of the scientific literature on scales to measure attitudes towards science (Fraser, 1981; Kennedy et al., 2016; Summers & Abd-El-Khalick, 2018; Wang & Berlin, 2010; Zhang & Campbell, 2011) was conducted, leading to an overarching view of the most common and relevant dimensions required for students to form positive attitudes towards science in STEM Education.

This analysis enabled the structuring of the model Attitudes towards Science in STEM Education (ACESTEM, Martín, 2020) with four fundamental dimensions as displayed in Table I.

TABLE I. Dimensional structure of the ACESTEM questionnaire

ACESTEM Dimensions	Definition	No. of items
Liking for science	Pleasure or enjoyment derived from learning or doing science-related activities or participating in science-related activities.	6 items
Professional interest in science	Willingness to undertake future studies in science or to work in a science-related profession.	6 items
Perceived usefulness of science	Social relevance given to science and male and female scientists.	5 items
Self-efficacy	Beliefs and perceptions regarding one's own ability to comprehend, learn, and work with science.	4 items

Source: Developed by author

Major Group 21 of Science and Engineering Professionals within Major Group 2 of Professionals; associate STEM professionals belong to Sub-Major Group 31 (Science and Engineering Associate Professionals) and to Sub-Group 35 (Information and Communications Technology Operations and User Support Technicians) within Major Group 3 of Technicians and Associate Professionals.

Building the scale required validating the content according to expert judgement followed by an exploratory factor analysis (EFA) of the scale on a sample of 408 students. This offered a four-factor structure with 24 items, a Cronbach's alpha of .906 and a McDonald's omega reliability of .909. The subsequent confirmatory factor analysis (CFA) conducted on a different sample of 295 students confirmed the four-factor structure, obtaining satisfactory adjustment indexes and a Cronbach's alpha of .914 and McDonald's omega with a reliability of .917, leading to a scale with 21 items.

Finally, once the dimensions and the items associated with each one of them were determined, the questionnaire was conceptually structured into two distinct parts: the first with socio-demographic data and the other with the dimension items. A five-response Likert scale was used to group the responses that accompany the questions in the items (Completely disagree, Disagree, Neutral, Agree, Completely agree).

Procedure

The students were selected by a non-probability convenience sampling, given that the schools chose to participate in a research and innovation project related to the attitudes and approaches to STEM Education. In this case, once the research was approved by the academic staff and the school's consent was obtained, the course tutors were contacted and the questionnaire items to be answered by the students were explained. Google Forms was used as an online tool, having previously applied the questionnaire to student participation in certain workshops related to STEM Education. The students were given 15 minutes to complete it in their school under the supervision of the tutor.

The descriptive analysis of each variable was conducted through frequency distributions, contingency tables, averages and standard deviations in quantitative variables. For the differential analysis of the variables, the averages were compared using Student's *t*-test, with gender as the independent variable, and Analysis of Variance (factorial ANOVA) to analyse the interaction of factors such as gender, the stage and profession of the father and the mother, in the attitude towards science in STEM education and its dimensions. Information regarding the Student's *t*-test value, the *F*-test in ANOVA, the probability associated

with these values (*p*), the degrees of freedom (*gl*) and the effect size [2] (*d*) or h^2. To test the hypothesis on the relationship between the attitude towards science in STEM Education and its dimensions, and age, we have used Pearson's coefficient *r* (*r*) and its associated probability of error (*p*). An associated Type I error probability of 0.05 is used as the criterion to reject the null hypotheses. IBM SPSS 20.0 for Windows was the program used for the statistical processing of the data.

Results

After the data was compiled, they were analysed in order to test the hypotheses developed. The following sections present the results according to each hypothesis.

Hypothesis 1: There are statistically significant differences in attitudes towards science in STEM Education and its dimensions, according to gender.

The first hypothesis in this article is of key importance, therefore, it was decided to conduct a Student's *t*-test, analysing the attitude towards science in STEM education and its dimensions according to gender. The results obtained were subsequently confirmed by means of the factorial ANOVA. Thus, in the factorial ANOVA, the interest lies not so much in the effect of each factor, but in the effect of the interactions between the factors (gender, stage, profession of the father and the mother) in the attitude and its dimensions.

To conduct the Student's *t*-test, the assumption of homogeneity of variance was tested with Levene's *F*, and was found to be homoscedastic in all cases. Given that the assumption of normality was not met for any of the cases when analysed with the Kolmogorov–Smirnov test, Mann–Whitney U nonparametric test was also conducted, confirming the results of the Student's *t*-test.

The analysis of the data in Table II demonstrates that boys possess different and more statistically significant averages (*p*<.01) than girls with respect to attitudes towards science in STEM Education (average in boys

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[2] Cohen's criteria was used to assess the magnitude of the differences. According to Cohen (1992), an effect size value of 0.20 represents a low difference, a value of 0.50 represents a moderate difference, and a value higher than 0.80 may be deemed a big difference.

being 3.47 and in girls, 3.20). This is repeated in all the dimensions except in usefulness (average in boys 3.90 and in girls, 3.79) where there are no statistically significant differences (*p*>.05) although the tendency is the same.

To assess the magnitude of the difference between the averages, its effect size was calculated. The attitude towards science in STEM Education (*d* = 0.37) and the dimensions of liking (*d* = 0.28), professional interest (*d* = 0.32) and self-efficacy (*d* = 0.42) were considered to range from low to moderate. The lowest effect size is associated with the dimension of usefulness (*d* = 0.15).

TABLE II. Differences in attitude towards science in STEM Education according to gender

	Gender	*N*	Mean	SD	*t*	*gl*	*p*	*d*
Attitude	Boy	198	3.47	0.70	3.76	406	.000	0.37
	Girl	210	3.20	0.71				
Liking	Boy	198	3.50	0.94	2.95	406	.003	0.28
	Girl	210	3.20	1.00				
Professional interest	Boy	198	3.09	0.98	3.20	406	.001	0.32
	Girl	210	2.77	1.02				
Usefulness	Boy	198	3.90	0.77	1.52	406	.128	0.15
	Girl	210	3.79	0.70				
Self-efficacy	Boy	198	3.45	0.82	4.20	406	.000	0.42
	Girl	210	3.11	0.84				

Source: Developed by author

Regarding the second hypothesis that posits that *there is a statistically significant and negative relationship between age and attitude towards science in STEM Education and its dimensions and it differs based on whether it is analysed in the sample of boy or girl students*, the analysis studied the existing correlations between age and attitude towards science in STEM Education and its four dimensions in the two samples separately.

It was thus observed that the relationships between attitude towards science in STEM Education and its dimensions of liking, usefulness and self-efficacy in the sample of girl students, and student age, are negative

and statistically significant (*p*<.01). Professional interest is the only dimension without a statistically significant relation (*p*>.05) as shown by the values in Table III.

TABLE III. Correlations between attitude towards science in STEM Education and student age

Sample	N	Attitude	Liking	Professional interest	Usefulness	Self-efficacy
Total	408	-.17**	-.22**	.01	-.20**	-.17**
Girls	210	-.13	-.17*	.07	-.19**	-.20**
Boys	198	-.22**	-.27**	-.06	-.21**	-.14

*p<.05; ** p<.01; ***p<.001
Source: Developed by author

If the correlational analysis is conducted on the sample of boys, it is observed that the correlations are somewhat higher than in girls and in the same direction in attitude towards science in STEM Education, liking and usefulness, although there is no statistically significant relation with professional interest or self-efficacy (*p*>.05). It is worth pointing out that there is a correlation with self-efficacy in the sample of girls, but not in the case of boys.

It is noted throughout the entire sample that the relations between attitude and age are negative and statistically significant (*p*<.01) but low. The highest correlation is the one established with liking (*r* = -.22), which shows that as they grow older, their interest in science decreases. Nevertheless, there is no relation between age and the dimension of interest (*p*>.05).

The third hypothesis states that *there are statistically significant differences in attitude and its dimensions according to gender (male/ female), educational stage (primary/secondary), mother and father's profession (STEM/non-STEM) and the different interactions between these factors.*

To test this hypothesis, we conducted a factorial ANOVA where the dependent variable is the attitude towards science in STEM Education and its dimensions, and the factors are gender, stage and profession of the father and the mother. Homoscedasticity was tested by means of

Levene's test for all cases. However, in some cases, the assumption of normality is not fulfilled and it is assumed, as stated by Blanca et al. (2017), that the non-fulfilment of the assumption of normality does not have a significant effect on the ANOVA and therefore, we proceed with the analysis, as displayed in Table IV.

TABLE IV. Factorial ANOVA Differences in attitude towards science in STEM Education and its dimensions based on gender, stage, profession of the father and the mother, and their interactions

	Attitude		Liking		Interest		Usefulness		Self-efficacy	
	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2
Gender (M/F)	7.629* M	.019	6.411* M	.016	5.849* M	.015	0.617	.002	6.791* M	.017
Stage (Primary/Secondary)	1.417	.004	5,209* Primary	.013	0.488	.001	1.601	.004	1.581	.004
Father's profession (STEM/non-STEM)	0.019	.000	.003	.000	0.388	.001	1.357	.003	0.387	.001
Mother's profession (STEM/non-STEM)	5.563* STEM	.014	4.062* STEM	.010	3.988* STEM	.010	0.907	.002	5.297* STEM	.013
Gender-Father's profession	0.073	.000	0.018	.000	0.000	.000	0.046	.000	0.532	.001
Gender-Mother's profession	0.187	.000	0.049	.000	0.129	.000	0.314	.001	1.082	.003
Gender-Stage	1,164	.003	1.578	.004	1.097	.003	2.179	.006	0.811	.002
Father's profession-Mother's profession	0.047	.000	0.003	.000	0.380	.001	0.038	.000	0,017	.000
Father's profession-Stage	0.149	.000	1.010	.003	0.010	.000	0.096	.000	0.030	.000
Mother's profession-Stage	0.448	.001	0.299	.001	1.831	.005	0,180	.000	0.960	.002
Gender- Father's profession-Mother's profession	3.315	.008	1.490	.004	1.814	.005	0.797	.002	6,483* M+Non-STEM Father+STEM Mother	.016
Gender- Father's profession-Stage	0.934	.002	2.225	.006	0.004	.000	0.723	.002	0.831	.002
Gender- Mother's profession-Stage	0.223	.001	0,381	.001	0.049	.000	1.584	.004	0.547	.001
Father's profession-Mother's profession- Stage	0.024	.000	0.644	.002	0.067	.000	0.010	.000	0.014	.000
Gender- Father's profession-Mother's profession-Stage	1.975	.005	2.761	.007	0.270	.001	0.383	.001	3.062	.008

*p<.05; ** p<.01; ***p<.001
Prev.: Prevalence The highest average is highlighted
Source: Developed by author

In Table IV, and in line with the results of testing the first hypothesis, there is a difference between girls and boys regarding attitude towards science in STEM Education and its dimensions ($p<.05$), as higher values are obtained, which is also displayed in Graphs I, II and III. This occurs in the different dimensions, except in perceived utility, where the differences are not statistically significant ($p>.05$), although the tendency is the same. With reference to the stage (primary or secondary), statistically significant differences were only noted in the dimension of liking ($p<.05$) for primary school students, compared to secondary school students who had lower values, as indicated in Graph I. This difference, however, is deemed low ($h^2=.013$) by Cohen's criteria (Cohen, 1992).

GRAPH I. Differences in attitude towards science in STEM Education and its dimensions according to gender and educational stage (primary/secondary)
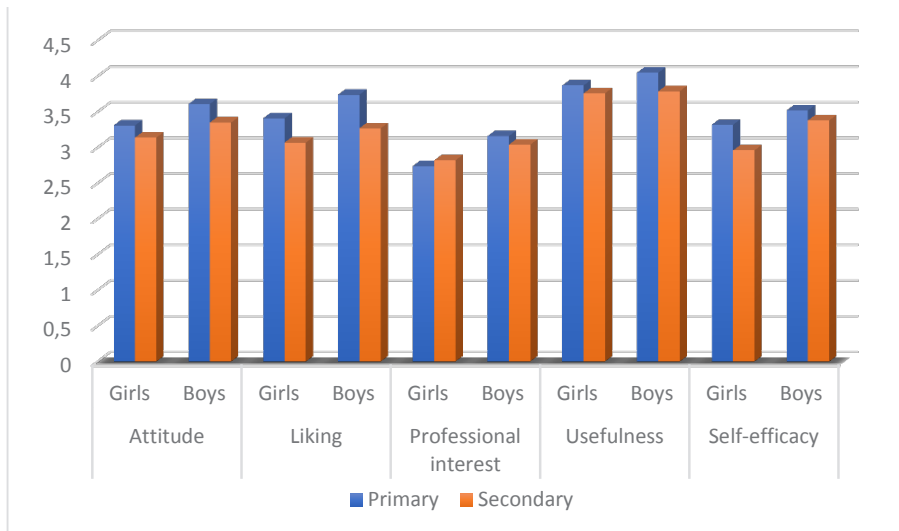
Source: Developed by author

GRAPH II. Differences in attitude towards science in STEM Education and its dimensions according to gender and the father's profession (STEM/non-STEM)
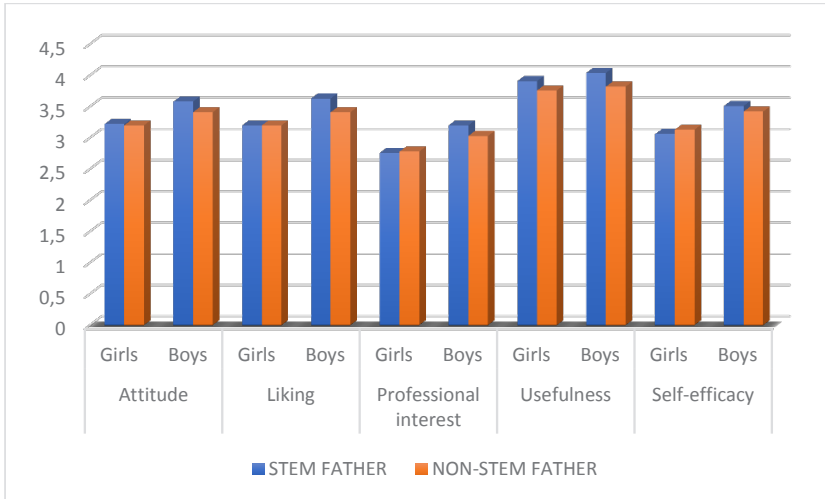
Source: Developed by author

GRAPH III. Differences in attitude towards science in STEM Education and its dimensions according to gender and the mother's profession (STEM/non-STEM)
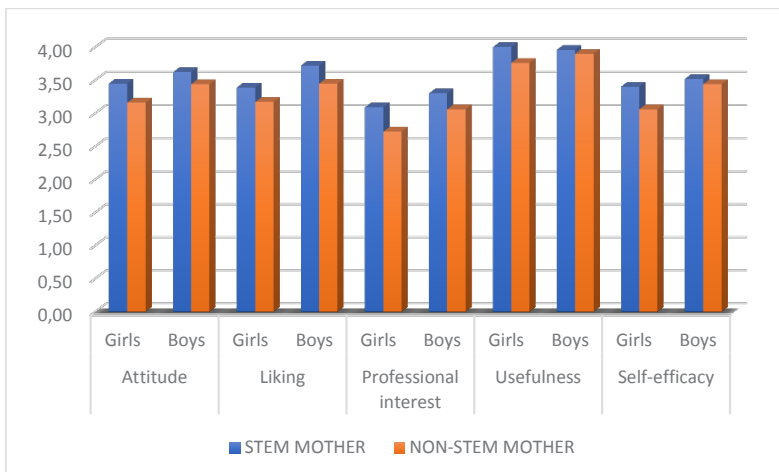
Source: Developed by author

When we analyse the differences based on the father's profession, it is noted that they are not statistically significant, the mother's profession being the factor that differentiates students both in their attitude towards STEM Education, as well as its dimensions, with the exception of perceived usefulness. The group of girls and boys whose mothers are in a STEM profession display higher values than those with mothers in professions unrelated to STEM, and these differences are deemed ($h^2 < .15$) low according to Cohen (1992). The dimension of perceived utility is the only one without statistically significant difference ($p > .05$) between both groups (student group whose mothers are in STEM professions, and group whose mothers are not in STEM professions). If we analyse Graph III, we see that girls tend to have higher scores than boys when mothers are in a STEM profession, although the interaction of both factors does not lead to statistically significant differences ($p > .05$). Additionally, and as may be seen in Graph III, when the mother is in a STEM profession, the differences in professional interest and self-efficacy are higher in the group of girls than in the group of boys where the differences are less notable. This trend may also be observed in Graph II where boys appear to have a tendency to score higher in attitude towards STEM Education and its dimensions when the father is the one in a STEM profession.

In the different 2 factor interactions, *F* does not have an error probability < 0.05, therefore, these combinations do not produce statistically significant differences in attitude towards science in STEM Education and its dimensions, as may be seen in Table IV, with effect sizes $h^2 < .010$ being very low.

F also does not have an error probability lower than 0.05 in the 3 factor interactions that have been studied, except in the interaction of gender, father's profession, mother's profession, with a $p < .05$ and $h^2 = .013$, a magnitude deemed low according to Cohen's criteria (Cohen, 1992). Within the effect of this interaction, it is observed that boys whose mothers are in a STEM profession but not their fathers, have a significantly higher average than girls whose fathers are in a STEM profession but not their mothers.

Finally, we observe in Table IV that the interaction of the four factors (gender, stage, father's profession, mother's profession) does not lead to statistically significant differences in attitudes towards science in STEM Education, nor in any of its dimensions ($p > .05$).

Discussion and conclusions

This research was motivated by the goal of exploring whether attitudes towards science in STEM Education has significant gender-based variations at early ages. Although many studies indicate that attitudes towards science begin to be established in early childhood, most of them are focused on secondary education. Thus, the importance of this research lies precisely in the fact that it is conducted on students between the ages of 10 and 14 years. We now discuss the developed hypotheses, taking into account the results obtained.

Regarding the hypothesis that there are statistically significant differences in the attitude towards science in STEM Education and its dimensions, according to gender, the analyses conducted in this study reveal that boys have different and higher statistically significant averages than girls when it comes to attitudes towards science in STEM Education, liking, professional interest and self-efficacy. This data is in line with the considerable research that shows that boys display more favourable attitudes towards science than girls (Denessen et al., 2015).

A link may be drawn with the works of Kim et al. (2018) who attempt to provide an explanation for the differences between boys and girls by propounding the idea that STEM identity is a type of social identity. Social identity determines who belongs to a social group, at the same time that it describes what it means to be a member of the group through a set of norms, attitudes, behaviours, features and stereotypes. Thus, the prototypical STEM member tends to be white, male, socially awkward and uniquely obsessed with their field of work (Cheryan et al., 2015). Persons who do not fit this prototype of the group tend to be marginalised members and given that prototypes in many STEM areas are often to be male, it is probable that girl students in these areas experience low prototypicality in STEM during their schooling. In accordance with the theory of social identity, we may point to the difficulty faced by girl students in identifying with STEM since their social environment gives them a series of signs that they do belong nor do they fit into STEM stereotypes.

Other research such as Oon et al. (2020) support these ideas, demonstrating that students consider science to be a typically male subject, and it is more favourably viewed by boys than by girls, as a stereotypical threat. In connection with the above, Sáinz (2020) states

that stereotypes that assign better skills in STEM areas to men may lead women to opt for education and professional careers that move away from STEM Education. Gender stereotypes in science are a source of concern as they generate a lack of identification with STEM Education in girls and women, thus creating not only negative attitudes towards science but also a decreased feeling of belonging to STEM Education, which lowers their intention to follow STEM careers (Ito & McPherson, 2018).

Additionally, and in relation to the second hypothesis, the analysis of the correlation between attitude towards science in STEM Education and its four dimensions in the sample of girls makes it clear that as their age increases, they derive less enjoyment from studying science, their liking decreases and they gradually lose interest in science-related subjects. Moreover, the social relevance given by girls to science and to male and female scientists (dimension of usefulness) also decreases with age, similar to self-efficacy. Nevertheless, a relation between age and professional interest or the intention of girls to pursue future studies in connection with science could not be drawn. In the case of boys, the correlations are somewhat higher than in girls, and in the same direction, although there is no relation either with professional interest or with self-efficacy.

The progressive lack of interest in science among boys and girls with age is a matter of concern, as if they develop and retain positive attitudes towards science at these ages, they are more likely to want to continue studying these subjects that they enjoy.

Regarding the second and third hypotheses, when we analyse what happens as boys and girls grow older, we found that in the case of boys, the negative correlation between the attitude towards science in STEM Education, liking and usefulness, is higher than in the group of girls. However, in the dimension of self-efficacy, girls obtain higher negative correlations than boys. When we look at the average values, what strikes us is that self-efficacy is the dimension that most differentiates girls and boys as they advance in their education, although we can only perceive it at the descriptive level. This is in line with some studies that demonstrate that within the same level of competence, girls tend to underestimate their results compared to how boys rate themselves (Bøe & Henriksen, 2013) or how self-efficacy has a greater influence on performance in women than in men (Fernández et al., 2019).

The results of different studies demonstrate that girls who internalise gender stereotypes have lower levels of self-efficacy and confidence in their skills than boys (Robnett, 2015) and that this appears to be influenced by their social context, including their parents' expectations (Garriott et al., 2017). It is not unreasonable to state, in line with Robnett (2015), that gender bias may be partially responsible for driving girls and women away from STEM Education and for the low self-esteem suffered by many of them.

If we continue to look at the results of this research and examine the differences based on the professions of the father and the mother (STEM or non-STEM profession), then we may infer that the father's profession does not make a difference in the averages with reference to the attitude or its dimensions. However, in the case of the mother's profession, there are statistically significant differences in attitude towards science in STEM Education, except in the dimension of usefulness. It is perceived that girls display greater differences than boys depending on whether the mother is in a STEM profession or not. This coincides with studies conducted by the OECD (2015) that confirm that the performance of girls in science appear to be more closely linked to backgrounds with mothers who have completed higher education (STEM profession), or with research such as the one conducted by Melhuish et al. (2008) that explains that the educational level of mothers is a relevant factor in the mathematical performance of girls and boys, or Avendaño et al. (2020) that shows the father's influence has a minimal effect in the process of career selection, while the mother's effect is significantly higher.

Finally, the role played by the mother's profession in developing self-efficacy in girls is highlighted. Of all the sources of the beliefs held by the subjects on self-efficacy, it is worth highlighting the role played by the vicarious experiences (Bandura, 1997) of children with mothers in STEM professions. Accordingly, girls may see other persons similar to themselves, in this case, of the same sex, being successful in their profession and thus develop positive beliefs regarding self-efficacy, thus creating a favourable judgement regarding their capacity to undertake similar activities, in this case, those linked to STEM areas. This vicarious observation may especially influence the self-efficacy of girls, encouraging them to continue their efforts when confronted with moments of failures.

It is also possible that the direct indication of mothers in STEM professions to their daughters that they possess the required capacity to

successfully undertake a task in this area, strengthens the perception of self-efficacy. This may boost the subject's efforts which in turn leads to improved skills and thus translates into positive beliefs regarding one's own capacity and attitudes towards science in STEM Education.

The conclusions drawn from this research leads us to believe that it is necessary to promote, from a very early age, school interventions that transform gender-related STEM stereotypes, as well as guiding families to understand the concept, meaning and value of STEM Education (Martín et al., 2019).

Future lines of research include analysing the relationship between student intentions when choosing a syllabus related to STEM Education, the factors that influence these intentions and the consistency with which these intentions can predict student behaviour, especially female students, as well as the study of additional variables such as, for example, the family's socioeconomic status, the parents' attitudes to STEM, and STEM teaching practices.

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Strengthening reading precursors in pre-readers

Fortalecimiento de los precursores de la lectura en estudiantes prelectores

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Abstract

Several research studies have demonstrated the efficacy of interventions to improve reading precursors, leading to more successful reading acquisition. Interventions to develop these skills are especially relevant in contexts that show low levels of reading proficiency on national and international evaluations, as in the case of Peru. It has been detected that the Peruvian educational curriculum does not contemplate working on pre-reading skills before beginning to read. Thus, the objectives of this study are: (1) to design a set of research-based activities that can be integrated into the Peruvian curriculum to stimulate these skills; (2) to test this intervention; and (3) to find out how other variables associated with the individual (Age, Sex, ESEC, and Executive Function) could be involved in the changes observed in the study. The activities were designed based on the target competencies and skills of the Peruvian curriculum in the area of communication, starting with the teachers' use of literary texts. The activities were carried out with a sample of 208 Peruvian five-year-old children, divided into an experimental group and a control group. The latter followed an intervention with the traditional teaching format. The results obtained by the two groups were compared, and to control the effect of other variables (Age, Sex,

ESEC, and Executive Function) and find out the degree of variance explained by the program, a multiple regression analysis was performed. The results show that the experimental group activities improved the reading precursors more than the control group intervention, and the regression analysis confirmed that the intervention explained most of the found in the final assessment. We can conclude that teachers can incorporate activities that complement the official curriculum, in order to improve their students' proficiency without placing an additional burden on them.

Keywords: emergent literacy, early reading; reading instruction; early intervention; official curriculum; reading teachers; pre-readers.

Resumen

En varias investigaciones se ha demostrado la posibilidad de intervenir y mejorar los precursores de la lectura y de cómo su mejora está relacionada con una adquisición de esta más exitosa. La intervención en estas habilidades es especialmente relevante en aquellos contextos que muestran bajos niveles de competencia lectora en las evaluaciones nacionales e internacionales como es el caso de Perú. Se ha detectado que el currículo educativo peruano no considera trabajar las habilidades prelectoras antes del comienzo de la lectura. Los objetivos de este trabajo son (1) diseñar un conjunto de actividades basadas en la literatura científica que se integre en el currículo peruano, dirigidas a la estimulación de dichas habilidades; (2) poner a prueba dicha intervención y (3) conocer como otras variables, asociadas al individuo (Edad, Sexo, ESEC y Función Ejecutiva) podrían estar implicadas en los cambios observados en el estudio. Las actividades se diseñaron basándose en las competencias que el currículo peruano pretende desarrollar en el área de la comunicación, a partir del uso de textos literarios impartidas por el profesorado. Se aplicó a 208 estudiantes peruanos de 5 años, divididos en grupo experimental y grupo control. Este último siguió una intervención con el formato tradicional de enseñanza. Se compararon los resultados de ambos grupos y para controlar el efecto del resto de variables y conocer el grado de varianza explicada por el programa se realizó un análisis de regresión múltiple. Los resultados muestran que las actividades mejoraron los precursores de la lectura en mayor medida que la intervención del grupo control y el análisis de regresión corrobora que la intervención realizada está explicando la mayor parte de la varianza. Se concluye que el cuerpo docente puede incorporar actividades que complementen el currículo oficial con el fin de mejorar la competencia de sus estudiantes y sin que les suponga una carga adicional.

Introduction

Before learning the formal conventions of written language, a series of skills associated with students' development have to be consolidated. These skills, known as precursors to reading, are also developed through the stimulation received from the environment (De la Calle et al., 2019).

These precursors include ***linguistic*** skills (Catts, 2015), highlighting the role of vocabulary (Vellutino et al., 2007) and the ability to manipulate and reflect on the grammatical structure of language (Cain, 2007); ***metalinguistic skills***, particularly *phonological awareness* (Landerl et al., 2019) and *knowledge about the components and functions* of written language (Murphy et al., 2016); ***alphabetic knowledge*** (Sunde et al., 2020); ***naming speed*** (Clayton et al., 2020), which together with phonological awareness and alphabetic knowledge would be the best early precursors to reading (De la Calle et al., 2019); and, finally, certain ***cognitive variables***, such as visual perception (Mantovani et al., 2021) and verbal memory (Injoque-Ricle et al., 2012).

Recent findings also show the involvement of the *Executive Functions*, given that in reading it is necessary to develop the ability to maintain attentional control and control interference (Carretti et al., 2017). In addition, the *Socioeconomic and Cultural Status* (ESCS) is also relevant in the acquisition of good reading performance (Escobar & Meneses, 2014).

Intervention in reading precursors

The tendency has been to train the skills that have shown greater involvement in the access to reading. Thus, most interventions have been directed toward developing phonological awareness, either in

isolation (Gutiérrez & Díez, 2017) or along with other skills, such as naming speed (Vander & Van, 2018) or alphabetic knowledge (Gutiérrez, 2018). However, programs have also been designed to enhance other precursors, such as compressive and automated vocabulary (Spencer et al., 2012) or knowledge about the components and functions of what is written (Neumann, 2013). Designs that intervene on all or most of the precursors have been shown to be more effective (Pears et al., 2016). Most of these interventions, in addition to improving the selected skills, have demonstrated their influence on subsequent reading acquisition (Gutiérrez & Díez, 2017; Romero et al., 2016). The programs are usually aimed at all the students, but some are designed for students who have difficulties with specific skills (Lovett et al., 2017).

Interventions can be distributed throughout the course (Gutiérrez & Díez, 2017) or have a specific number of sessions (Arancibia et al., 2012). Some programs, usually supported by ICTs, make the number of sessions and their duration more flexible (Romero et al., 2016). One way to work on these skills is through shared reading (Gutiérrez & Díez, 2017) or reading picture books (Schryer et al., 2015). Less frequent are interventions that integrate the activities into the educational curriculum (Vera, 2011), taking into account the teacher's direct participation in programming and implementing the activities (González et al., 2013) and validating a natural and integrative context (Bowyer-Crane et al., 2008).

Training in these skills is especially relevant in contexts that show low levels of reading proficiency on national and international assessments, as in the case of Peru (Schleicher, 2019): only 37.6% of second-grade students (7-8 years old) in Peruvian schools (public and private) are able to achieve a satisfactory text comprehension level (Peruvian Ministry of Education, MINEDU, 2019).

Pre-reading skills in the Peruvian curricular framework

The Peruvian early education curricular framework (3-6 years) is organized in curricular areas that establish the competencies to be developed and the learning experiences schools must provide for their students (LaTorre, 2014). The Communication area consists of two fundamental sub-areas: text comprehension and oral expression (Table 1).

TABLE 1. Area of communication. Main competencies and capabilities in Early Education

Area of communication	Competency	Curricular capabilities
Text comprehension	Understands written texts	Internalizes the characteristics of the writing system
		Reflects on the form, content, and context of written texts
		Reorganizes information from various written texts
		Infers the meaning of written texts
		Retrieves information from various written texts
Oral expression	Expresses him/ herself orally	Adapts his/her oral texts to the communicative situation
		Expresses his/her ideas clearly.
		Strategically uses a variety of expressive resources
		Interacts collaboratively, maintaining the thematic thread

Note. Correspondence between competencies, capabilities, and areas of communication based on the peruvian curriculum

Within this area, reading experiences are developed through contact with different texts in order to be able to construct their meaning and express opinions about them. These are the so-called 'literary activities', a space without a specific structure for working on oral expression and text comprehension skills, allowing teachers to follow their own methodology (MINEDU, 2015). They expect that through contact with written texts, preschool students will gradually deduce the mechanisms of reading . They start from a global approach that sets aside the synthetic approach, which is necessary for word decoding, especially in transparent languages such as Spanish. This approach even questions the relevance of addressing letter knowledge in this educational stage, ignoring the evidence of current research, which shows a clear relationship between success in reading acquisition and the development of phonological awareness and alphabetic knowledge.

The present study

When children are learning to read, the Peruvian curriculum tries to make them deduce the basic reading mechanisms through interactions with a series of texts, putting aside the teaching of certain fundamental pre-reading skills (phonological awareness and explicit and systematic teaching of the alphabetic principle). Therefore, the present study aims to design an intervention that enriches the Peruvian Education Ministry's approach to early reading. This intervention considers the development of these pre-reading skills, but without contradicting the Ministry's guidelines or ceasing to use texts that give meaning to the teaching.

Thus, based on the above, this study has three specific objectives: (1) to elaborate a set of evidence-based activities (Clayton et al., 2020; Injoque-Ricle et al., 2012; Landerl et al., 2019; Mantovani et al., 2021; Murphy et al., 2016; Sunde et al., 2020; Vellutino et al., 2007) that are compatible with and can be integrated into the Peruvian curriculum and are designed to stimulate all the pre-reading skills; (2) to test this intervention, carrying out a comparative analysis of the pre-reading skills developed by the participating students versus those who receive the traditional program; (3) to find out how other variables associated with the individual (Age, Sex, ESCS, and Executive Function) might be involved in the developmental changes observed in the study.

Design and methodology

The empirical study was conducted using a quasi-experimental design, with pretest-posttest repeated measures between an experimental group (enriched program) and a non-equivalent control group (traditional Peruvian curriculum). It was not possible to perform a complete randomization of the children in the groups because the unity of the participating classes was maintained (Johnson & Christensen, 2000). The ethical values required in research with humans were respected (informed consent, protection of personal data, non-discrimination, gratuity, and the possibility of leaving the program), and the study was approved by the Human Research Ethics Committee of the University of Valencia.

Participants

The study involved 208 five-year-old children (M=65.89 months, SD=3.25 months) from three public schools in two districts of Metropolitan Lima with similar socioeconomic characteristics (San Borja and San Luis) in Local Educational Management Unit 7. There were six classrooms in the Experimental Group and four in the Control Group. The number of participants per classroom ranged from 16 to 24 students. Table 2 shows the distribution of students by classroom and school. It was not possible to mix the control and experimental groups in the schools because the latter were reluctant to participate unless a coherent program was maintained in all their classrooms. In addition, given the coordination among the teachers in the same school, it was difficult to keep them from commenting on and/or sharing materials or activities, which could have contaminated the results.

TABLE 2. Distribution of participants in groups

Group	School	Shift	N	%
Experimental	Virgen de Lourdes	Morning	23	11.1
			25	12.0
		Afternoon	24	11.5
			22	10.6
		Total	94	45.2
	Manuel Gonzales Prada	Morning	18	8.6
		Afternoon	16	7.7
		Total	34	16.3
Control	Niño Jesús de Praga	Morning	21	10.1
			23	11.1
		Afternoon	18	8.6
			18	8.6
		Total	80	38.5

Given that at least one-third of the sample was supposed to form the Control Group (CG), the Niño Jesús de Praga school was assigned to this

group, with the other two schools assigned to the Experimental Group (EG).

Variables and instruments

Demographic and socio-economic data

First, *Demographic Data* were collected to characterize the participants: *Sex*, *Age* in months, and *Socio-economic and Cultural Status* (ESCS). The test used for this purpose was an adaptation of the one used in Peru by the OECD (2017) on the PISA reports (MINEDU, 2017). This questionnaire provides three sets of data. First, the *Highest education level of parents* (HISCED) considered both parents, with the following categorization: 'low' (neither parent has secondary education), 'medium' (at least one parent has secondary education), and 'high' (at least one parent has higher education). Second, the *Highest parental occupational status* (HISEI) categorized participants into four levels based on the parent with the highest level. Finally, the *Household Possessions Index* (HOMEPOS) was composed of several variables about what the family owns, with special attention paid to certain cultural goods, such as the number of books. Most of the questions are corrected as 1 or 0, depending on whether the good is owned or not. However, on questions where there may be a high number, such as books, they were categorized into levels to reduce their influence on the final score.

Pre-reading skills

Batería de Inicio a la Lectura, BIL 3-6 (Beginning Reading Battery) (Sellés et al., 2008). This battery consists of 15 tests grouped in five factors that evaluate *Phonological Awareness* (CtF); *Alphabetic Knowledge* (CtA); *Metalinguistic Knowledge* (CtM); *Linguistic Skills* (HaL); and *Cognitive Processes* (PrC). The reliability coefficients for these tests, according to the authors, range from 0.54 to 0.97.

Executive function

Childhood Executive Functioning Inventory (CHEXI) (Thorell & Nyberg, 2008). It is composed of two factors, *Working Memory and Inhibitory Control,* which add up to a total score (*Executive Function),* with a reliability of 0.89, according to the authors.

Variables collected in the program

The first part of the study involved designing a set of tasks, based on scientific evidence, aimed at stimulating pre-reading skills. A brief summary of these tasks can be seen in Table 3: objectives, contents, and methodology. The variables targeted in the intervention were the following:

Phonological awareness, for which different tasks were developed, graded according to their developmental sequence of acquisition. Initially, they were supported by manipulative elements (Bowyer-Crane et al. 2008; Herrera & Defior, 2005):

a) *Counting words.* The difficulty was adapted to the developmental stage of the students, given that at four years of age, they still have problems segmenting sentences with definite articles and prepositions (Sellés & Martínez, 2014).

b) *Counting syllables.* At this age, in Spanish, it is easy for children to perform segmentation tasks with simple two-syllable words (CV), and they are reaching the maximum performance level for monosyllabic words with a complex syllable structure (CVC) (Cruz et al., 2005).

c) *Rhyme.* We took into account that, in Spanish, detecting rhyme is not an easy task, due to the low presence of monosyllabic words ending in a consonant (Herrera & Defior, 2005). Thus, bisyllabic and trisyllabic words were used, whose rhyme is more difficult to detect.

d) *Isolating syllables and phonemes.* We took into account that, developmentally, the isolation of the initial phoneme is easier for four- and five-year-old children (Suárez-Coalla et al., 2013).

e) *Omitting a syllable.* This skill, although it begins to develop at early ages, is not consolidated until the age of six (Sellés & Martínez, 2014), and it involves two tasks: first, identifying the final sound of the word and, second, avoiding saying it.

Alphabetic Knowledge. Its development requires instruction or contact with letters, our program addressed its stimulation through the analysis of certain segments in the texts. . The program prioritized vowels, which are acquired before consonants (Owens, 2003), as well as more frequently used consonants, corresponding to significant words in their context (Owens, 2003).

Linguistic Skills. These skills are based on the following conceptions of language development at age five: a productive vocabulary of 2200 words, including some basic concepts (left-right and some temporal concepts), and some basic grammatical skills (Owens, 2003). The teaching of new vocabulary and the analysis of basic concepts were also carried out through the analysis of literary texts (Owens, 2003).

Components and Functions of Reading. At five years old, the child has already been introduced to notions about the directionality of the text, right to left and top to bottom, the difference between reading and writing behaviors (between three and four years old), and knowing what reading consists of and what its function is (at five years old) (Ortiz and Jiménez, 2001). The tasks were adjusted to these development levels.

Basic Cognitive Processes. These activities were also developed transversally using literary texts. For example, learning poems or riddles was proposed, which required the use of *Auditory Sequential Memory,* or the use of graphics and words to stimulate the *Visual perception* of printed symbols, their directionality in the text, and letters (Kotaman, 2020).

TABLE 3. Enrichment activities and sessions dedicated to their intervention

Curricular capabilities	Beginning reading skills	Enrichment activities	Sub-skills	N. Sessions
He/she internalizes the writing system	*Phonological awareness and alphabetic knowledge*	Tasks of counting syllables and counting words. Rhyming activities: reading poems, children's songs, word games. Activities of isolating syllables and phonemes and omitting syllables. Alphabetic knowledge through the texts worked on.	Rhyme	6
			Counting words	5
			Counting syllables	7
			Isolating syllables	5
			Isolating phonemes	6
			Omitting syllables	5
			Alphabetic knowledge	6
Reflects on the form, content, and context of written texts.	*Metalinguistic knowledge*	Reflective processes on the elements of written language, learning to identify the structure and functionality of reading.	Recognize words	3
			Recognize sentences	2
			Functions of reading	9
Reorganizes information from various written texts Infers the meaning of written texts Clearly expresses his/her idea. Strategically uses a variety of expressive resources Interacts collaboratively, maintaining the thematic thread	*Linguistic knowledge*	Based on work with literary productions, increase vocabulary, extract and analyze sentences.	Vocabulary	6
			Grammatical structures	3
			Basic concepts	2
Recovers information from diverse written texts	*Cognitive processes*	Memorization of poems, riddles, stories, recipes… Identification of symbols and images.	Auditory sequential memory	7
			Visual perception	6

Procedure

Because the groups could not be randomized, the first step in the study was to check that the two groups could be considered comparable, at least on the descriptive and control variables. The aim was to verify that there were no significant differences between the groups in *Age*, the *ESCS* and its subcomponents *HISEI, HISCED and HOMEPOS*, and *Executive Function* (EF), as well as its factors: *Inhibitory Control* and *Working Memory*. It should be noted that the *ESCS* questionnaire was not filled out by some families of the children participating in the study. The intervening variables (Phonological Awareness –CtF–, Alphabetic Knowledge –CtA–, Metalinguistic Knowledge –CtM–, Linguistic Skills –HaL–, and Cognitive Processes –PrC–) were also included in this initial study carried out, using a t–test for independent samples.

Demographic and *ESCS* data were collected before the intervention. Once this information had been gathered, each participant in the study was evaluated individually. A trained psychologist who was part of the research team administered the Beginning Reading Battery (Batería de Inicio a la Lectura), BIL 3–6 (Sellés et al., 2008) to each participant. During the administration of this test, the researcher had to observe the students and fill out the protocol corresponding to the *Scale of Executive Functions* (CHEXI). All the schools had a space where the evaluation could take place in appropriate conditions.

Once the students had been evaluated, the intervention plan with enrichment activities was implemented. These tasks did not increase the time the curriculum proposes for literary activities (contact with texts to deduce reading strategies) because some activities were substituted by others. Thus, based on the competencies of the Early Childhood Education curriculum (see Table 1), teachers were instructed to substitute some of the usual exploratory activities with others that specifically worked on pre–reading skills. A total of 20 sessions were held, two sessions per week, and the teachers were responsible for carrying out the tasks. Meanwhile, during these 10 weeks, the control group continued with the contents and methodology promoted in the Peruvian curriculum. In order to compare the interventions, the teachers of the control group were asked to use the same texts as the experimental group, with the two interventions only differing on one aspect. That is, while the control group was engaged in the usual literary activity, the experimental group

performed an enrichment activity (see Ysla, 2015). The work sessions were structured as follows for both groups:

a) *Preparation and presentation of the literary production (CG and EG).* Initially, the topic of the text was presented, with the purpose of activating their previous knowledge and facilitating their comprehension. Then the text was presented, and students were encouraged to discover what type of text it was (story, poem, riddle, recipe, news). Subsequently, the class had to follow along while the teacher read aloud (6 minutes).

b) *Comprehension and analysis of the literary production (CG and EG).* After the initial reading, comprehension questions were presented at the literal, inferential, and critical levels (5 minutes).

c) *Core Activity.* At this point, the CG and EG activities diverged. While the CG maintained the *Literary Activity* as stipulated in its program, working on activities designed to deepen the processes of interpretation and reflection, the EG participated in the proposed enrichment activities (see Table 3). The work in this part of the study was in small groups and monitored and modelled by the teacher (12 minutes).

d) Finally, time was left for *Individual work* (CG and EG). Each child worked individually on a card with the activities he/she had done in the group in the previous stage (7 minutes).

Final evaluation. Once the training period had been completed by both groups, the BIL 3–6 test was administered again to all the participants.

Results

The previous study verified that there were no significant differences between the groups (see Table 4) in Age, the ESCS and its subcomponents, HISEI, HISCED, and HOMEPOS, and Executive Function and its factors: Inhibitory Control and Working Memory. The groups were also comparable in the domain of pre–reading skills (Phonological Awareness –CtF–, Alphabetic Knowledge –CtA–, Metalinguistic Knowledge –CtM–, Linguistic Skills –HaL–, and Cognitive Processes –PrC–.

TABLE 4. Initial comparison of CG and EG

	Group	N	Mean	SD	t (df)	p
Age (months)	Control	80	66.18	3.03	0.985 (206)	.326
	Experimental	128	65.72	3.38		
Working Memory	Control	80	12,31	5.38	1.345(206)	.180
	Experimental	128	11.30	5.25		
Inhibitory Control	Control	80	11.45	1.73	1.155(206)	.249
	Experimental	128	11.17	1.67		
Executive Function	Control	80	23.76	6.08	1.486(206)	.139
	Experimental	128	22.46	6.13		
HISEI	Control	54	2.61	1.09	0.092 (173)	.927
	Experimental	121	2.59	1.05		
HISCED	Control	53	2.74	0.49	1.569 (173)	.119
	Experimental	122	2.61	0.51		
HOMEPOS	Control	49	5.65	2.59	-1.647 (173)	.102
	Experimental	108	6.34	2.35		
ESCS	Control	48	-0.05	0.91	-0.605 (173)	.546
	Experimental	108	0.04	0.91		
CtF	Control	80	19.69	5.93	-1.398 (206)	.164
	Experimental	128	20.86	5.86		
CtA	Control	80	9.31	7.26	-.388 (206)	.698
	Experimental	128	9.70	6.93		
CtM	Control	80	9.15	2.62	-0.474 (206)	.636
	Experimental	128	9.33	2.74		
HaL	Control	80	18.94	4.20	-1.663(206)	.098
	Experimental	128	19.96	4.35		
PrC	Control	80	32.47	6.78	1.215 (206)	.226
	Experimental	128	31.20	7.62		

Note. HISEI (Highest parental occupational status), HISCED (Highest education level of parents), HOMEPOS (Household Possessions), ESCS (Socio-economic and Cultural Index), CtF (Phonological Awareness), CtA (Alphabetic Knowledge), CtM (Metalinguistic Knowledge), HaL (Linguistic Skills), Prc (Cognitive Processes)

After establishing the equivalence of the groups, the mastery of pre-reading activities was compared in the two groups after the intervention,

which was the second specific objective. Thus, an analysis of covariance (ANCOVA) was performed for each factor. The dependent variable was always the trained skill, and the factor was always belonging to the CG or EG. The initial score obtained on the pretest was introduced as a covariate in each study. This design was chosen because, as stated above, it was not possible to completely randomize the students into experimental and control groups. In these cases, the recommendation is to include the initial score to control the differences in the initial variance (Johnson & Christensen, 2019). Table 5 shows the descriptive values on the posttest, the result of the ANCOVA for each skill studied, and their effect sizes (Cohen's d).

TABLE 5. Posttest descriptive statistics and ANCOVA

	Group						Effect Sizes *Cohen's d*
	Control		Exper.				
	Mean	SD	Mean	SD	*F (df)*	*p*	
CtF	23.94	5.38	33.57	4.39	27.135 (1,204)	.000	1.961***
CtA	11.59	7.12	14.7	6.93	10.780 (1,204)	.001	0.442*
CtM	10.61	2.83	13.87	1.53	27.756 (1,204)	.000	1.395***
HaL	21.16	3.39	24.89	3.04	12.254 (1,204)	.001	1.158***
PrC	37.28	4.35	40.21	3.02	13.751 (1,204)	.000	0.782**

Note. CtF (Phonological Awareness), CtA (Alphabetic Knowledge), CtM (Metalinguistic Knowledge), HaL (Linguistic Skills), PrC (Cognitive Processes).
* Small effect size <=.50, ** Medium effect size >.50 y <=.80,
*** Large effect size >.80

Third, we wanted to know the effect of other possible explanatory variables on the observed change, as well as the degree of variance explained by the intervention program. Multiple regression analysis was used to achieve this final objective. Each of the pre-reading skills analyzed

was used as the dependent variable in order to determine the weight of the variance explained by the intervention program (dichotomous variable) compared to the other possible explanatory variables included in the study: *Age, Sex, ESCS, and Executive function*. These last two variables were standardized before they were introduced. Likewise, given that the groups were theoretically non-equivalent because the participants were not randomized, the initial scores were also included in the regression model, as Theobald and Freeman (2014) proposed, to avoid possible biases in the initial samples. The final summary of the model is presented for each factor, as well as the coefficients for the proposed model.

TABLE 6. Hierarchical Regression CtF (Phonological Awareness)

	B	SE B	β	t(sig.)	R	R^2_c	Δ R^2
Model 1					.686	.467	.471
Group	10.12	0.87	0.69	11.71*			
Model 2					.812	.654	.188
Group	9.01	0.71	0.61	12.744*			
Pretest	0.51	0.06	0.44	9.184*			
Model 3					.821	.668	.016
Group	9.01	0.69	0.61	12.997*			
Pretest	0.52	0.05	0.46	9.644*			
Sex	1.71	0.64	0.13	2.692*			

Note. * Significance <=.001

In relation to CtF (Table 6), the regression equation with three predictors is significant (F(3.152)=104.953, p<.000), with a *corrected R^2* of .668. Belonging to the experimental group was the greatest predictor of this equation. In addition, the initial score on the factor was also quite relevant, as would be expected. Finally, the *Sex* of the student was also significant in the model because being male was related to a higher increase in the score. Another issue to consider is that age in months was not significant, although the age differences could have been reflected in the pretest without its influence varying throughout the intervention

program. Neither *ESCS* nor *Executive Function* entered the regression model.

TABLE 7. Hierarchical regression of CtA (Alphabetical Knowledge)

	B	SE B	β	t(sig.)	R	R2c c	Δ R2
Model I					.829	.686	.688
Pretest	0.84	0.05	0.83	18.423*			
Model 2					.853	.724	.039
Pretest	0.84	0.04	0.82	19.520*			
Group	3.09	0.66	0.20	4.708*			

Note: * Significance <=.001

In the final CtA model (Table 7), the regression equation with two predictors is significant (F(2.153)=204.106, p<.000), with a *corrected R^2* of .724. In this case, the greatest predictor turned out to be the pretest score. This is logical when dealing with letter knowledge, which is a very small set whose possible increase has a clear ceiling effect. Even so, belonging to the experimental group explained a small amount of variance on the posttest. None of the other predictor variables entered the final proposed model.

In the final model with the CtM (Table 8), the regression equation with the greatest explained variance was the one with three predictors (F(3.152)=210.144, p<.000), with a *corrected R^2* of .557. Again, belonging to the experimental group was the greatest predictor in this equation. Other predictors were the score and the *Executive Functions*, given that a better score on CtM slightly, although significantly, influenced the posttest score.

TABLE 8. Hierarchical Regression of CtM (Metalinguistic Knowledge)

	B	SE B	β	t(sig.)	R	R2c	Δ R2
Model 1					.621	.382	.386
Group	3.60	0.37	0.62	9.830*			
Model 2					.728	.524	.144
Group	3.48	0.32	0.60	10.833*			
Pre-test	0.38	0.06	0.38	6.853*			
Model 3					.752	.557	.036
Group	3.50	0.31	0.61	11.307*			
Pretest	0.30	0.06	0.31	5.331*			
EF	0.54	0.15	0.20	3.557*			

Note. EF (Executive Function), * Significance <=.001

TABLE 9. Hierarchical Regression of the HaL (Linguistic Skills)

	B	SE B	β	t(sig.)	R	R^2_c	Δ R^2
Model 1					.693	.477	.480
Pretest	0.59	0.05	0.69	11.931*			
Model 2					.789	.617	.142
Pretest	0.54	0.04	0.63	12.491*			
Group	3.07	0.41	0.38	7.578*			

Note. * Significance <=.001

In the final model obtained for the HaL (Table 9), a regression equation with two predictors was obtained ($F(2.153)=125.963$, $p<.000$), with a *corrected R^2* of .617. In this case, the greatest predictor also turned out to be the pretest score. Even so, belonging to the experimental group represents a significant increase in the variance explained on the posttest. None of the other variables analyzed entered the final model.

TABLE 10. Hierarchical Regression of the PrC (Cognitive Processes)

	B	SE B	β	t(sig.)	R	R^2_c	ΔR^2
Model 1					.533	.280	.284
Pretest	0.28	0.04	0.53	7.822			
Model 2					.668	.439	.162
Pretest	0.29	0.03	0.54	9.002			
Group	3.39	0.51	0.40	6.684			

Note. * Significance <=.001

Finally, in the analysis with the PrC factor (Table 10), we found a regression equation with two predictors (F(2.153)=61.611, p<.000), with a *corrected R²* of .439. In this case, the greatest predictor was again the pretest score, followed by belonging to the experimental group. None of the other variables considered had sufficient weight to be significant in the final model. It is important to recall that a large part of the weight of these variables could already be reflected in the pretest score.

Conclusions

The first specific objective of this study was to elaborate a series of evidence-based activities that could be integrated into the Peruvian early childhood curriculum to develop pre-reading skills. The challenge was to create activities based on reading a series of texts previously established by the Ministry as part of the official program. This enrichment was necessary due to the absence of current evidence-based elements, in the original proposal, designed to stimulate the development of pre-reading skills (especially phonological awareness and alphabetic knowledge).

The design and implementation of these activities confirmed, first, that it is feasible to carry out these types of tasks in early childhood education classrooms without changing or contradicting what is established in the curriculum. This evidence provides the opportunity to use text-based activities to specifically intervene in pre-reading skills while maintaining the significance of the existing curriculum. Sometimes there is a gap between the current reading instruction and the socio-constructivist

perspective underlying the pedagogical renovation in early childhood education, progressively moving away from the text and focusing more on decoding (Sánchez & Santolaria, 2020). This study demonstrates the possibility of combining the two perspectives.

The second specific objective was to test the effectiveness of the proposal in developing pre-reading skills. The results showed that the experimental group improved significantly, compared to the control group, on all the skills targeted in the intervention. In addition, the regression analysis confirmed that the intervention explains most of the variance and is, along with the pretest score, the most relevant change factor of all the factors considered.

Thus, after performing activities related to the use of rhymes, sound games, or decomposition of sounds the phonological awareness improved more in the EG. This result is consistent with other phonological awareness intervention programs, that have been shown to be effective (Gutiérrez & Díez, 2017; Suárez, 2013). In our study, the significance of this result lies in the fact that it is possible to use text analysis to engage to identify and manipulate sounds.

The intervention in alphabetic knowledge also led to a significant improvement in the experimental group, but this skill was less sensitive to the intervention. This result could be due to the fact that, in this program, as in other previous programs (Alfonso et al., 2012), the name of the letters was not taught directly. Instead, based on the analysis of written material used in class (stories, cards, recipes), we tried to initiate the students in understanding the correspondence between the printed letter and the sound. Even so, the intervention was successful and resulted in greater learning than in the control group, without renouncing the principle of meaningfulness, which is so important in early reading.

Although the Peruvian curriculum contemplates involving children in reading situations, a more specific intervention was carried out. The results show that students in the experimental group were more aware of the nature of written language and its forms and functions. The tasks, which started with recognizing and interacting with written productions, allowed students to begin to realize that texts contain words and sentences, an issue that is not usually considered in the curricula but is fundamental in learning to read (Murphy et al., 2016). This experience reinforces the results of other intervention programs (Bedard et al., 2018; Nevo & Vaknin-Nusbaum, 2018), and it shows that it is not sufficient to

have contact with printed material because there is a need for intentional, systematic instruction oriented toward learning to read.

In addition, the Peruvian curriculum explicitly intervenes in the development of vocabulary, but in our proposal, the intervention also effectively addressed other linguistic sub-skills, such as grammatical structures and basic concepts as in other previous studies (e.g. Spencer et al., 2012). Although the curriculum was already oriented towards the development of these linguistic components, the use of these new activities reflects the need to enrich the tasks in order to enhance their development. Moreover, we should not forget that the level of oral language acquisition has a significant effect on the development of phonological awareness (Pasquarella et al., 2015).

In the case of cognitive processes, our material was designed to manipulate the written material. For example, the students had to differentiate between a letter or a number to improve their perceptual skills. Similarly, reading aloud productions such as rhymes or poems and asking them to learn them encouraged the retention of phrases, thus working on auditory sequential memory. Training these skills increased their development, as previous studies found (Romero et al. 2016). A possible explanation for the improvement in perceptual ability would be that the subtest that evaluates this skill consists of identifying graphic elements that are very similar to letters, an issue directly addressed in the activities.

This shows that these skills can be adequately taught through pedagogical actions using specific activities supported by scientific evidence, and that these tasks can be implemented by the teachers (González et al., 2013) and are most effective when working on various reading precursors (Romero et al., 2016).

Limitations and prospective

It remains to be seen whether and how improvements in these skills foster learning to read. It was difficult to propose this objective because students in Peru do not remain in the same school after finishing Early Childhood Education, and the number of participants to whom a reading test could be administered was not very representative. A new research proposal would be to find out if this method of including specific activities,

when working with literary texts, has an impact on the acquisition of the reading and on motivation to read.

This study shows that teachers can incorporate activities into their tasks that complement the curriculum. However, previous studies highlight deficient teacher preparation in the area of reading precursors (Meeks & Kemp, 2017), which suggests the need to train them to expand their knowledge about reading readiness, introducing updated content about pre-reading skills and their relationship with success in reading acquisition, without having to give up the principle of meaningfulness (Sánchez & Santolaria, 2020). In this regard, it would be especially relevant to consider when to start this training by investigating teachers' and student teachers' preconceptions about learning to read (Trigo et al., 2020).

Finally, to further facilitate success in beginning to read, a comprehensive intervention could be proposed during the entire school year, not only in literary activities (as in this experience), but also progressively and transversally addressing pre-reading skills within a meaningful context. Although this was a school-based intervention, we should not forget the importance of greater family involvement in creating a reading environment that supports classroom interventions (Gentaz et al., 2015).

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A retrospective look at the research on dyscalculia from a bibliometric approach[1]

Una mirada retrospectiva a la investigación en discalculia desde una aproximación bibliométrica

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Abstract

Dyscalculia is a learning disorder that affects the correct acquisition of arithmetic skills and significantly influences both the daily life of students and their academic success. Being a disorder with an estimated prevalence between 2.27% and 6.4%, it has received much less attention than others, such as dyslexia or attention-deficit/hyperactivity disorder (ADHD). This study, based on a methodological design of the mapping of science and from a bibliometric approach, allows for the visualization of the scientific literature on dyscalculia present in the Web of Science (WoS) and Scopus databases, dimensioning the research carried out from the moment the term dyscalculia was used for the first time to the present and analyzing the evolution of scientific literature on this subject and how it has been organized and structured. The collected publications have been analyzed with the support of the VOSviewer

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program and a bibliographic coupling analysis between countries has been carried out as well as word co-occurrence analysis and the citation of sources and publications. Results indicate that over the past few years, the scientific community has shown a growing interest in in dyscalculia, strongly localized in a small group of countries, and a predominance of contributions focused on understanding the disorder and in its diagnosis, yet there is still a great need for research that provides solid evidence for educational intervention aimed at the full inclusion of students with dyscalculia, beyond proposals for the design of support resources, especially technological ones.

Resumen

La discalculia es un trastorno del aprendizaje que afecta a la correcta adquisición de las habilidades aritméticas y que puede llegar a influir significativamente tanto en la vida cotidiana del alumnado como en su trayectoria académica. Siendo un trastorno con una prevalencia estimada entre el 2,27% y el 6,4%, ha recibido mucha menos atención que otros como, por ejemplo, la dislexia o el Trastorno por Déficit de Atención e Hiperactividad (TDAH). Este estudio, a partir de un diseño metodológico propio del mapeo de la ciencia y desde una aproximación bibliométrica, permite visualizar la producción científica sobre discalculia presente en las bases de datos Web of Science (WoS) y Scopus, abordando la investigación realizada desde que el término discalculia fue empleado por primera vez hasta nuestros días y analizando cómo ha evolucionado y cómo se organiza y estructura la literatura científica sobre esta temática. Las publicaciones recolectadas han sido analizadas con apoyo del programa VOSviewer y se han efectuado análisis de acoplamiento bibliográfico de países, de citación de fuentes y publicaciones y de co-ocurrencia de palabras. Los resultados muestran un creciente interés de la comunidad científica por la discalculia en los últimos años, fuertemente localizado en un grupo reducido de países y un predominio de las contribuciones centradas en la comprensión del trastorno y en su diagnóstico, adoleciendo aún de investigaciones que aporten sólidas evidencias para la intervención educativa orientada a la inclusión plena

del alumnado con discalculia, más allá de propuestas de diseño de recursos de apoyo, sobre todo tecnológicos.

Introduction

Learning difficulties in mathematics create a huge obstacle to becoming fully literate in mathematics learning, understood in its dual role as a language and also as a key to understanding the world around us. Mathematics is the key to understanding a huge quantity of information that we receive on a daily basis, which is largely numerical, and crucial to resolving problems. The origin of the term learning disabilities (LDs) has a long history, which, on an international level, can be divided in five time periods (Hallahan and Mercer, 2002). The first corresponds to the European Foundation Period (1800-1920), centering on neurological discoveries related to speech and literacy skills. The second, is the U.S. Foundation Period (1920-1960), when the development of tests and intervention methods was the focus. In the third period (1960-1975), LDs were first formally recognized by definition and categorized. Then, in 1962, Kirk and Bateman (1962) coined the term *learning disabilities* for the first time, referring to a retardation, disorder, or delayed development, caused by possible cerebral dysfunctions or emotional or behavioral disorders in reading, writing, language, mathematic processes, or in other scholastic subjects. The fourth period (1975-1985) refers to a relatively stable time in comparison to the previous periods and is marked by reaching consensus not only on the concept and definition of LDs but also on diagnostic methods. Lastly, in the period leading up to the present, different institutions like the National Joint Committee on Learning Disabilities (NJCLD), the American Psychiatric Association (APA), and the World Health Organization (WHO) have consolidated the definitions and classifications of LDs. In this way, the most recent definition of LDs, published in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (APA, 2013), considers them

neurological developmental disorders that impede learning capacity or the ability to learn specific foundational academic skills (for example, reading, writing, or mathematics). In the latest version of the International Classification of Diseases (IDC-11, 2020), developed by the World Health Organization (WHO) and to be implemented starting January 1st, 2022, learning disabilities fall under the category "6A03 Developmental Learning Disorder."

Focusing on the national level, Spain affirmed people with disabilities' rights to integration and education in the Law of Social Integration of the Disabled (1982) and, more concretely, in the Royal Decree (334/1985) on the organization of Special Education. While Learning Disabilities have no concrete definition, they are integrated into a wider category of Special Educative Needs (NEE) (Coronado-Hijón, 2008). According to the Law of General Organization of the Educational System (LOGSE, 1990) the adaptation of teaching/learning to the characteristics of students with or without special needs must be made available, and, furthermore, in the Organic Law of Education (LOE, 2006), and the Organic Law on Improvement of Educational Quality (LOMCE, 2013) students with learning disabilities are included within the category of those with Specific Learning Disabilities (SLDs). Nowadays, the Organic Law Project, which modifies the LOE and was published November 25th, 2020, ascertains that "school centers must have the resources necessary to attend to all disabled students in the best conditions" (p.69).

Regarding scientific publications on LDs, those which include research on dyslexia or ADHD are much more prevalent than those on dyscalculia (Kaufmann *et al*., 2013 and May and Ahmad, 2020), despite the fact that dyscalculia can be found in 2.27% to 6.4% of the scholastic population (Estévez *et al.,* 2008). Dyscalculia is a specific neurobiological learning disorder caused by abnormalities in the cerebral structures behind numeric representation and information processing (Butterworth *et al.,* 2011). It is likely to have genetic origins, as children with family members suffering from dyscalculia have been found to be at higher risk of suffering from this disorder. Dyscalculia interrupts the correct acquisition of mathematic skills and significantly interferes with academic performance and everyday activities related to mathematics or those that require the use of such. It is an "unexpected" disorder as it can be found in children who have completely normal intelligence levels and otherwise appropriate scholastic development (Sans *et al*. 2012). Furthermore,

dyscalculia presents in a heterogeneous way, yet children with dyscalculia experience difficulties with the most basic aspects of numeric processing and calculation in general. As such, these children could have a poor sense of numbers or quantities, may experience problems with identification, counting, reading, writing and/or classification of numbers and are likely to have trouble with completing arithmetic or mathematical problems (Fonseca *et al.*, 2019). Moreover, although dyscalculia can appear on its own, one forth of children affected by dyscalculia show tendencies for other disorders like ADHD, dyslexia, language disorders, anxiety, etc.

The main motivation behind this research is the fact that dyscalculia is generally unknown to society nowadays (Arroyo, 2018) and is rarely included in scientific literature in comparison to other learning challenges or disorders (Torresi, 2018 and Haberstroh and Schulte-Körne, 2019). The main objective of this paper is to visualize all the scientific activity to date regarding dyscalculia in order to identify ideas, tendencies, and inherent structures of the state of the question of this disorder, which in turn, aids in decision making related to its treatment from both a research standpoint as well as an organizational and political standpoint on what actions to take by those responsible for the field of education.

In this context, the theoretical framework for the current study is essentially based on Shneider (2009) and his theory on the evolution of the scientific discipline. His theory states that there are four stages to the evolution. The first one outlines the problem, identifying important questions to be resolved and offering the first tentative answers to those questions. In the second stage instruments, techniques, and processes used to tackle the problem are developed. The third stage is more prolific and studies showing expansion of knowledge on the problem begin to be published, and sub-disciplines as well as other lines of more specific or new research come up. Finally, in the fourth stage theories and general knowledge are consolidated. The idea of evolutionary phases lays out a clear framework for approaching and analyzing dyscalculia, thus it is the motivation behind the instruments of calculation used in this study as well. More specifically, for this research, a bibliometric analysis of the scientific production on dyscalculia over a wide period of time has been chosen, ranging from the moment the term started being used in the field of science to the present, supporting the analysis with visual elements like maps and graphs that help show the actual amount of scientific

literature on this topic together with sources, countries, key words, and the most relevant publications.

Bibliometrics is a fundamental part of scientometrics and is quantitative study of the production of documents in a certain discipline through the application of mathematic methods and statistics to the analysis of its characteristics (Spinak, 1998). There are two approaches to bibliometrics: the descriptive and the evaluative (van Leeuwen, 2004). This study uses both descriptive methods and evaluative methods in order to show, on one hand, the main quantitative characteristics of the publications (evolution and volume of literature) as well as the value of the influence of the publications and the complex relationships between them (bibliographic coupling, citation analysis and co-occurrence analysis).

The bibliometric analysis carried out for this study is based on a visualization of bibliometric networks, using the software VOSviewer (version1.6.15) as the main tool. This software was chosen because it not only allows for the construction of bibliometric networks, but also provides the graphic representation of such, which facilitates analysis and interpretation (Van Eck and Walkman, 2010). In order to carry out this type of analysis, it is necessary to have a large amount of bibliographic information, which, for this paper, was found in the WoS and Scopus bibliographic databases. These sources were chosen because they are the two largest and most important databases worldwide and contain literature on almost any discipline (Pérez-Escoda, 2017).

Methodological procedure

This research has been conducted using a methodological design based on science mapping and, in particular, the visualization of scientific production with maps using specific tools developed for that task based on the selection and retrieval of documents in specialized databases supported by their underlying metrics.

Database search processes

On November 16th, 2020 a search on scientific literature related to dyscalculia was carried out in the WoS and Scopus databases. In both,

the terminology used in the search was *d*scalculia*, with the aim of retrieving the most publications possible, including publications in both English and Spanish. There was no other combination or additional filter applied to obtain this first general look at how dyscalculia has been dealt with in scientific literature.

More specifically, this search included titles, summaries, author key words and KeyWords Plus in the publications. From this initial search, a total of 502 documents came up in the WoS database and 1220 in Scopus. After a quick overview of some popularly cited articles retrieved in this search, it was clear that many of the publications were not actually about dyscalculia. This, in part, was due to the fact that the WoS database automatically generated some terms (KeyWords Plus) based on the titles of the cited articles, which, afterwards, added key words suggested by the authors. This meant that an article could be included in the first search even if it did not mention dyscalculia because it was used as a reference in another article that did, in fact, mention dyscalculia. In response to this problem, the search was then limited to the word appearing in the title of the publication or its summary. Hence, the Scopus database search was the following: *TITLE (d*scalculia) OR ABS (d*scalculia),* while in the WoS database, after limiting the search field *"Tema"* (Title, Summary, author's key words, Plus key words), publications that fit the criteria were hand picked.

The time period established for the selection of publications was between 1970 and 2020 due to the fact that the 1970s was an important time of worldwide educational change. More specifically, for example, in 1974 dyscalculia was coined for the first time (Kosc, 1974).

Additionally, the WoS database search was limited to the Social Science Citation Index (SSCI), Conference Proceedings Citation Index-Social Sciences and Humanities (CPCI-SSH) and Book Citation Index – Social Sciences and Humanities (BKCI-SH), while Scopus did not provide this option.

Taking into account the search parameters as described above, a total of 391 documents were found in WoS and 781 in Scopus, with journal article publications at the forefront, making up 80.72% of all the literature found in WoS and 70.5% of those found in Scopus (Figure 1).

The specific inclusion criteria for each of the analyses carried out is explained in detail under their respective sections in the present study (*Results).*

FIGURE 1. Diagram showing search process
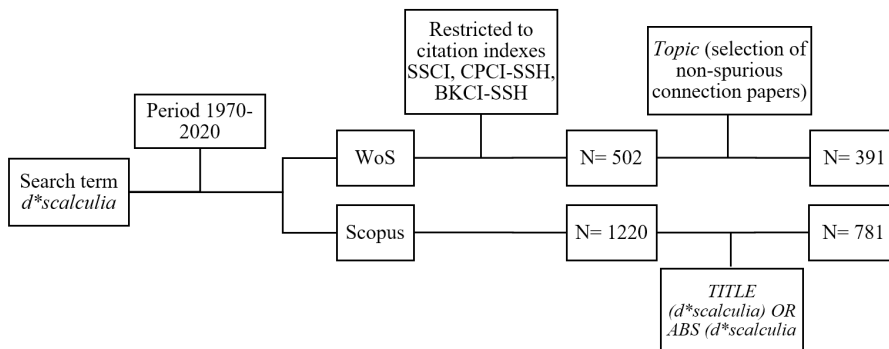
Construction of VOSviewer bibliometric maps

Once the selection of publications was obtained, all data was transferred to the VOSviewer in order to carry out the following analyses: bibliographic coupling between countries for the observation of publication distribution as a function of country of origin and, therefore, detecting state initiatives like research groups who lead the way in advances in the field of dyscalculia while highlighting some ethnographic characteristics to help explain such; source citation in order to discover where the most attention was paid to dyscalculia and an analysis of such attention in terms of reach, purpose, and links to a scientific field; co-occurrence of words in order to find which were the most meaningful topics related to dyscalculia in the publications and the motivation behind such; and, lastly, citation of publications in order to find those most relevant within the different scientific fields that deal with dyscalculia. In this vein, two types of bibliometric maps were constructed: network visualization and density visualization. Network visualization maps are made up of nodes and lines. The nodes may represent a variety of elements (journals, publications, authors, countries, or key words) while the lines show the relationships between the nodes and the strength of said relationship (Van Eck and Waltman, 2010). The color of the nodes and lines indicates the formation of a conglomerate or a cluster, that is to say, the formation of a group of related words. However, while the nodes on the density

visualization maps are similar to those on the network visualization map, their color indicates the density of the elements at that point. The higher the number of elements in the area of one point, the heavier the density, and, thus, the redder the point becomes, while, on the other hand, the less dense and lesser the value, the closer it is to a blue color. In order to construct all the bibliometric maps, the fractional count was used, as supported by Perianes-Rodriguez *et al.* (2016). These authors concluded that, for various reasons, the fractional counting approach is preferable over the complete count. Moreover, the terms included in the program were cleaned using the Thesaurus in order to exclude duplicates and those terms not related to the information being analyzed.

Results

Evolution over time and volume of literature

As a jumping off point for this analysis, a quantitative exploration was carried out to find out how many documents have been published on dyscalculia in scientific literature and its evolution over the time period 1970-2020. The search was executed mid-November of 2020, and, given the fact that numerous scientific journals publish their editions at the end of the year, some publications of interest for this study could have been left out. While the number of such publications is estimated to be low, the impact of such has yet to be to be determined.

In the analysis of the evolution of literature on dyscalculia over time, two graphs were created to represent the distribution of the documents published from 1970 to 2020 in both the WoS and Scopus databases on a timeline of the most important events in history related to dyscalculia (Figure II and III). These two elements are presented together in order to detect any possible relationships between them. The most important events chosen for the timeline are the following:

- 1962: Kirk and Bateman begin to use the term *learning disabilities* when referring to disorder, alteration or delay in development caused by a possible brain dysfunction and/or any behavioral or emotional disorder affecting reading, writing, language, arithmetic processes and other scholarly skills.

- 1969: The Learning Disabilities Act is passed in the USA and is considered to be the first law published on a global scale for the treatment of children with LDs, having a significant impact on other countries (García and González, 2001).

- 1974: The term *dyscalculia* is coined for the first time by Dr. Kosc. His research points out that dyscalculia is a structural disorder related to mathematic skills whose origin can be found in the parts of the brain responsible for mathematical abilities.

- 1987: Near the end of the 1980s, specific centers for research on LDs are established. Standing out among them is the Learning Disabilities Research Centers consortium, founded in 1989 (National Institute of Health, 2019). This group has carried out various projects related to the cause, origin, and development of LDs.

- 1990: From this year on, there is a marked increase in interest in magnetic resonance machines (MRIs) for the study of brain disorders (Singh, 2018).

- 1997: From the end of the 1990s and on, studies have been published underlining genetics as one of the possible causes of dyscalculia, as predicted by Kosc 25 years before (Shaley, 2004).

- 2000: From 2000 on, numerous studies have been created highlighting the important role information technology and communications (TICS) play in the education of students suffering from LDs (Adam and Tatnall, 2008).

FIGURE II. Distribution of documents in WoS and historical timeline of dyscalculia
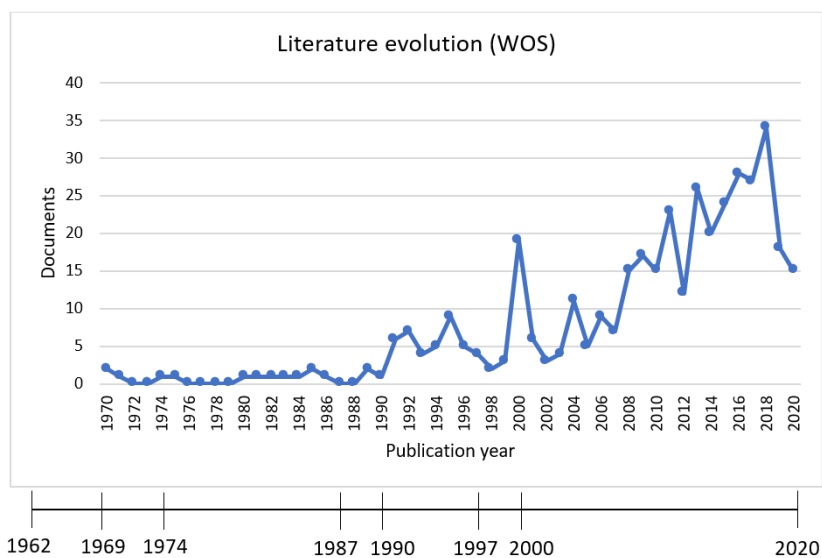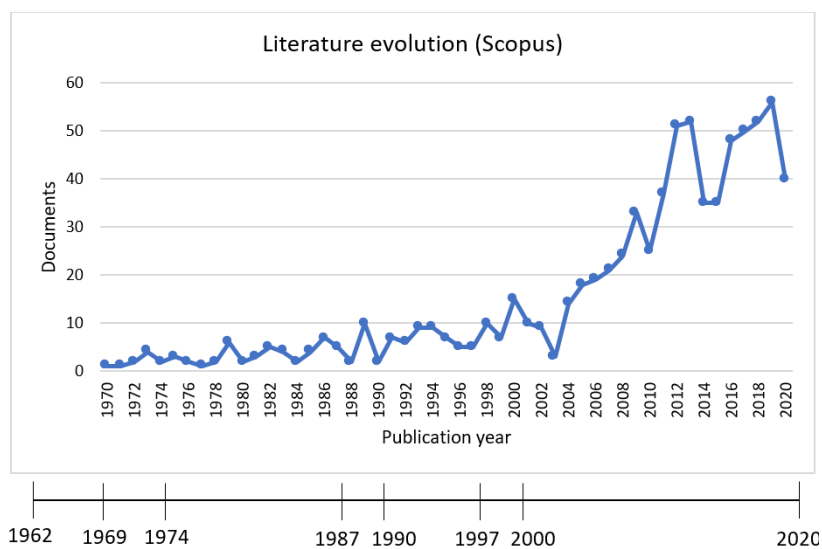

FIGURE III. Distribution of documents in Scopus and historical timeline of dyscalculia

These two graphs show a trend of exponential growth in literature on dyscalculia. This rise reflects the gradual increase in interest in and attention paid to dyscalculia over the last decade, with a large influx of documents into the WoS database in 2018 and the Scopus database in 2019. However, the increase in publications has been variable, which can be seen from the repeated rise and fall in the number of documents throughout the years. One can see how various events on the timeline coincide with periodic moments of increase in research on dyscalculia as, over the past 30 years, there have been various momentary boosts in incentive for these scientific publications. From 1990 on, for example, the number of studies from a neurological standpoint increased rapidly due to the increased interest in MRIs use in studies on brain disorders. These studies revealed how dyscalculia is affected by poor coordination between one or more parts of the brain responsible for basic calculations (Sing, 2018). At the end of the 90s, different studies on genetic predisposition to dyscalculia can be observed, highlighting hereditary risk as one of the causes behind this disorder (Shaley, 2004). Moreover, in the last 25 years different programs and digital tools have been developed for the detection, diagnosis, and intervention for dyscalculia (Drigas *et al.*, 2016), encouraged by the growing use of TICs in the education of students with LDs (Reigosa-Crespo *et al.*, 2020).

On the other hand, keeping in mind this study's objective of analyzing the volume of scientific literature on dyscalculia, different searches were carried out using the terms: "dyslexia" (*d*slexia*), "TDAH" (*ADHD*), aphasia (*a*asia*). This served to compare the volume of literature on dyscalculia to that of other LDs or disorders. This search was done in the Scopus database using the same parameters as those used with the term dyscalculia. A total of 3941 results came up for documents on dyslexia, 11214 on ADHD, and 14479 on aphasia, compared to only 781 for dyscalculia. This data can be seen in the graph on the left (Figure IV) and is accompanied by a second graph on the right, which specifically compares dyslexia to dyscalculia. As one can observe, the first graph shows how the number of scientific publications on dyscalculia is very low as compared to those of other LDs or disorders, a trend that occurs even when comparing just dyslexia to dyscalculia, despite having a different growth factor and different starting points. In fact, in the case of dyscalculia, the ascending trend of publications commented on earlier is

almost indiscernible when next to the corresponding evolution of other LDs or disorders.

FIGURE IV. Comparison of the volume of literature in Scopus
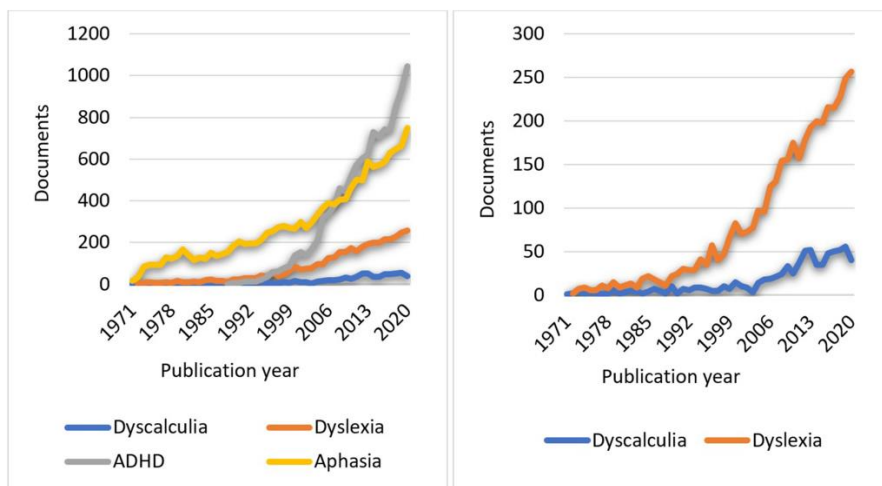
Analysis of bibliographic coupling of countries

In order to observe the distribution of publications as a function of the country of origin, a bibliographic coupling of countries was carried out. Figures V and VI show the density map visualization of the analysis. This analysis included only the countries with 10 or more associated publications, which reduced the sample to 13 countries out of the 52 found in WoS and 21 of 85 in Scopus.

FIGURE V. Density map visualization of the bibliographic country coupling analysis in WoS
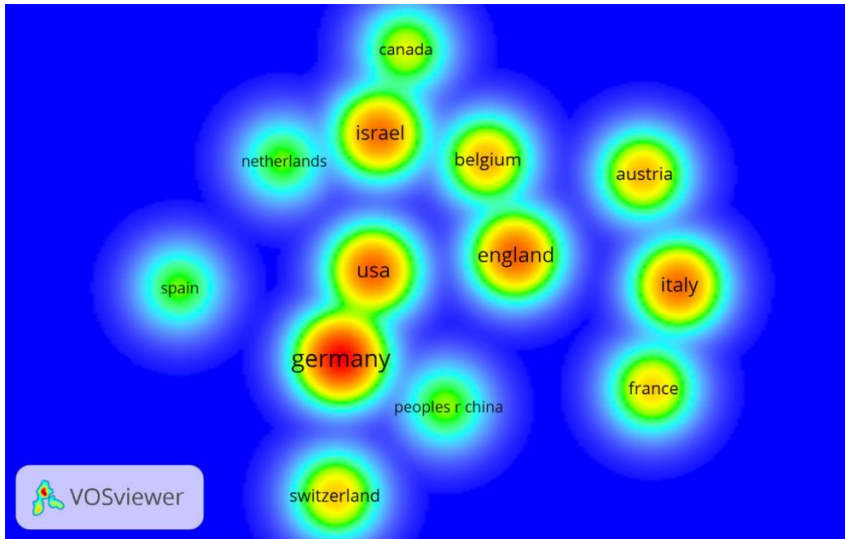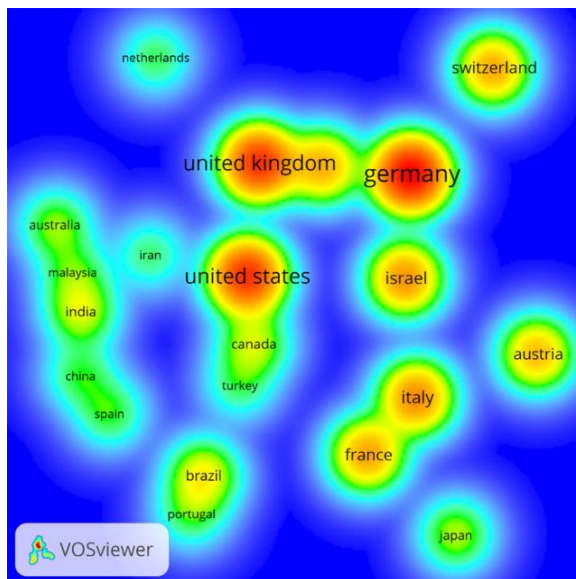

FIGURE VI. Density map visualization of the bibliographic country coupling analysis in Scopus

In both WoS and Scopus, the five countries with the most publications on dyscalculia in descending order are Germany, the United Kingdom, the United States, Italy, and Israel. The first three countries were to be expected since they are major world powers with expansive territories and large populations. These countries house important, influential institutions and centers with powerful research groups who publish their findings in English (English being the native language of two of them). Furthermore, in line with what has been previously mentioned, the first publications on dyscalculia appeared in these countries, making their studies the foundation for research thereafter. The fact that the third and fourth countries with the most publications on dyscalculia are Italy and Israel is more surprising. These countries have fairly disparate profiles compared to the first three countries and fall closer to the Spanish profile.

Source citation analysis

With the objective of getting to know the bibliographic sources that have the most publications on dyscalculia, an analysis of the source citations was also carried out. Figures VII and VIII show density visualization maps of the results of this analysis as a function of the relative weight of the documents. Sources with at least 10 publications were included. In WoS there were 6 sources retrieved out of 182 total, while in Scopus there were 9 out of 408.

FIGURE VII. Density map visualization of the source citation analysis in WoS
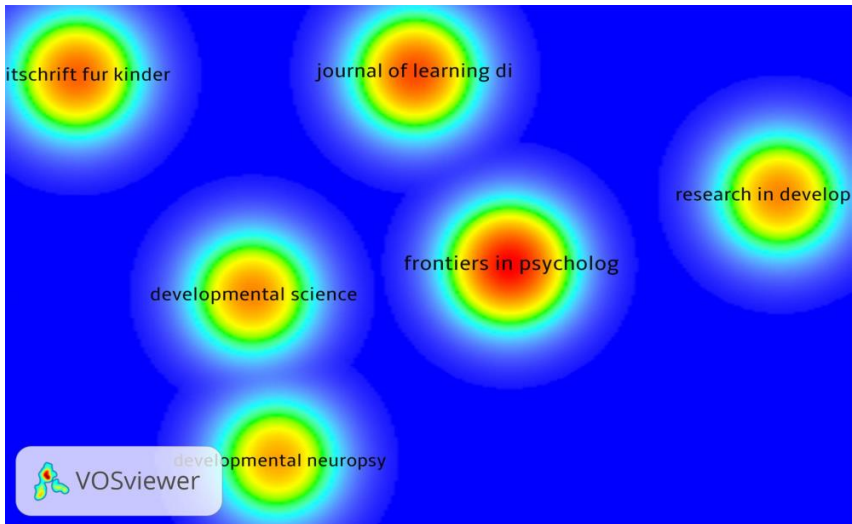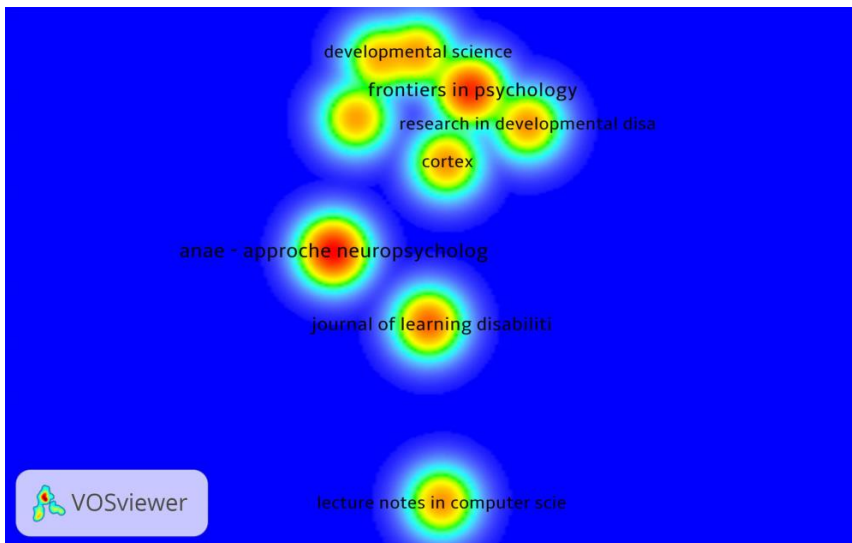

FIGURE VIII. Density map visualization of the source citation analysis in Scopus

This analysis clearly shows a link between the frequency of publications on dyscalculia and the field of Psychology (Frontiers in Psychology, Developmental Science, Developmental Neuropsychology, Cortex, Neuropsychologia…). This is partially due to the fact that, since the creation of the International Group for the Psychology of Mathematics Education in 1976, psychology has become one of the most important perspectives for the research on and interpretation/analysis of mathematics education (Coessens *et al.*, 2013). A closer look at the characteristics of the interventions into dyscalculia, as collected and analyzed by Chodura *et al.* (2015) as well as Monei and Pedro (2017), shows them to be predominantly clinical, outnumbering classroom interventions and other aspects of action-research.

Word co-occurrence analysis

Through word co-occurrence, the following analysis focused on identifying the main lines of research and the topics most frequently addressed in relation to dyscalculia in scientific literature. Figures IX and X show network visualization maps of said analysis which only included terms that appeared 10 times or more in the publications. Using this criterion, 54 terms came up in the WoS database. However, the number dropped to 47 after excluding word duplicates or words that only referred to the methodology used, the country in which the study was carried out, or technical issues regarding participants. On the other hand, 199 terms came up in Scopus, which decreased to 145 after similar data cleaning.

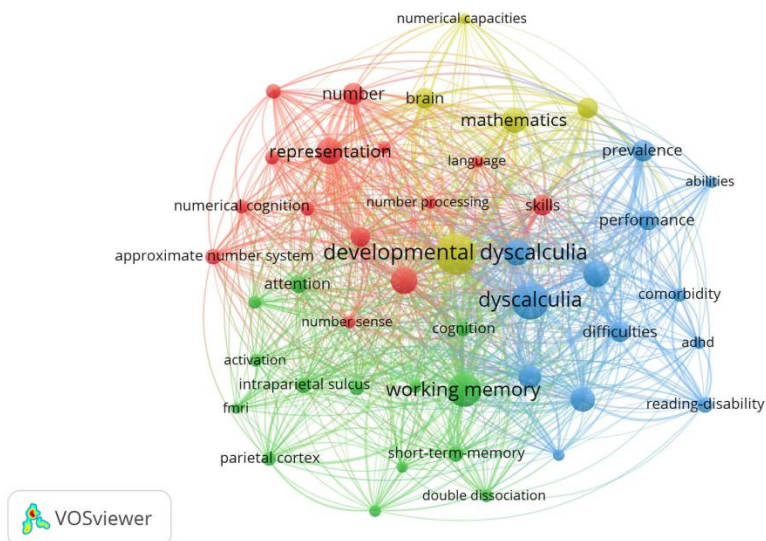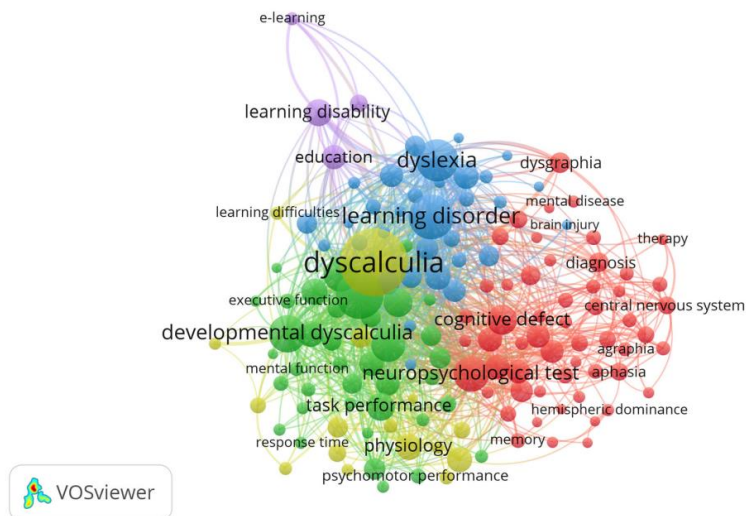**FIGURE IX.** Network map visualization of word co-occurrence analysis in WoS

FIGURE X.. Network map visualization of word co-occurrence analysis in Scopus

As one can see from the maps generated, the results of the WoS database search turn out to be grouped into the following four categories or clusters. For each cluster, the five most frequent terms are listed below in order of greatest occurrence to least.

- Cluster 1 (red): individual-differences, representation, number, skills, magnitude, approximate number system.
- Cluster 2 (green): Working memory, attention, short term memory, intraparietal sulcus, cognition.
- Cluster 3 (blue): Dyscalculia, dyslexia, disability, learning disabilities, deficits.
- Cluster 4 (yellow): Developmental dyscalculia, mathematics, achievement, brain, numerical capacities.

From these groups one can determine the following main lines of research on dyscalculia as those that focus on: identification and classification of signs and symptoms and of the disorder (Cluster 1, C1), the analysis of dyscalculia from a neurocognitive perspective (C2), the establishment of dyscalculia's comorbidity with other learning disorders as well as its prevalence (C3), and, lastly, to a lesser degree, the analysis of dyscalculia's impact on mathematics performance for those students suffering from the disorder (C4).

On the other hand, five categories, not four, were generated from the Scopus database:

- Cluster 1 (red): Neuropsychological test, magnetic resonance imaging, cognitive defect, cognition disorders, psychological aspect.
- Cluster 2 (green): Mathematics, developmental dyscalculia, arithmetic, cognition, developmental disorder.
- Cluster 3 (blue): Learning disorder, dyslexia, calculation, attention deficit disorder, comorbidity.
- Cluster 4 (yellow): Dyscalculia, physiology, pathophysiology, psychology, mathematical concepts.
- Cluster 5 (purple): Learning disability, education, teaching, e-learning.

In this case, the main lines of research correspond to the following clusters: the study of the neurological basis of dyscalculia (C1), the understanding of dyscalculia from a cognitive perspective (C2), the

comorbidity of dyscalculia with other learning disorders and its prevalence (C3), the identification of signs and symptoms of dyscalculia (C4), and, lastly but also to a lesser degree, the characteristics of the most appropriate teaching methods practiced with students suffering from the disorder (C5).

Publications citation analysis

The last analysis focused on finding the most relevant publications within the scientific field of dyscalculia through a citation analysis of publications, which could be a jumping off point for a systematic review/revision of the literature that is not discussed in-depth here. For this purpose, an analysis of those documents with at least 100 citations has been included, which has lead to the selection of 28 publications of 391 found in WoS and 50 out of 781 in Scopus. Figurers XI and XII show the network visualization maps of this analysis.

FIGURE XI. Network map visualization of publications citation analysis in WoS
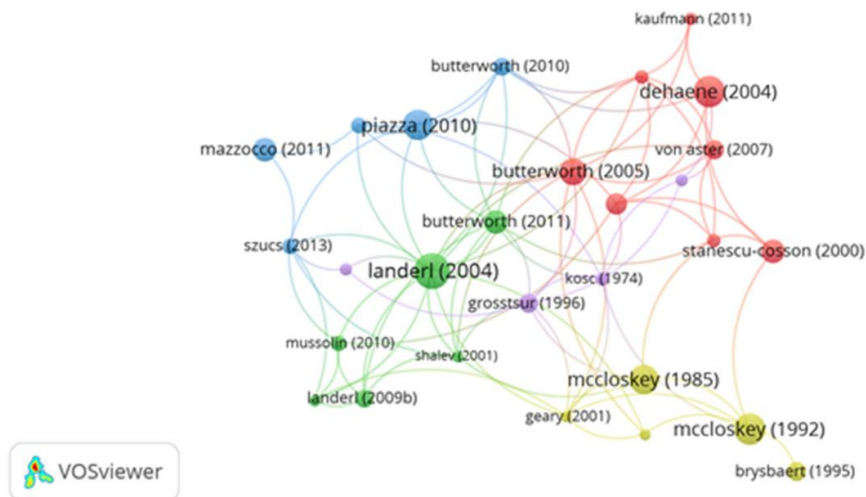
FIGURE XII. Network map visualization of publications citation analysis in Scopus
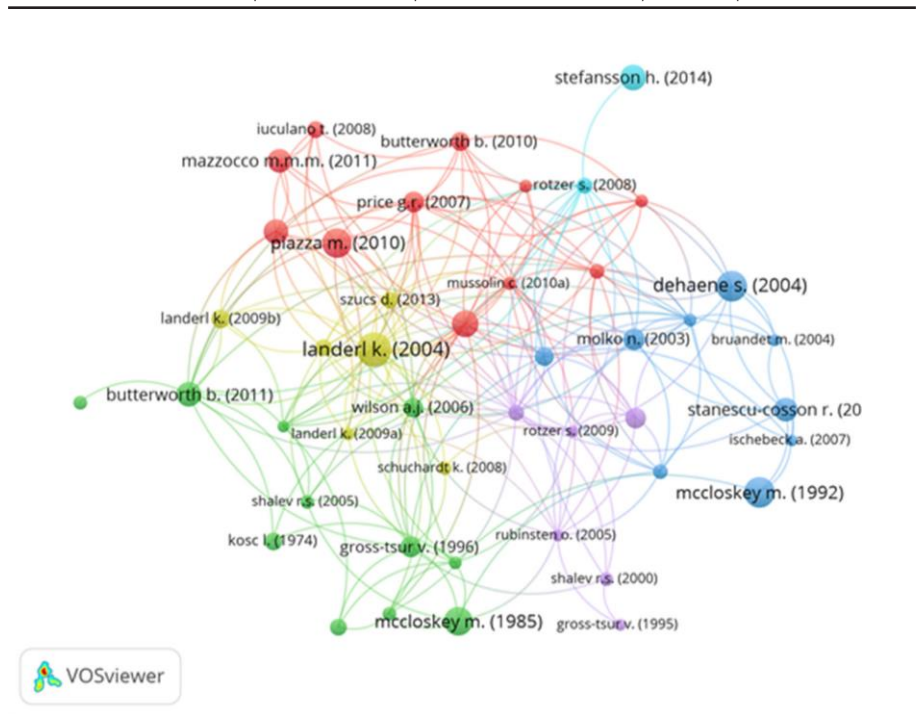
Taking into account the clusters of publications shown in these maps, different criterion for grouping can be interpreted. In some instances, the publications have been grouped together because they share an author. This is the case of the yellow Scopus cluster (Figure XII) whose publications share Karin Landerl as an author. In other clusters, the publications are connected by the perspective from which dyscalculia is studied. For example, the publications in the blue cluster share a mostly neurological approach. Nevertheless, some resulting cluster formation does not coincide with the term co-occurrence analysis. Therefore, if a first systematic review of the literature is effectuated, classification of documents by subject should be carried out deductively.

Discussion and conclusions

In etymological terms, research of this type consists of following traces of the past, like clues, for the advancement of knowledge. When this is done from a bibliometric perspective, the variables examined come from bibliographic sources, which, in and of themselves, are not enough to draw conclusions if they are not organized and presented in a way that facilitates the understanding of their evolution, the identification of patterns and trends, as well as the ability to establish connections and detect lagoons of information which could give way to a possible line of investigation towards the attainment of objectives that result in the finding answers to questions proposed in the scientific community about one particular topic. In this way, the present study, whose results have been described and examined above, helps verify with evidence hypotheses that had come up naturally from previous lectures and informal conversations with students suffering from dyscalculia, their families, teachers, as well as professionals who deal with educational orientation and provide psychopedagogical support. With this study, ideas described by Torresi (2018) and Haberstroh and Schulte-Körne (2019) on how there is a shortage of scientific literature on dyscalculia, have been confirmed, although, on the other hand, there has been a marked surge in interest in this disorder in the last decades. This study also corroborates the findings of Arroyo (2018), which indicate that dyscalculia continues to be relatively unknown on a global educational scale despite the fact that concern for mathematical literacy has constantly been on the rise, not only politically but also socially and in the area of research and investigation. It seems contradictory that more studies have not been launched on dyscalculia in countries like Spain, where the TIMSS and PISA reports show an alarming percent of students at low levels when compared to other countries with high quality math education like Finland, Estonia, and Singapore, among others.

The analysis of bibliographic coupling of countries has raised questions as to why Spain is not at the top of the list of counties that have published more frequently on dyscalculia, despite the large concern for attention to those who have SLDs. Regarding the fourth and fifth position, Israel's strong educational integration policy stands out as well as its consolidated effort to provide services for and research into the SLDs (Al-Yagon and Margalit, 2016). On the other hand, in the case of

comparing Italy and Spain, one must take into account the two most important differences between their scientific publications on dyscalculia as pointed out by Cottone (2017). The first is the fact that Italy has chosen English as the main language of communication in research on dyscalculia, whereas Spain uses Spanish, a language with less scientific diffusion in the databases used for the present study. This leads to the second difference, which is the fact that Italian researchers have published most of their articles in European or American journals, while Spanish researchers have tended to publish in Spanish or Latin-American journals. In fact, the presence of Spanish journals in the Social Science sections of WoS and Scopus is small compared to other countries despite a significant increase in the last decade (Somoza *et al.*, 2017). Thus, it is necessary for Spanish researchers to increase production in international journals so that publications achieve wider dissemination while keeping up production Spanish and Latin-American journals (Ruiz-Corbella, *et al.*, 2014). Lastly, one of the influential factors behind the absence of Spain among countries with the most publications on dyscalculia is the small amount of research found on the impact of integration and educational inclusion in the fields of Psychology and Mathematics Education. As such, the lines of research in Psychology center on Social Psychology (Agudelo *et al.*, 2003), while the lines of research in Mathematics Education focus on Mathematic curriculum design, development and evaluation, as well as teacher training and theoretical development in the discipline itself (Rico, 2000).

Upon observation, the results of the term co-occurrence analysis are relatively easy to interpret. The clusters and cluster size as well as the nodes that make up the clusters show that most lines of research in dyscalculia follow psychological and neurocognitive approaches. Furthermore, they center fundamentally on diagnosis and are not commonly oriented to treatment design, educational attention, or educational intervention. If one focuses on the analysis of source citation, there seems to be a predominant connection between dyscalculia and Psychology. Regarding this observation, it must be pointed out that dyscalculia should not be limited only to Psychological approaches given that the recognition and diagnosis of a problem is useless if one cannot propose methods to prevent and limit its negative effects. The present bibliometric analysis has helped prove the distance between basic diagnostic research and the reality in the classroom concerning dyscalculia. Consequently, it

would be important to carry out qualitative research on dyscalculia including action-research design, and research-based design and case study design, among others. All studies have the ability to contribute to the design and validation of educational intervention programs, which, in turn, encourage well-rounded inclusion of students with dyscalculia in the math classroom, helping to offer math re-educational protocol for students when necessary, especially in cases of late diagnosis. The focus should be on eliminating barriers to math learning with personalized educational design that molds to differences between individuals and promotes awareness of the heterogeneous profiles of students with dyscalculia. This is in line with Muntaner (2019) and Trillo and Trillo (2020), who affirm the need to develop an inclusive educational model in the classroom through the presence participation, and progression of children with special educational needs in the regular classroom.

The present study has limitations inherent in the methodological design as well as the tools used. Limitations fundamentally include the method of measurement, and thus, the ability to distinguish between quality and quantity upon limiting the searches in both databases and the procedure's inability to detect *literatura gris*, as pointed out by Paez (2017). In any case, despite a range of limitations or weaknesses, the authors of this study consider the analysis carried out to have reached its objective and that the results obtained do, in fact, highlight trends, evolutions, clusters and mark possible future lines of research that could contribute to the advancement of research on dyscalculia. As such, the authors recommend further, complimentary studies that can help lessen the afore mentioned limitations and those related to in-depth, systematic revision of scientific literature on dyscalculia, based on, for example, the results of the current line study of the present authors. A new revision would help identify, among other things, the current state of knowledge on this disorder and what information is needed for the future.

In conclusion, the current authors deem it necessary to stimulate and execute more studies focused on the design and evaluation of dyscalculia intervention programs that would help math (re)education programs to be more efficient in the classroom of students suffering from this disorder. Said projects must, overall, correspond to basic principles of inclusive education and, in particular, incorporate and guaranty the presence, participation, and progress of students with dyscalculia.

We hope that visualizing the current state of the situation of research on dyscalculia, as this study does, helps stimulate the development of new lines of research that will lead to the correction of what we observe to be deficiencies in the present time, as expressed before, so that no one, despite having dyscalculia, is left behind in mathematics.

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Arithmetic word problems in Primary Education. An analysis of teaching guides

Problemas aritméticos verbales en Educación Primaria. Un análisis de guías didácticas

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Abstract

Introduction: Textbook teaching guides that complement textbooks are key tools that guide teachers when implementing the curriculum in the classroom, especially in terms of assessment, one of the most relevant elements of the curriculum due to the repercussions that it entails. Methodology: this study analyzes the current scenario of arithmetic word problems in seventy-eight assessment tests of seventy-two primary mathematics' teaching guides created by six Spanish publishers. We addressed two study objectives: to find out the word problem frequency compared to other routine tasks and to characterize the problems according to semantic structure, level of challenge, and the statement's situational context. Results: our findings reveal that these tests contain a low number of arithmetic word problems compared to other types of exercises. In addition, the problems included in these tests show little variability in terms of their semantic structure, with problems mostly belonging to the subcategories of consistent arithmetic word problems (the easiest subcategories), which involve a low level of challenge and lack situational context that increases the understanding of the statements. These results coincide with those obtained by previous research, which has been carried out with curriculum materials published during previous legislative frameworks. This shows that, despite the changes in the educational laws in Spain, publishing houses have barely modified how they handle problem solving. Conclusions: the teaching guides do

not constitute adequate tools to evaluate mathematical competence of problem-solving skills in primary school students. In addition, they can contribute to developing superficial and passive resolution strategies.

Keywords: Assessment, teaching guides, mathematics, primary education, problem-solving, textbook.

Resumen

Introducción: Las guías didácticas que complementan a los libros de texto son un material clave que orienta al profesorado sobre algunos aspectos relevantes referentes a la concreción del currículum en el aula, especialmente en la evaluación, uno de los elementos curriculares más relevantes por las repercusiones que conlleva. Metodología: En el presente estudio se analiza el tratamiento de los problemas aritméticos verbales en setenta y ocho pruebas de evaluación incluidas en las guías didácticas de matemáticas publicadas por seis editoriales españolas. El análisis se dirige a conocer cuál es la frecuencia y variabilidad de los problemas frente a otras tareas rutinarias y cuál es su caracterización de acuerdo con su estructura semántica, su grado de desafío y el contexto situacional en que aparecen. Resultados: Los resultados muestran que estas pruebas contienen una proporción escasa de problemas en relación a los de ejercicios de aplicación mecánica. Asimismo, los problemas incluidos en estas pruebas se caracterizan por presentar una escasa variabilidad en su estructura semántica, por pertenecer mayoritariamente a las subcategorías de problemas aritméticos verbales consistentes (las más sencillas de resolver), por implicar un escaso grado de desafío y por carecer de un contexto situacional enriquecido. Estos resultados son, además, coincidentes con los obtenidos por investigaciones previas, que se han llevado a cabo con materiales curriculares publicados en marcos legislativos anteriores, lo que muestra que, a pesar de los cambios en las leyes orgánicas de educación, las editoriales no han modificado a penas el tratamiento que otorgan a la solución de problemas. Conclusiones: Se concluye, por tanto, que estas pruebas editadas en las guías didácticas no constituyen herramientas adecuadas para evaluar la competencia matemática en proceso de la resolución de problemas de los alumnos de Educación Primaria, y que pueden llegar a contribuir al desarrollo de estrategias de resolución superficiales y pasivas.

Palabras clave: Educación primaria, evaluación, guías didácticas, libros de texto, matemáticas, resolución de problemas.

Introduction

The role of textbooks and teaching guides in the classroom.

Textbooks are an inherent part of education as we know it. According to Area (2000), "if we had to choose a representative symbol of education, surely many would be inclined to refer to textbooks" (p.189). In fact, current research has shown that textbooks play a hegemonic role in most educational systems in developed countries (Escudero, 2015; Fuchs and Bock, 2018).

Although it is not the only resource used by teachers, nor is there a homogeneity regarding its use, data is overwhelming. According to the Spanish National Association of Book and Teaching Material Publishers (ANELE), 81.30% of teachers used textbooks as a main resource in 2014. These teachers acknowledged that they used textbooks on a daily basis. Furthermore, 71.90% of parents considered textbooks to be essential in the education of their children, both in educational centers and at home. Its influence is so decisive that for a long time, classic authors such as Apple (1992), or more recently Gimeno (2015), considered the textbook to be the real curriculum embodied in educational practice, or the authentic interpreter of the official curriculum when referring to implementing the different levels of the curriculum.

However, textbooks are not an isolated element in the educational context. The teaching guide that accompanies it is also a decisive instrument in terms of determining which curriculum is actually taught and evaluated in school. In Spain, after the enactment of the General Education Law in 1970, a new publishing modality appears that will replace the previous textbooks that only included answers: teaching guides. From that moment on, a new phase which is still in force begins. It will now be the teaching guide and not the teacher, who will be in charge of interpreting and operationalizing the requirements of the official curriculum: what, how and when to teach; and also what, how and when to evaluate. Thus, like textbooks, teaching guides can be considered windows into school reality or the current curriculum.

The relevance of problem solving in mathematics education.

The importance of problem solving (PS) in the mathematics teaching-learning process is a foundational aspect accepted by the entire community of mathematics educators (Piñero, Castro-Rodríguez, and Castro, 2019). Furthermore, the 126/2014 Royal Decree, which establishes the basic curriculum for primary education, states that: "problem-solving processes constitute one of the main axes of mathematical activity and must be the main source and support of learning throughout the educational stage, given that they constitute the cornerstone of mathematics education" (p.33). The RD organizes the content of the mathematics curriculum into five large blocks: mathematical processes, methods, and attitudes; numbers; measurements; geometry; and statistics and probability, highlighting the importance of the first block, corresponding to PS, which: "has been formulated with the intention of being the backbone of the rest of the blocks" (p.33).

In the same way, different international evaluations (IEA's TIMSS for primary education or OECD's PISA for secondary education), consider PS to be a key process for the evaluation of different cognitive levels. In this sense, according to Piñero et al. (2019), these international assessment frameworks use PS as a fundamental indicator when evaluating the mathematical competence of students and the quality of educational systems.

However, the results of these tests show that in Spain, both mathematics, in general, and PS, in particular, are the Achilles heel of a considerable number of students. International reports (TIMSS, 1995, 2011, 2015 and 2019), confirm the need for the Spanish educational system to focus attention on mathematics. In 1995, Spain participated for the first time in this evaluation, assessing levels of 7th and 8th grade students. It ranked 32nd out of 39 participating countries for 7th grade, and 31st out of 41 for 8th grade. With 4th grade students, in the 2011, 2015 and 2019 editions, Spain was below the average of the OECD and EU countries in the four mathematical content domains and in the three cognitive domains, with significant differences in the cognitive domain "reasoning", which corresponds to PS.

There is no doubt that the reasons behind these results are complex and are due to factors of various kinds. To unravel this issue, research has focused on the one hand, on the indices of the social, economic, and

cultural status of each country (ISEC, according to TIMSS-2019), and on the other hand, on the policies that regulate the different educational systems, especially in terms of teacher professional development and curriculum materials.

Regarding curriculum materials, textbooks take on a special significance. This significance has led researchers to conduct a large number of studies dedicated to analyzing textbooks from multiple perspectives (Fuchs and Bock, 2018; Vojíř and Rusek, 2019). In terms of PS, the precursor study in Spain was carried out by Orrantia, González, and Vicente (2005) with mathematics textbooks published in the normative framework of the LOGSE (1990). Based on this pioneering work, other studies have been carried out which aimed to verify the evolution of the scenario described in this initial study (Chamoso, Vicente, Manchado, and Múñez, 2014; Vicente and Manchado, 2017; Vicente, Manchado, and Verschaffel, 2018). At an international level, some of the most recent studies are those of Cai and Jiang, (2017); Tarim (2017); Van Zanten and Van den Heuvel-Panhuizen, (2018); or Yang and Sianturi (2020).

All these studies have made it possible to understand what type of problems are solved by students on a daily basis. However, to the best of our knowledge, these analyses have not been carried out with the teaching guides. Therefore, given the importance of the guides as documents in which students' assessment tests are presented in a pre-prepared way, the main contribution of this study is to analyze the relevance of arithmetic word problems (hereinafter, AWPs) in the mathematics assessment tests for primary education, published in the teaching guides of six of the most relevant textbook publishers in Spain.

To achieve this purpose, we addressed two specific objectives: a) to examine the types of items that appear in the assessment tests of the teaching guides by analyzing the difference in frequency between exercises and word problems; and b) to characterize these word problems based on three variables: their semantic structure, their degree of challenge, and the statement's situational context.

We consider that these objectives are of interest, given that it is the first study carried out in Spain that analyzes these variables in the teaching guides of mathematics textbooks. In addition, we believe that the results can help to determine if these materials pay sufficient attention to the evaluation of PS processes in primary education, and if the problems used are appropriate from a pedagogical point of view.

Method

Materials

The study sample included the mathematics teaching guides from six publishing projects: Grupo Santillana ("Know How"); Grupo Anaya ("Learning is growing"); Ediciones S.M ("Savia"); Grupo Vicens Vives ("Active Classroom"); Grupo Edebé ("Talentia"); and Grupo Edelvives ("Superpixépolis"), published between 2014-2015 when the LOMCE came into force (2013).

The analysis focused on the different assessment tests used to evaluate the mathematical learning acquired by students, both at the beginning of a school year and at the end of it, proposed by each publisher.

Taking into account that there were six selected publishers, six grades in primary education, and two assessment tests for each publisher (initial and final assessment), seventy-two assessment tests were analyzed. In addition, Santillana offers complementary "advanced" assessment tests for each grade, so six more tests were added to the total. Therefore, the final number of analyzed tests was seventy-eight.

Word problem variables

To analyze the frequency and variability of each of the items, a coding system was created according to the two following variables:
    a) Item type, distinguishing between exercises and word problems.
    b) Problem characterization according to their semantic structure, degree of challenge, and situational context.

Word problem vs. exercise

A fundamental question for the coding of this variable was the conceptual delimitation of the word problem and the exercise. To do this, we relied on definitions that emphasize the difference between the two concepts: the word problem differs from the exercise in that the solver does not previously have a procedure or algorithm, a solution scheme or

standard procedure that leads with certainty to a solution. Therefore, word problems are conceived as non-routine tasks, as a challenge or a challenging and reflective situation, where there are no ways to reach the solution automatically (Schoenfeld, 1985).

An exercise, on the contrary, is a routine, mechanical and reproductive task that leads directly to the solution through the application of previously learned knowledge. Thus, while the "word problem implies thinking", "the exercise implies mechanizing" (Alsina, 2006, p.114).

Furthermore, exercises are not contextualized, they are not associated with any specific situational context, while word problems, in addition to having a conceptual or mathematical nature, have a textual and contextual nature, given that the first step to solve any word problem is obviously by reading the problem statement. A widely accepted definition of AWPs assumes that these are verbal descriptions of problematic situations in which one or more questions are posed and the answer must be obtained through reasoning and the application of mathematical operations from the numerical data available in the statement (Verschaffel, Depaepe, and Van Dooren, 2020).

Based on these general criteria and following the coding system used in the pioneering study by Orrantia et al. (2005) with textbooks, items expressed through verbal language were considered word problems. E.g., "The playground for the little children measures 63 steps, and the one for the older children, 97 steps. How many more steps does the playground for older children have?" (Anaya), was considered a word problem. But "97 - 63 = ?" was regarded as a mathematical exercise.

However, circumstances expressed through verbal language such as "How much is needed to reach one euro? Data: a 50 cent coin, a 20 cent coin, and a 10 cent coin "(Vicens Vives), were not considered word problems, because even though it is a verbal description, it does not appear within a situational context.

Word problems are also defined as verbal descriptions at the end of which one or more questions are asked. Therefore, items without explicit questions were not coded as word problems. E.g., "Daniela left home at 8:30 in the morning. The journey to the airport took 30 minutes. Parking and check-in luggage, half an hour. When she finished, she went to the departure lounge and waited 15 minutes before the plane took off. The plane took off at (…)" (Anaya).

Finally, for word problems that asked several questions after presenting the information, each question was coded separately, given that it is the question that determines the semantic structure of the problem, resulting in as many categories as formulated questions. E.g., "The ten books used in second grade cost 235 euros and school supplies cost 97 euros. When buying the books and school supplies, Silvia paid with a €500 bill. How much do books and school supplies cost? How much money did she get back? How much does a family with 3 children pay for books?" (Vicens Vives). In this example, three independently categories are distinguished: combine 1 (first question), change 2 (second question), and multiplication (third question).

Semantic structure

The eighteen categories proposed by Heller and Greeno (1978) were used for the word problem's semantic structure codification: two subtypes of combine problems, six of change, and six of compare; as well as the six categories of matching problems proposed by Carpenter and Moser (1983).

The consistency hypothesis proposed by Lewis and Mayer (1987), which distinguishes between the language used in problems as being consistent or inconsistent, was also taken into account. Consistent problems, which are easier to solve, have a consistency or coherence between the surface structure of the problem and the algorithm needed to solve it. E.g.: "Juan has 3 marbles. In one game he **wins** 5 marbles. How many marbles does Juan have now?" (3 + 5 = 8).

However, in inconsistent problems, this "keyword" indicates the opposite algorithm, so that terms such as "win" are used when subtraction is needed to solve the problem. E.g.: "Juan has some marbles. In one game he **wins** 5 marbles. Now Juan has 8 marbles. How many marbles did he have?" (8 -5 = 3).

For the coding of complex arithmetic word problems, the categorization system proposed by Orrantia et al. (2005) is used. It includes eleven categories, although as the authors point out, the possibility of identifying new categories is contemplated. E.g., category A: "Sergio had 150 euros. On his birthday, his father gave him 35 euros and his mother 46 euros. How much money does Sergio have now?". This problem presents both

a change and a combination, with the change structure being the main one.

Problems combining various arithmetic operations were also coded. These problems (which are counted in parentheses in Table 3) were coded in the corresponding addition and subtraction category. E.g.: "Lydia made 20 collages and Caesar made half as many as Lydia. Teo made twice as many collages as Lidia. How many collages did they make together?" (Santillana).

Finally, because we were interested in understanding the entire typology of word problems used in the assessment tests, problems that required only multiplication and/or division to answer the questions were also coded, although a further categorization of these problems was not carried out.

Degree of challenge

The second variable that was analyzed was the word problem's degree of challenge. The expression "degree of challenge" refers to problems that go beyond the selection of data and the execution of the corresponding operation. For analyzing this variable we also used the categorization system from Orrantia et al. (2005), which considers the general categories of information and invention.

a) Superfluous information (extra data): irrelevant information appears that must be discarded for a correct understanding and resolution of the problem. E.g.: "Ana bought a box of 15 paints. Her friend Marta gives her another box containing 7 pens and 9 paints. How many paints does Laura have now?"

b) Missing information (minus data): data necessary to find a solution is omitted. E.g.: "Mario has gone to the park to play marbles with his friends. Mario has 17 marbles, and his friend Jorge gives him 7. How many marbles does Jorge have left?"

c) Total invention: from given elements or other structurally similar or different problems, the student is asked to formulate a totally new problem. E.g.: "Formulate a problem based on these data: children's tickets cost 8 euros and adult tickets cost 12 euros".

d) Partial invention: complete the problem with the question or with some data. E.g.: "Marta is 12 years old, her brother Juan is 9 years old, and her cousin Sara is 7 years old."

Situational context

The last of the characteristics we analyzed was the situational context of the problems. Standard word problems are those that are devoid of any kind of background information. These are very short problems in terms of the information they provide: only premises with data and questions. According to Staub and Reusser (1995), all the necessary information to solve these problem is present in the statement and all the information in the statement is necessary to answer the question. However, these problems can be enriched by including background information to help understand the problem statement. To characterize this variable, the study by Orrantia et al. (2005), which establishes a series of categories based on the Reusser (1990) model was used: description, intention, action, cause, and time. E.g., intentional information referring to the protagonist's needs, purposes, goals, aims, or motives: "Ivan wants to buy some swimming goggles...", (Santillana); causal information: "A farmer collected 450 kilos of grapes. He removed 63 kilos because they were damaged…" (Santillana). Furthermore, the possible combinations of the previous categories were coded: e.g., action + intention: "This week we collected money to help children in a country where there had been a flood..." (Anaya).

Content analysis procedure and reliability

To ensure that the item codification process was reliable, an inter-rater reliability analysis was carried out.

Regarding the distinction between word problems and exercises, the second author of the study codified all the items included in the teaching guides. Subsequently and independently, the first author encoded 100 items randomly selected from the set of items in the unit of analysis. Additionally, and in order to ensure the reliability of the process, four researchers with a PhD in Education or Educational Psychology carried out the coding of a total of 40 items also randomly selected from among the items that made up the unit of analysis.

In terms of the analysis of the problem's semantic structure, degree of challenge, and situational context, again the second author carried out the coding of all the items. In this case, the first author independently coded 120 word problems, and then five researchers with a PhD in Education or Educational Psychology coded 10 word problems according to the semantic structure and 5 word problems according to their degree of challenge and situational context.

Finally, Cohen's Kappa index was calculated with the SPSS 27 statistical package (see Table 1), to determine the degree of agreement between the different codifications. This index takes into account, not only the degree of agreement between coders, but also the degree of agreement that can be attributed to chance, thus providing a more reliable indicator than just the percentage of agreement.

TABLE 1. Value and interpretation of Cohen's Kappa index for inter-rater reliability analysis

Aspect subject to inter-rater reliability	Number of coders and items evaluated	Overall agreement %	Cohen's κ	I.C (95%)	Consistency (Landis and Koch,1977)
Exercises vs. Word problems	Two coders, 100 items	95.83%	.95	.90-99	Almost perfect
	Five coders, 40 items	95%	.90	.77-1.0	Almost perfect
Semantic structure	Two coders, 120 problems	88.33%	.83	(.76-.90)	Almost perfect
	Five coders, 10 problems.	68%	.67	(.76-.90)	Substantial
Degree of challenge	Two coders, 120 problems	95.83%	.94	(.90-.99)	Almost perfect
	Five coders, 5 problems	100%	1	-	Perfect
Situational context	Two coders, 120 problems	90.83%	.89	(.93-.95)	Almost perfect
	Five coders, 5 problems	84%	.82	(.60-.1)	Almost perfect

Source: Own elaboration

Results

Item distribution in the assessment tests

First, the results corresponding to the distribution of the analyzed items from the assessment tests are presented, distinguishing between exercises and word problems. As can be seen in Table 2, the total distribution of the items (1904) is very uneven. The assessment tests consisted mainly of routine tasks, that is, exercises (82.70%) and to a lesser extent word problems (17.30%). Table 2 also reveals that the six publishers present a similar scenario in terms of the low proportion of items dedicated to evaluating problems.

TABLE 2. Total results of item distribution in the assessment tests, distinguishing between exercises and word problems.

PUBLISHER	ITEMS	EXERCISES	WORD PROBLEMS
SANTILLANA	421	315 (74.8%)	106 (25.2%)
ANAYA	159	139 (87.4%)	20 (12.6%)
S.M.	110	88 (80%)	22 (20%)
VICENS VIVES	384	311 (81%)	73 (19%)
EDEBÉ	203	169 (83.3%)	34 (16.7%)
EDELVIVES	627	554 (88.4%)	73 (11.6%)
TOTAL	1904	1576 (82.8%)	328 (17.2%)

Source: Own elaboration

AWP characterization according to semantic structure and degree of challenge

The analysis of all 328 word problems (see Table 3) shows that there were 163 simple problems (49.70% of the total), 42 complex problems (12.80%), 115 multiplication and/or division problems (35.10%), and 8 that implied some degree of additional challenge (2.44%).

The first relevant result reveals the low variability in terms of the word problem's different semantic categories and subcategories. Most are concentrated in the simplest subcategories: combine 1 and change 2 (between them they concentrate more than 40% of the simple problems). The rest of the categories presented a practically marginal frequency. According to the consistency hypothesis, there is a tendency to overrepresent problems that are easier to solve. Thus, of the 163 simple problems presented by publishers, 143 (87.73%) were consistent problems (easier to solve), while only 20 were inconsistent problems (12.27%).

The analysis of complex AWPs offered a similar scenario, characterized by low subcategory variability. Of the eleven categories of complex word problems proposed by Orrantia et al. (2005), only six were considered, although most were concentrated in a single category: "A".

Finally, both the multiplication and/or division word problems, as well as the mixed problems, which combine addition, subtraction, multiplication, and division (in parentheses in Table 3), begin to be included by publishers in second grade assessment tests, at which time the multiplication algorithm is introduced into the official curriculum.

The scarce presence of problems that include an additional degree of challenge is also noteworthy: only 8 out of the 78 problems form the assessment tests required students to partially invent a problem (simpler task). The category of total invention is not contemplated, nor the information category: problems with superfluous or omitted information.

TABLE 3. Total results of word problem frequency and variability in the assessment tests for each grade

Problem category/grade		1°	2°	3°	4°	5°	6°	TOTAL
SIMPLE PRO-BLEMS	CA1	1	1	1	1	1	0	5
	CA2	1	8(3)	7(4)	4(8)	3(3)	2(7)	50
	CB1	8	10(1)	12(6)	3(17)	2(18)	4(4)	85
	CB2	1	0	0	2(1)	0	(5)	9
	CP1	2	(2)	4	1	0	2	11
	CP2	0	(2)	0	0	0	0	2
	CP3	1	0	0	0	0	0	1
CONSISTENCY HYPOTHESIS	CONSISTENT	11	25	30	33	27	17	143
	INCONSIS-TENT	3	2	4	4	0	7	20
TOTAL SIMPLE		14	19(8)	24(10)	11(26)	6(21)	8(16)	163 (49.70%)
COMPLEX PRO-BLEMS	A	0	0	3	9	6	8	26
	B	0	0	0	0	2	2	4
	C	0	0	0	0	1	0	1
	D	0	1	1	0	1	1	4
	E	0	1	0	2	0	1	4
	F	0	0	2	0	1	0	3
TOTAL COMPLEX		0	2	6	11	11	12	42 (12.80%)
MULTIPLICATION AND/OR DIVISION PROBLEMS		0	6	23	25	30	31	115 (35.06%)
PROBLEMS WITH ADDITIO-NAL DEGREE OF CHALLEN-GE		1	4	2	1	0	0	8 (2.44%)
TOTAL		15 (4.57%)	39 (11.89%)	65 (19.82%)	74 (22.56%)	68 (20.73%)	67 (20.43%)	328 (100%)

CA = Change; CB = Combine; CP = Compare. In parentheses, problems with addition and/or subtraction + multiplication and/or division.
Source: Own elaboration.

After the general analysis of the results, we proceeded to compare the role that the problems play in the assessment tests of the six publishers. The results (see Table 4) show that there are three publishers that include a significant number of word problems (Santillana, Edelvives, and Vicens Vives), while three publishers (Edebé, S.M., and Anaya) include a significantly lower number of word problems. However, a detailed analysis shows that how publishers use word problems in assessment

tests is similar, given that the proportion of consistent problems is in all cases greater than that of inconsistent. Furthermore, the distribution of complex problems in textbooks from all publishers is very low in terms of frequency and variability.

TABLE 4. Total results of word problem frequency and variability according to each publisher

	SANTILLANA	EDELVIVES	VICENS VIVES	EDEBÉ	S.M	ANAYA
TOTAL SIMPLE	24(32) (17.0%)	28(16) (13.4%)	13(13) (8.0%)	6(7) (4.0%)	8(4) (3.0%)	9(2) (3.0%)
CONSISTENT	52 (15.8%)	40 (12.10%)	22 (6.7%)	12 (3.6%)	11 (3.3%)	9 (2.7%)
INCONSISTENT	4 (1.2%)	4 (1.20%)	4 (1.2%)	1 (0.3%)	1 (0.3%)	2 (0.6%)
TOTAL COMPLEX	26 (8.0%)	5 (1.5%)	3 (1%)	5 (1.5%)		4 (1.2%)
MULTIPLICATION AND/OR DIVISION	24 (7.3%)	19 (5.7%)	44 (13.4%)	15 (4.5%)	9 (2.7%)	4 (1.2%)
CHALLENGE		5		1	1	1
TOTAL	106 (32.3%)	73 (22.2%)	73 (22.2%)	34 (10.3%)	22 (6.7%)	20 (6.1%)

Source: Own elaboration

AWP characterization according to situational context

Of the 328 problems, only 48 (14.6%) contained situational information of some kind (see Table 5). The analysis by grade showed that the teaching guides begin to enrich the background of the word problems from third grade on. In first and second grade, this support for mathematical and contextual understanding of word problems is non-existent, precisely at a moment when they are most necessary, given that students begin to solve problems in a formal way.

The most frequent categories were those referring to the actions of the protagonists, which in theoretical terms are the least relevant for the understanding and creation of the episodic situation model proposed by Reusser (1990). The rest of the categories appeared in a very low proportion. Given that the number of word problems is so low, and because there are hardly any differences between publishers, the data for this variable are presented as a whole, without specifying the distribution of problems by publishers.

TABLE 5. Results of word problem frequency and variability taking into account the situational context

Situational information/grade	1°	2°	3°	4°	5°	6°	TOTAL
Action	1		2	7	7	2	19
Description			3	2	2		7
Time							0
Cause						1	1
Intention			3	1	3	1	8
All							0
Action + description			2	2	3		7
Action + time							0
Action + cause			1		1		2
Action + intention		1		1	1	1	4
TOTAL	1	1	11	13	17	5	48

Source: Own elaboration.

Discussion

In order to examine to what extent the assessment tests of the teaching guides constitute effective instruments to evaluate the mathematical competence of schoolchildren, our study aimed to analyze (a) how publishers use word problems compared to exercises and (b) the characterization of these AWPs according to their semantic structure, degree of challenge, and the situational context depicted in the problems.

Results concerning the number of word problems vs. exercises are totally irregular. Most of the tests designed by the six publishers present a similar scenario, characterized by a high number of exercises compared to a very limited number of items dedicated to problem solving, which according to the international framework established by TIMSS (2019) would encourage and promote reasoning skills.

On the other hand, the analysis of the word problem's semantic structure, degree of challenge, and situational context offers a discouraging picture. In terms of semantic structure, the most relevant findings show a low variability of AWP types and subtypes, given that, of the twenty categories of simple problems, the six publishers only include a total of

six subcategories in their assessment tests. In addition, we observed a low frequency of inconsistent problems (more difficult to solve), compared to consistent ones, which can be solved by using superficial strategies. This scenario coincides both with national studies that have analyzed textbooks in Spain (Chamoso et al., 2014; Orrantia et al., 2005; Vicente et al., 2018), as well as international studies that have also studied this variable (Despina and Harikleia, 2014; Tarim, 2017). Thus, it is common to find the same word problem categories in textbooks and in the teaching guides from this study: on the one hand, combine 1, change 1 and 2, or compare 2 and 3 (of a consistent nature) AWPs; on the other hand, word problems that are categorized as combine 2 and compare 1, the inconsistent problems that are easier to solve from a structural point of view. The rest of the word problems have a minimal or even residual presence. Likewise, the presence of complex AWPs does not compensate for the lack of complexity of the simple ones, given that the results, coinciding with the study by Orrantia et al. (2005), show that the majority of complex problems are concentrated in category "A" where a consistent change structure is combined with another equally consistent combine structure. Therefore, the most numerous problems used by publishers to assess students' mathematical competence are the easiest to solve.

However, the semantic structure is not the only variable that causes word problems in the teaching guides to be the easiest to solve. The "challenging" problems, that is, those non-routine problems in which the application of an arithmetic operation does not lead to solving the problem, are practically nil. These results are similar to previous studies, which have either focused on the information variable (Orrantia et al., 2005: Wijaya et al., 2015), or on the invention variable (Cai and Jiang, 2017; Orrantia et al., 2005). As a consequence, students infer that solving a problem is doing something with all the numbers present in the statement, given that it will always contain the necessary data for answering the question. In this way, reasoning skills, as a tool to obtain additional information (problems with less data) or to select only the necessary information (problems with more data), are not promoted. In addition, teaching guides do not contemplate the invention of problems as an essential task for assessing mathematical competence.

Regarding the situational context, these assessment tests present word problems in highly standardized or stereotyped contexts (very precise premises with data and questions), with little or even no relevant

background information that could help students solve them. In fact, of the small proportion of problems enriched with background information, the most numerous categories (action and description) are precisely the least relevant to generate the episodic situation model (Reusser, 1990), and those that would be the most relevant when connected to the mathematical model of the problem are the least numerous (character's intentions, goals, and purposes) (Orrantia, Tarín, and Vicente, 2011). The results of the most recent international studies that have analyzed this variable (Brehmer, Ryve, and Van Steenbrugge, 2016; Wijaya et al., 2015) have also shown that textbooks include problems in "purely mathematical" contexts. For these authors, it is necessary to include situationally enriched contexts that arouse the interest of students and that help them integrate mathematical information with non-mathematical information, an aspect that would improve the teaching-learning process of PS.

To summarize, we consider that the PS proposals in the assessment tests contribute to the students developing superficial and passive resolution strategies, which demand little cognitive effort. This approach also favors the development of inaccurate beliefs about what it really means to solve a problem, given that this meaning depends as much on the type of tasks carried out in the classroom, as on the evaluation methods.

Limitations and future lines of research

This study has some limitations that must be taken into account. The first of these is not having offered a more exhaustive analysis of the multiplication and/or division problems, problems that, although they have been coded as such, have not been analyzed in detailed according to the subcategories presented in the study of Chamoso et al. (2014).

We should also point out that in the present study, only the teaching guides of six publishers have been analyzed. Although these publishers cover a good part of the textbook publishing industry in Spain, there are other minority proposals on the market and other PS projects that have not been considered in this study for reasons of space. Therefore, although our review is comprehensive, it cannot be considered fully exhaustive.

Finally, as a future line of research, we consider it necessary to update the AWP textbook scenario. As we have pointed out, based on the pioneering study by Orrantia et al. (2005), carried out with textbooks published during the LOGSE (1990), various studies have been developed with the purpose of updating this issue. However, these reviews have been carried out with textbooks published during the legislative framework of the LOE (2006) and LOMCE (2013). The promulgation of the new education law (LOMLOE, 2020), and its fortieth additional provision in which it is stated that the educational authorities will provide textbooks free of charge, would allow us to expand this analysis and check whether the legislative changes and, therefore, changes in school textbooks are effective when it comes to addressing the learning process of PS or, on the contrary, as research has shown so far, publishers remain oblivious to successive educational reforms, teaching and evaluating in the same way.

Conclusions

The analysis carried out allows us to conclude that the assessment tests included in the teaching guides are characterized by a reduced number of word problems, a low variability of the different categories and subcategories, a high frequency of consistent problems, a very limited proportion of challenging problems, and a standardization of problem statements.

The low quantity of word problems undermines the important role that PS should have in both teaching and assessing mathematical competence in primary education. A role which has been described as serving as the "backbone" of the rest of the mathematical contents (RD, 126/2014). Given the relevance of PS in the mathematics curriculum, this content should be reflected in its assessment. However, as we have found, PS is not a priority in the teaching guide's assessment tests of the analyzed publishers.

On the other hand, there is a relationship between the most frequent problems and the degree of difficulty. In this way, the most numerous problems are precisely the simplest to solve, that is, problems whose resolution does not require advanced conceptual knowledge or the application of sophisticated resolution strategies. In addition, the scarce variability (only seven subcategories of the twenty possible appear),

represents an obstacle to the advancement of students. As Lester (2013) points out, students will improve as problem solvers "only if they are given opportunities to solve a variety of types of tasks" (p.272).

In addition, problems that imply a certain level of challenge, or problematic situations formulated beyond what is considered a stereotyped situational context, are very limited. In this regard, no problem with superfluous or omitted information is included. All the problems presented contain what Wijaya et al., (2015) call "coincident information", that is, sufficient and necessary data for their resolution. The approach to this type of problem is key to developing the ability to solve problems, given that it helps students consider the context as a relevant element when addressing the solution. Otherwise, students end up adopting mechanical solving strategies in which only the statement data must be selected and operated with (Salado, Chowdhury & Norton, 2019). In addition, problem invention tasks are underrepresented, despite the fact that research has highlighted this type of task as essential for the development of mathematical competence (Cai, Hwang, Jiang & Silber, 2015).

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How do School Counsellors Perceive Death Education? A Qualitative Study[1]

¿Cómo perciben las orientadoras una educación que incluya la muerte? Un estudio cualitativo

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Abstract

School counsellors' perceptions of death education have not yet been studied in Death Pedagogy, although death is a phenomenon that is inherent in life itself and, in circumstances such as the current pandemic and post-pandemic, can be ubiquitous in everyday experience, both individual and collective. Thus the objective of this study was to ascertain school counsellors' perceptions of death education. The study design was qualitative and descriptive. Six counsellors working in Spanish state schools at early childhood, primary, secondary and sixth-form levels participated. A content analysis of topics and semantics was performed using the Jaccard index. Some notable views expressed by participants were: (1) death was associated with violence, prurience and dehumanization in the media, social media and some videogames, and hence the current social image of the topic was not suited to educational purposes; (2) death education was associated mainly with tutorial intervention in counselling for bereaved

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students, although its educational value in curriculum subjects, cross-curricular topics and tutorial action plans was also acknowledged; (3) death education was necessary, though problematic and controversial; (4) a shift of approach was needed, moving from health and psychological intervention towards education and pedagogy; (5) the leading role in counselling and guidance should be taken by tutors; (6) schools should design and implement not only death education but also bereavement counselling plans, adaptable to the student, as a part of the school educational project. The main conclusion was that in order to take advantage of the potential of Death Pedagogy in both organisational and didactic terms, specific training was required for school counsellors, teachers and parents.

Key words: Death Pedagogy, death education, school counsellors, curriculum, schools

Resumen

Desde la Pedagogía de la muerte no se ha estudiado la percepción de los orientadores educativos hacia una educación que incluya la muerte, aunque se trate de un fenómeno y de un tema inherente a la vida que, en circunstancias como la actual de pandemia y post pandemia, sature la cotidianeidad y las vidas individuales y colectiva. El objetivo del estudio es conocer las percepciones de los orientadores sobre una educación que incluya la muerte. El diseño es cualitativo descriptivo. Participaron seis orientadoras de centros públicos de educación infantil, primaria, secundaria obligatoria y bachillerato del contexto español. Se realizaron análisis de contenido temático y semántico, apoyado en el índice de Jaccard. Algunos resultados destacados, desde la perspectiva de las orientadoras, fueron: (1) La muerte está asociada a morbo, violencia y deshumanización, por los medios, redes sociales, películas y algunos videojuegos; los conocimientos de partida para la educación son inadecuados. (2) La educación que incluye la muerte se asocia, primariamente, al acompañamiento en el duelo desde la tutoría; reconocen su valor didáctico desde asignaturas, temas transversales y plan de acción tutorial. (3) La educación que incluye la muerte es necesaria, controvertida y difícil. (4) Se require un cambio de perspectiva epistémica: de la salud o intervención psicológica, a la educativa o pedagógica. (5) Se precisa asumir que el protagonismo orientador es de los tutores. (6) La escuela debe diseñar y desarrollar, tanto una enseñanza que incluya la muerte, como planes de acompañamiento educativo en situaciones de duelo, adaptables a los alumnos, como parte del proyecto educativo del centro. La conclusión más relevante es que el aprovechamiento del potencial orientador de la Pedagogía de la muerte, tanto organizativo como didáctico, requiere la formación específica de orientadores, profesores y padres.

Palabras clave: Pedagogía de la muerte, educación que incluye la muerte, orientadores, currículo, escuela

Introduction

Although Dewey (1902) had already recognised the importance of curricula in education, theoretical study of the topic began with Bobbit's work (1912, 1918). From the outset, efficiency-based and progressive outlooks clashed. Aside from attempts to balance these two approaches (Apple, 1993; Franklin, 1986; Kliebard, 1986; Tanner, 1991), up to now the predominant tendency has been functionalist, centred on developing skills and abilities, since this has responded better to professional, economic and social needs. The reconstructionist approach (Pinar, 2003) enriched both analysis and educational development, as it embraced a critical and democratic citizenship perspective. But none of these views identified the need for an education that addresses the issue of death.

Death is not included in curricula (Herrán, Rodríguez, & Miguel, 2019; James, 2015; Stylianou & Zembylas, 2016; Rodríguez, Herrán, & Miguel, 2020a); neither is it present in national education systems, with a few exceptions such as Denmark and Australia (Lytje, 2016), countries that have developed procedures, training and guidelines on Death Pedagogy for teaching and counselling students who have lost a loved one (Hinton & Kirk, 2015; Rodríguez, Herrán, Pérez-Bonet, & Sánchez-Huete, 2020b).

The Covid-19 pandemic has brought death to the fore on a daily basis. This constant concern also involves schools and their staff. Teachers acknowledge the need for training in how to approach death in tutorial intervention with bereaved students (Rodríguez et al., 2020b). Further, the uncertainty associated with illness and death has acquired heightened importance among children and adolescents (Götz et al., 2020).

The profession's failure to call for an educational response to death is therefore incongruous and contradictory, especially bearing in mind various indicators and observations relating to both temporary and more enduring concerns: (1) We cannot educate for life, as UNESCO (2014, 2015) suggests, without including death, since death is integral to life; (2) if it is not to be incomplete and misguiding, education should be concerned with what is most important to human beings, although this may not be explicitly demanded; (3) death is always present on both individual and group levels, for example in biological processes, accidents, terrorist attacks, wars, cruelty, suicide, loss of biodiversity, pandemics, etc.; (4) losses of loved ones affecting school students are common – in a recent study (Rodríguez et al., 2020b), 70.4% of a sample

of 683 teachers stated that their students had suffered losses of loved ones in the last 5 years; (5) the education community, including teachers (Rodríguez et al., 2020b) and families (Herrán, Rodríguez, & Serrano, 2020), is favourable towards the inclusion of death in formal schooling; (6) education including the awareness of death and the finite nature of life contributes to a more complete all-round education (in terms of attitudes, values, skills, etc.) for both individuals and societies.

Death Pedagogy studies teaching and education that includes death (Rodríguez et al., 2020a). The scientific development of Death Pedagogy can be based on nine epistemological dimensions. Corr, Corr, & Doka (2019) identify the cognitive, affective, behavioural and values dimensions, which can be combined in curriculum design, while Herrán et al. (2000) and Herrán & Cortina (2006) add five more: the curricular, the social, the complex, the conscious and the developmental. Since death is seen as a topic that is "transversal to the transversal" (i.e. it runs across even cross-curricular topics: Herrán et al., 2000), it does not necessarily mean adding further content or subjects, but rather a broader, more inclusive approach from the educator and a curriculum with more pedagogical depth. For if schools do not address a radically human topic such as the awareness of death, then the education they offer will necessarily be incomplete, in relation to their aim of equipping students to live a fuller life.

In Death Pedagogy, death education has been studied in relation to: (1) Education for citizenship and for a more complete, aware and critical life (Corr et al., 2019; Herrán & Cortina, 2006; Mantegazza, 2004; Petitfils, 2016); (2) curriculum design (Herrán et al., 2000; Herrán et al., 2019; James, 2015; Stylianou & Zembylas, 2016; Rodríguez et al., 2020a); (3) historical events such as the Holocaust (Lindquist, 2007; Tenzek & Nickels, 2017; Zembylas, 2011); (4) teaching methods and resources for addressing the issue of death (Herrán & Cortina 2006; Herrán et al., 2000); (5) teacher training (Herrán & Cortina 2006; Herrán et al., 2000; Stylianou & Zembylas, 2020); and (6) the education community's perceptions (Dyregrov, Dyregrov, & Idsoe, 2013; Herrán et al., 2020; Hinton & Kirk, 2015; Potts, 2013; Rodríguez et al., 2020b).

The last-mentioned studies found that teachers and families had favourable attitudes towards the inclusion of death in education (Herrán et al., 2020; Rodríguez et al., 2020b), with significant variables such as gender (women had more favourable attitudes) and religious beliefs (atheists were also more positive). Research into the education

community's perceptions of death education has been quantitative, with some exceptions, such as case studies like that of Potts (2013) among primary-school teachers who had counselled students in situations of bereavement.

There are very few studies involving school counsellors. While there does exist some research analysing the impact of death education on the training of counsellors in the mental health field (Doughty & Hoskins, 2011; Harrawood, Doughty, & Wilde, 2011; Servaty-Seib & Tedrick, 2014), we found no studies of their perceptions in schools. This lack of research among school counsellors is striking, given the professional importance of the role. Since the functions of school counsellors are in assessment, student development and teacher training and innovation, these specialists are potentially important as initiators of projects, programmes and actions in training and in updating methodology. More specifically, the functions of the educational counsellor can be essential in fostering the inclusion of death in school curricula and the design of procedures and guidelines for tutors dealing with student bereavement (Cortina & Herrán, 2011; Doughty & Hoskins, 2011). Both the current absence of research and the importance of the figure of the counsellor in the Pedagogy of Death argue in favour of undertaking studies that will lead to the production of knowledge and its transference to pre- and in-service counsellor training encompassing death education.

In the light of all the above, a qualitative study was devised to answer the following research question: What perceptions and attitudes do primary, secondary and sixth-form school counsellors have towards death education?

Method

Study design

The study was qualitative, with a descriptive design. This assumes that the knowledge produced comes from participants' own views, experiences and perceptions; hence we strove to apprehend participants' discourses from their own point of view. The study thus centred on describing and understanding their experiences (Marshall & Rossman, 2016) of both death education in general and in specific terms in schools.

The study was approved by the ethical committee of the coordinating body.

Participants and procedure

The population studied was that of school counsellors in Spanish state schools at early childhood, primary, secondary and sixth form levels. An intentional sampling method was used, taking the variable of "professional school counsellors" as the criterion of inclusion. The sample comprised 6 counsellors, and this was deemed appropriate in terms of the objectives and methodological design of the study (Table I). It should be noted that in the Spanish context a single counsellor works as a consultant in three or four different schools at early childhood and primary level, whereas in secondary education every school has a counsellor. All participants were women, thus conforming approximately to the overall socio-demographic status of the population studied (Navarro & Casero, 2012).

School counsellors from rural and urban schools known to the researcher team were invited to take part. Participants were chosen and contacted in accordance with information and confidentiality procedures and informed consent was obtained. The interviews were carried out in offices in the participants' schools. A relaxed, friendly atmosphere was created, and the interviews were recorded in audio format for subsequent transcription.

TABLE I. Sample socio-demographic data

Initial training	Experience as school counsellor	Type of School	Setting
Primary School Teaching and Pedagogy	25 years	Early Childhood and Primary School (ages 3-12)	Urban
Educational Psychology	18 years	Early Childhood and Primary School (ages 3-12)	Rural
Educational Psychology	17 years	Early Childhood and Primary School (ages 3-12)	Rural
Psychology	6 years	Early Childhood and Primary School (ages 3-12)	Urban
Primary School Teaching and Psychology	23 years	High School (ages 12-18)	Urban
Pedagogy	3 years	High School (ages 12-18)	Rural

Instrument

A semi-structured instrument was designed and validated by a panel of 8 experts in the Pedagogy of death. It was submitted to an inter-rater concordance, being assessed firstly individually, and then combining the experts' opinions in order to develop the definitive version.

The script of questions was divided into four sections: (1) Participant characteristics (training, years of experience, school, etc.); (2) questions on the place of death in society; (3) questions on how to educate people on the topic of death and the role of school counsellors; and (4) questions on the inclusion of death in the curriculum.

Data analysis method and rationale

The data were analysed following Miles, Huberman, & Saldaña 's (2013) procedure, namely a content analysis in three stages or steps:

- Step 1: Topic content analysis. With no prior coding, phenomenological reality was directly addressed, identifying participants' discursive positions.

- Step 2: Semantic content analysis. After an initial categorization and coding of the discourses, the data were filtered, and categories and subcategories that were codified only marginally or not at all were eliminated or included in other categories. In this way information saturation was sought. The Jaccard index (I_j) was used for similarity of coding, since it is a coefficient yielding knowledge of the strength of relationships among elements and clusters.

- Step 3: The results were interpreted and the conclusions verified.

The main categories had to do with the views, and the reasoning behind these, that the counsellors had regarding death education and the various actors affecting education: society, families, teachers, counsellors, schools and students.

The NVIVO 12 qualitative data analysis program was used.

Results

The first topic analysis of the counsellors' views determined the frequencies (n) and percentages (%) of the most important ideas defining their perspectives. Their first 20 terms with a length of five or more letters were taken as the criterion for counting the frequencies and percentages.

Length was estimated by taking into account the semantic field of death education, identified and validated in prior studies (Rodríguez et al., 2020a). The list was revised on one occasion, leaving aside "word stops" and "empty words" that did not add content to the analysis.

"Death" was the most frequent term (n = 195) and also had a high percentage weighting (26.03%). This was due to the nature of the study, as death was its central topic. In second place, "children" appeared 58 times (7.74%), also logically, since they were the final target group of the study. The n = 43 times that "education" appeared (5.74%) demonstrated the relationship between death and education in the counsellors' discourses. The term "family" occurred with the same percentage (n = 38; 5.72%), in reference to the need for school-family coordination. The noticeable

presence of "bereavement/mourning" (*duelo* in Spanish; n = 38; 5.07%) attests to how the counsellors understood death education; i.e. as centred on palliative counselling rather than on a normalizing method or on the curriculum. The term "curriculum" did not appear in their discourses.

Below the topic analysis is discussed in greater depth using the categorization and coding of the interviews and presenting the most recurrent topics in each category (society, school, family, teachers, counsellors and children). Also we discuss the most significant relationships in the semantic content analysis, as indicated by the Jaccard index (Ij), and corresponding to the strongest ideas emerging from the analysis.

Society

The counsellors saw death as a "taboo" topic in society (n = 7; P_4: "The fact that they don't take children to funerals, burials and so on, because well … Because of the supposed trauma they'll have … Well, what I think is that we're experiencing it in that way. We're experiencing it in terms of ignorance") and suggested a "lack of awareness" of death among the population (n = 7; P_6: "In general we all want to be 'happy cool' because we have this 'happy cool' society and things that are problems, we don't want them. They bother us").

Participants also thought that society gives death "negative associations" (grief, fear, etc.) (n = 4; P_5: "This feeling of 'poor little one', 'I'll hold your hand', right? With a feeling of, well, that, of pity"), and some stated that there was a generalised "indifference" around the topic (n = 3; P_4: "What parents teach their kids to do is ignore death, avoid it, not to talk about these topics, it's a taboo subject and that, to me, is worrying"). The correlation of these two first ideas ("taboo" and "lack of awareness") was Ij = .82.

The view of death as taboo seemed to be linked to the feeling that death was a "non-prioritized subject" among the population, at least externally speaking (n = 5; I_j: .5; P_5: "So, as it isn't normalized, it's that the media, the news are really fast, really traumatic. I mean, everything is just like that and then suddenly we switch to something like a festival or whatever").

This was also related both to the presence of death in "religion" (n = 2; I_j = .66; P_5: "I mean, death used to be like really isolated. I mean, it's always been prominent also because of religion") and to the explicit "morbid curiosity and violence" with which it is presented in the media (n = 2; I_j = .5; "One influence is that we have so much violence and so much death in the media, in movies, so it's kind of being trivialised. Like it looks like you shoot someone and then in the game they come back to life. So it's a false death, just a temporary passing state […] then when it really happens, that means you'll have a bit of a problem with the experience").

The alternative they foresaw, in terms of helping society to approach death in a more normal way in education, centred on creating "more general culture" among the population (n = 3: P_2: "I think that they tackle it younger, when they're small. They include the little ones in it. I think that we, [the non-Roma population], we usually… keep it apart from the kids").

Schools

Although participants thought that at present the topic of death "lacks normalisation in schools" (n = 7), most were also of the view that "death should be included in education" (n = 4), with comments such as that of participant P_4: "I don't think I've known of any school that treats death as a cross-curricular issue. If only". These ideas had a moderate correlation of I_j = .4. One interviewee stated that when schools included death it was done through a "religious" approach (n = 1: P_4: "Those of us who aren't religious or who don't bring religion to our kids, it's a bit more difficult for us").

Participants prioritized the treatment of death through an approach that was "palliative (centred on situations of loss)" (n = 5), with statements such as (P_3): "We work on mourning, because in the case of the older ones we accompany the family a bit more and by praying, maybe, a little ritual of farewell" […]; "We did a little homage in the gardens where the kids participated with a song they'd written. So, yes, they did a ritual of farewell for their classmate".

Participants associated the inclusion of death in teaching to other contents, mentioning teachers' "overload" (n = 1; P_5: "Obviously schools

have a responsibility in education, but schools aren't responsible for everything and it's necessary to take on responsibilities"). They also related it to "school-family coordination" (n = 4; I_j = .5; P_3: "Of course, then [including death in education or not] also depends a bit on the parents' ideas, right? If they're religious or not") and with "training for education professionals" so that they could deal with death appropriately (n = 1; P_3: "There I think we're just improvising really. But it's like everything: until you have your first case, because it's all, kind of, researching it, seeing what there is about the topic, looking at what you can do in class…"). These two views were linked with a correlation of I_j = .5.

Families

Interviewees thought that there was a "need for training" (n = 9) in death education for students' families. They noted that families requested guidance from them in this area (P_5: "They ask us, we advise them and if it's not our responsibility, we help them with managing it"). This idea correlated completely with families' "lack of resources" in death education (n = 6; I_j = 1). For example, P_4 stated: "To give you an idea, he avoided frustrating the kids to such an extent that on the day of his mother's funeral he took them to Warner [a theme park]".

Yet participants also linked the "lack of resources" and "need for training" to parents' "overprotection" (n = 6; I_j = .6, respectively) of their children (P_5: "More that protection it's overprotection, which in the end doesn't benefit the children's development. In this way we're not equipping them to develop the necessary skills to be autonomous and have a balanced overall development"). Thus in the counsellors' view, families' "lack of resources" was associated with their "need for training" and with "overprotection".

Lacking the necessary training, families reacted as any other educator would, on the basis of what they saw as preferable, whether this was correct or not (n = 3: P_4: "The mother, of course, was using her common sense. She was doing it right. What happened was she was worried because the mourning was going on a long time"). "Action on the basis of one's own experiences" was related to the "need for training" with a correlation of I_j = .6. Further, there were interviewees who stated that families saw the inclusion of death from a "non-religious standpoint"

(n = 1; P$_2$: "Regardless of whether you're a Catholic or not, well yes you could… Well, maybe prepare them for experiencing it in a normal way").

Most participants referred to the need for "school-family coordination" in educating children about death, in order to avoid contradictory messages that might confuse them (n = 19; P$_2$: "If there's not a consistent message from everyone, saying the same… Then, well, we confuse the kids still more. That's why you have to be in touch with the families"). This "school-family coordination" correlated with the "need for training" with a rating of I$_j$ = .7.

Teachers

Teachers' concept of death (according to the interviewees) embraced loss as part of life (n = 2; P$_6$: "I think that everyone thinks that since it's part of life you have to take it on board in some way before it happens…").

It was also apparent that the majority of participants saw the "palliative approach (response to bereavement)" in death education as paramount (n = 13; P$_4$: "When it happens, it affects people, and it affects the tutors a lot when there are situations when someone's passed away or one of a child's parents, or something, a grandparent [it's typically a grandparent], since it's the tutors who usually broach the topic with the child"). They also drew attention to the "overload" they saw teachers as having (n = 7; P$_5$: "Afterwards, the teachers, society is constantly sending them a different kind of message that says, as well as that, you must educate kids in values, in emotions, for bereavement, you must attend them… I mean, in the end everything ends up… […] on the teachers' shoulders").

The participants considered that death bore a "relationship to the subjects" through which death education could be addressed (n = 5; P$_4$: "Music, art…"; P$_6$: "One of the topics to tackle could be this because it forms part of life. But also you can deal with it in natural sciences, history, etc. It depends. Maybe you can tackle it from everywhere, because there's also a lot of literature for talking about it"). In addition to the curricular subjects, participants were of the opinion that the "tutorial action plan" was important for educating pupils about death (n = 12; I$_j$ = .8; P$_3$: "Well, then, maybe, across the curriculum, like watching a movie, right? or reading a book on the subject, right? The tutors can do that"). Interviewees remarking this "relationship with the subjects" also thought

that death education should be dealt with in the "tutorial action pla", with a strong correlation between the two views (I_j = .8).

It was also seen as "important" to include death in the teaching of some "typical cross-curricular issues" (n = 3; I_j = .75; P_1: "These are issues you have to deal with. The same as health education. You can work on death through health education, to see it as something normal, but also so that they learn to manage their emotions").

The counsellors were aware for the "need for training" on death education for teachers (n = 5; P_5: "And the teachers, in the end, we're people, we're parents […] we also soak up this social tendency to avoid this frustration and pain so that children won't suffer. So, I think so, yes, it would be really good if we had training on the subject, yes"). Despite this, one participant was relatively "indifferent" with regard to death and its educational potential (P_2: "Well, no. In that specific way, I wouldn't [deal with the subject of death]"). Regarding topics to br included in such training, interviewees referred to the contents, methods and resources of death education for its "inclusion in the subject currriculum" (n = 3; P_2: "Basically, training for teachers in methodology and content. Content and methodology, particularly, because methodology, in this case, is really important"), cross-curricular issues and "counselling for bereavement" (n = 9; I_j = .6; P_4: "The psychology of grieving. I mean, how these processes happen so that you know how the person will manage their grieving, problems that can arise in managing grieving").

Participants also stressed the need for teachers to "plan the period of mourning" (n = 6; P_5: "[They ask us] 'What do you think? I've done this.' It seems great to me, I give them a few guidelines and tell them 'If you see that this lasts a long time, tell me and we'll monitor the situation'") and the inclusion of such planning in the "school education project" (n = 5; P_2: "It's part of the programme and in this school we work on it"), the two views having a correlation of I_j = .8.

School counsellors

In this category we present the counsellors' own concepts of death and their potential role in designing and implementing death education.

The counsellors stated that their concept of death was different to that of teachers, since in their case it was related to "partial deaths" (n

= 6; P_5: "But with grieving, with separation [from parents]… It's like any other process"). Like teachers, however, in some cases they related it to the "life cycle" (n = 3; P_6: "It's just another part of life. We're all born to die [laughs]. I mean, we have to acccept it as such") and with "universal death" (n = 1; P_5: "In the same way that your pet dog dies, your cat, etc… So death is there, it's part of everything").

The counsellors seemed to have a positive attitude towards "death education" (n = 13; P_4: "I'm really sure of it. I mean a huge yes, really really big, underlined, in bold type and fluorescent letters. I mean yes, yes, yes. Particularly, think about it… To make up for inequality, because in the families they don't tackle it") and they noted, therefore, their own "need for training" (n = 12; P_1: "We deal with a lot of things, but we don't have the tools, that's what I see… A lot about depressions, medicines, we work on emotional intelligence… And then there are a lot of difficulties in putting it all into practice, because theory includes a lot of stuff, but then you have to think…").

This opinion, although almost unanimous, was not shared by all participants. One mentioned her "scepticism" due to the lack of social demand, educational development (n = 4; P_2: "Well the truth is that no one's ever considered it, neither me or any of the families… No, I'd say no…") and "lack of understanding" of the topic (n = 4; P_2: "It's just that death… I wouldn't know how, to tell you the truth… From what point of view, and how… I don't know if it would be to help them deal with death, I don't know, I don't know…"). At the same time, other interviewees saw the Pedagogy of death as "an educational innovation" (n = 2; P_4: "I think it would be really great if it was a topic for innovation, but well… I think so, gradually…").

The participants' opinion was that teachers should intervene as tutors in situations of bereavement ("palliative approach"), and they defined their own role when a student loses a loved one (n = 22; P_1: "In the Educational Psychology Department our role is to coordinate and advise, but advise in service"). Such educational action correlated completely to the "need for training" ($I_j = 1$).

Interviewees also referred to their own work "overload" (n = 6; P_6: "But that, since your day-to-day work takes up all your time and you have less and less time and you go less time to each school, and so in the end we only respond to urgent problems") and the ambiguity with which families see their role (P_3: "And me, when some parents say [because we

give a lot of guidance to parents], then they tell you, 'No, what I mean is…' And I say, 'No, no'").

In general, the counsellors showed a favourable atittude towards receiving training in the Pedagogy of death as a counselling approach, together with the rest of the education community. Thus P$_2$ stated: "This is happening. We want information, support, advice, what we have to do and what we can do… But not so that it's just a hotchpotch." This was particularly the case, in line with with their view of death education outlined above, with regard to "counselling for bereavement" (n = 15; P$_6$: "A bit of all the stages you pass through, like any emotion, like any grieving… the stages you pass through… Because we all study that in our degree… What grieving is, right? And also looking at the bibliography").

To a lesser extent they called for training on the "inclusion of death in the curriculum subjects and cross-curricular issues" (n = 6; P$_6$: "And lastly a bit of teaching materials and resources that can be… That can be used at different ages and times").

Children

The school counsellors were of the opinion that children "were not interested" in death (n = 5), unless they had had "close experiences" (n = 11) (P$_5$: "Well, interest in the subject, no. When there's an event, yes. When there's an event"). They stated that in early childhood education (ages 3 to 6) death was treated in an educationally normal way (n = 5; P$_5$: "I think that in early childhood, more naturally. It's what they come up with most spontaneously, 'My pet, my little doggy'. I mean, in early childhood we work much more on emotions and the kids have this spontaneity").

They noted that blocking feelings in relation to death appeared among children at primary school age. Due to their cognitive development they began to associate death with fear and uncertainty (n = 6; P$_3$: "The topic of death yes, from the age I told you of around 6… I think that it's a bit because they're afraid. I mean, that the idea of 'Are you going to die? And what will happen?' frightens them"). Also they were of the opinion that those children who were able to integrate death into their education relatively naturally could be "educational models for others" (n = 7; P$_5$: "Well, you think about it, or any project we work on together… Obviously, fine, but then… and then the kids are ahead of us").

Table II shows the strength of the associations among participants' perceptions of death education according to the Jaccard index (Ij). It should be read as follows: those who referred to "code A" also systematically referred to "code B".

TABLE II. Correlations between codes

Category	Code A	Code B	I$_j$
Society	Taboo	Lack of awareness	.82
	Taboo	Not a priority issue	.5
	Taboo	Religion	.66
		Violence and prurience	.5
Schools	Not normalized	Yes, it is important	.4
	Yes, it is important	School-family coordination	.5
	School-family coordination	Training for education professionals	.5
Family	Lack of knowledge	Need for training	l
	Lack of knowledge	Overprotection	.6
	Overprotection	Need for training for families	.6
	Educational potential	Need for training for families	.6
	School-family coordination	Need for training for families	.7
Teachers	Relationship with subject areas	Tutorial action	.8
	Yes, it is important	Classical cross-curricular issues	.75
	Need for training	Support and guidance for bereavement	.6
	Planning the period of mourning	School education project, tutorial action plan	.8
Counsellors	Palliative (centred on bereavement)	Need for training	l

As we can see from the Table II, the counsellors related the condition of death being a social "taboo" to the lack of applied awareness (Ij = .82), its lack of social importance (Ij = .5), its links with religion (Ij = .66) and violent or morbid images in the mass media, social media, films and some video games (Ij = .5).

Regarding schools, the counsellors linked the importance of death education to the need for educational coordination between families and schools (Ij = .5). They saw this coordination as needing to be based, essentially, on training for educational professionals (Ij = .5) and families (Ij = .7).

Training for families on their role in educating their children around death was associated with overprotection (Ij = .7), the lack of related knowledge and skills (Ij = 1) and the educational potential of death (Ij = .6).

Regarding how teachers could approach death education, interviewees indicated its inclusion in the curriculum subjects and tutorial action (I_j = .8), and through classical cross-curricular issues (Ij = .75).

Teacher training was called for in order to help students in situations of loss (I_j = .6). Also there was a unanimous call for such training for school counsellors (I_j = 1).

Participants were also of the opinion that death education should be included in school planning documents such as the education project, the tutorial action plan and the planning of the mourning period (I_j = .8).

Discussion

The qualitative approach enabled us to observe participants' attitudes, openings, blockages, difficulties and experiences around death education in schools. The following discussion of the results is divided into three topics: (1) Society, death and children. (2) The objectives and scope of the Pedagogy of death; and (3) the practice of death education in schools.

With regard to (1) death in society, the school counsellors observed that death is a socially-conditioned taboo topic that affects their students. This perception is shared by the whole education community, from teachers (Rodríguez et al., 2020b) to families (Herrán et al., 2020). The taboo status of death perhaps has to do with the way that society treats it. A trivialising, dehumanized image of death prevails, promoted by the mass media, social media (Selfridge & Mitchell, 2020) and certain videogames (Maté, 2018); and all of this has an impact on children's and adolescents' perceptions. It would seem that the discourse around death and its normalization encounters more difficulty outside the religious sphere, as some participants stated. Thus they asserted that children

were not interested in death, unless they had had "related experiences". In Herrán et al. (2000) and in Herrán & Cortina (2006), however, it was found that children aged 3 to 6 incorporate death in their speech and play in a natural way, and that primary and secondary school pupils are undoubtedly interested in it, in a different way, going beyond solely bereavement.

On the object and scope of the Pedagogy of death (2), the discourses of the counsellors associated death education particularly with tutors' responses to loss among their students (Corr et al., 2019; Herrán et al., 2000). It was assumed that schools should plan procedures and educational counselling and support actions for cases of bereavement, and that these should be flexible and adaptable to the needs of children and adolescents (Akerman & Statham, 2014; Herrán & Cortina, 2011). Further, the value of teaching death in curricular subjects, cross-curricular issues and tutorial action plans was recognised. Other educational possibilities, for example through plans for attention to diversity or methodologies such as 'significant moments', 'partial deaths' (Dennis, 2009; Herrán et al., 2000) and 'teachable moments' (Eyzaguirre, 2006; Corr et al., 2019) did not appear in participants' views. Participants were unanimous in recognising the scope and potential of the Pedagogy of death, both didactic and organizational. There was agreement that training was necessary for all members of the education community (the counsellors themselves, teachers and families). This concurrence coincides with that found in other studies (Dyregrov et al., 2013; Herrán et al., 2020; Hinton & Kirk, 2015; Potts, 2013; Rodríguez et al., 2020b). When interviewees were asked about the contents of such training they stressed its applied character: procedures, resources and methodologies. Without denying the importance of the practical side, however, Herrán & Cortina (2006) argue that the Pedagogy of death requires appropriate awareness-based theoretical self-training, since it is a deep, radical topic.

With regard to the practice of death education in schools (3), the counsellors observed that death is not integrated in education in schools due to its status as a social taboo. This perception also coincides with prior studies (Herrán et al., 2000; Herrán et al., 2020; Potts, 2013; Rodríguez et al., 2020b). They saw this as complex, controversial and challenging (Simon, 2011; Zembylas, 2014). The concept of "difficult knowledge" (Garret, 2017), applied to education, is thus relevant to their situation. Another type of difficulty stemmed from the belief that the

inclusion of death in the curriculum would lead to educational overload. The normalisation of death, however, does not involve more subject knowledge but greater depth and more universal content. For example, Herrán et al. (2019) demonstrated that it was pedagogically incongruent to include the Holocaust in the secondary school curriculum and not genocide, since the former is only one of many in history.

Another issue of great pedagogical interest has to do with two of the counsellors' own possible difficulties. The first was in defining educational guidance from a pedagogical perspective rather than from that of psychology or health. The second was due to their awareness that their role was secondary to that of the tutors (Herrán & Cortina, 2006; Herrán et al., 2000), both in the educational approach (prior to the event of loss) and in the palliative. School counsellors would thus take on a supporting role, except in the case of difficult bereavements (Kroen, 1996), in which they could intervene or refer the case for more specialised treatment.

Conclusions and limitations

In the light of the results and the above discussion, the following conclusions were drawn. (1) The view of the school counsellors taking part in the study was that the issue of death was currently characterised by a "lack of normalization in schools". They saw it as a taboo topic in society and education, trivialized and associated with tragedy, violence and morbidity. Hence an attitude frequently found among participants was to help students to deal with death. (2) Compared with the scope of current theory on the topic, participants' notions of death education were limited, mainly centred on bereavement and helping students cope with death. These perceptions situate death still further from education. (3) The psychologization and lack of a clearly defined role of educational psychology make it difficult to discern clearly and pedagogically the organisational and didactic implications of death education, both for the normalising approach and the palliative. (4) Pedagogical training on death education is necessary for counsellors, teachers and families. (5) Comparison of our results and prior research enable us to enhance our understanding of the deficiencies and potentials of death education in education for living with more awareness. (6) The inclusion in education

and the curriculum of a radical topic such as death allows us to glimpse a path towards a possible evolution of both the curriculum and education as a whole (Herrán & Cortina, 2006).

Lastly, certain limitations of this study should be acknowledged. A wider sample, more representative of the different regions of Spain, would have allowed the comparison of counsellors at different levels of education and in different contexts. Further studies with a larger sample and taking a phenomenological perspective will be able to explore in greater depth the issues touched on in this study, which we see as preliminary, due to the lack of research in the topic. Also, the role of psychological guidance on death education could have been assessed from the perspective of other actors in the education community. These limitations point to future research possibilities in a fruitful discipline, i.e., the Pedagogy of Death, in the hope of contributing to a more complete education of human beings, to the science of pedagogy, and within in, the field educational counselling.

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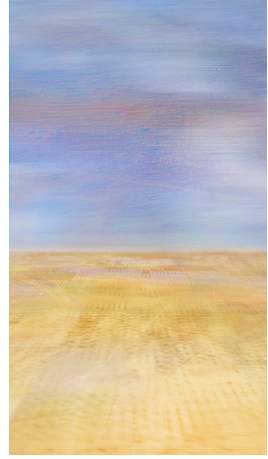
Reviews

Reviews

Farrell, T. & Jacobs, G. (Eds.) (2020). *Essentials for Successful English Language Teaching (Second Edition).* **London: Bloomsbury Publishing. 192 pages. ISBN: 978-1350093393**

Essentials for Successful English Language Teaching (Second Edition) provides readers with a well-rounded insight into the significance of the eight essentials in second language education. The authors characterize how these eight techniques can be implemented within the Communicative Language Teaching (CLT) Approach. The book consists of eleven chapters that can be divided into three parts. The first part is the introduction. The second part runs from Chapter Two to Chapter Nine, introducing the eight essentials in detail. The third part includes Chapter Ten and Chapter Eleven, which shows how teachers can implement the eight essentials using technology and cooperation. Moreover, final reflections on the use of the eight essentials are provided in this part.

Chapter One introduces the paradigm shift from traditional teaching methods to the CLT method. Since the implementation of the CLT is not ideal as expected, the following sections in this chapter center on how readers should really understand and implement CLT as a real paradigm shift. First, ideas concerning CLT as well as the development of it are proposed. Then the eight essentials for implementing CLT are briefly introduced and the eight essentials are related to one another. Thus, they should be treated as a whole for the successful implementation of CLT.

Chapter Two introduces the first essential: encourage learner autonomy. Learners' autonomy is a learner-centered approach to second language learning. Learners are empowered to choose some of the teaching materials and techniques during class. Meanwhile, they should also be responsible for their own learning and the learning of those with whom they interact. To implement learner autonomy, three means of enhancing learner autonomy are listed: group activities, extensive reading program, self-assessment. Group activities activate second language learners' autonomy and provide learning resources for them.

An efficient way to group learners is setting up groups heterogeneously in accordance with learners' proficiency. The application of extensive reading program is another way to help learners develop their autonomy. Students are encouraged to choose their own reading materials by their interests and proficiency level as well as develop a life-long reading habit. Self-assessment promotes learner autonomy since learners develop their own internal criteria for their class performance, which enables them to take great control of their own education. One point worth noticing is that learner autonomy is not equal to teacher indulgence. Teachers should be more flexible and become true facilitators of learning. Namely, they should be prepared to cope with difficulties during the class.

Chapter Three describes the second essential: emphasize the social nature of learning. The social nature of learning means learners should learn from each other rather than trying to learn by themselves, which means that second language learning should be contextualized and cooperative. In order to interact successfully during class activities or outside of class, both teachers and learners need to promote their cooperative learning skills. To achieve this goal, cooperative learning activities should be conducted in second language classes, among which two kinds of cooperative learning activities are listed: group work and project work. In group work, teachers and students working together have access to various ideas and different grouping techniques can also be adopted to fit particular learning situations. Project work offers teachers and students a wider opportunity to cooperate actively with group members as it helps to break down physical barriers which often separate them from cooperative learning. Focusing on social nature of learning, teachers act as observer and participant during class. Moreover, students should be given space to try to learn on their own and their roles vary depending on the situation such as facilitator, time keeper, reporter, etc.

Chapter Four articulates the third essential: develop curricular integration. Curricular integration means various subjects are taught jointly so that learners are able to understand the links between subject areas. By appreciating these links, learners gain a whole view of the subject matter and a deeper purpose for learning. There are many forms of implementing curricular integration including content based instruction, project work, developing language competence, and using Language for Specific Purposes, etc, among which the use of a variety of

multidisciplinary resources can enrich the given lesson. These resources are commonly used to teach concepts, enhance students' engagement and motivation, promote critical thinking through experiences, or represent learning in multiple forms. Teachers may act as participant or facilitator and help orchestrate the integration of resources to provide optimal opportunities for learning. Students should actively participate in the activities such as making choices about the content of study, monitoring one's own thinking and learning from multi-disciplinary perspectives.

Chapter Five introduces the fourth essential: focus on meaning. Learning is not a passive process of obtaining knowledge from teachers. Rather, learners should actively construct meaning through searching for the links between the prior experience and new experience. This is a shift from the behaviorist to socio-cognitive framework. Within the socio-cognitive framework, some of the classroom applications focusing on meaning are outlined, such as Task-Basd Language Teaching(TBLT), building meaningful vocabulary, inquiry, etc. When second language students are bewildered or uninterested in the teaching materials, teachers should construct a scaffolding to support learners. On one hand, teachers should choose appropriate textbooks to help students construct knowledge. On the other hand, a diverse range of materials beyond the textbook should be searched as the complements to the textbook. Learners should be actively engaged in activities to construct meaning by connecting new information with prior knowledge and cooperating with peers and teachers.

Chapter Six introduces the fifth essential: celebrate diversity. Diversity means that teachers recognize and celebrate learners' uniqueness and it is discussed from the following perspectives: teacher awareness, learning styles, communication styles, multiple intelligences, and cross-cultural communication. Teacher awareness means that teachers should have a clear awareness of their own reality so that they are prepared to accommodate the needs, learning preferences and styles of students. Every student has their own learning style so it poses constant challenges to teachers when they need to cater for these learning styles. Teachers can use a variety of teaching methods and grouping patterns to solve the problems. Learners' communication styles are also influenced by their background so sometimes learners' ways of talking are not in line with the communication patterns in class. Teachers should attempt to appreciate the differences and try to learn more about students' cultures.

Multiple intelligences mean learners' distinctive capabilities and interests working together during class. Teachers' instructions must be varied to match with the intelligences that are appropriate for students to develop and students in turn will also appreciate working with people in varied intelligences groups, which is thought to celebrate diversity. In cross-cultural communication, teachers face challenges because students share different cultural background. To be proficient in communication, teachers should be aware of prejudice and try to avoid prejudging in teaching. To accommodate diversity in class, teachers should spot the differences and bias as well as build cultural respect. Moreover, they should spare more time for students to consider and bloom the classroom activities. To sum up, second language teachers must gauge students' learning styles and try to accommodate diversity in class.

Chapter Seven describes the sixth essential: expand thinking skills. Learning is not a sole process of collecting lower-order facts to be remembered and then coping with exams. Rather, learning should aim to develop higher-order thinking skills, i.e., cultivating critical and creative thinking. Learners should be instructed to think about their thinking, reflect on and elevate their thoughts and beliefs. Moreover, learners should be encouraged to ask questions and behave creatively as they are producers of novelties instead of passive receivers. To expand thinking skills, teachers should be aware that language should be taught contextualized and through meaningful content, which can be fused into techniques such as question-and-answer pairs, critical writing, the SUMMER model, etc. Expanding thinking skills maintains that learners become critical thinkers and construct knowledge that goes beyond the classroom.

Chapter Eight introduces the seventh essential: utilize alternative assessment methods. The alternative assessment instruments have been applied to complement traditional assessment methods such as multiple choice, true-false, and fill-in-the-blank items which focus on lower-order thinking. Compared with traditional assessment instruments, alternative assessment instruments work on processes through which learners attain higher order thinking. These instruments are not the sole measurement while they also provide facilitative resources for learners and monitor students' competence through the learning process. Time-consuming and difficult as they are when in implementation, they are gaining prominence due to their superiority. To utilize these instruments

successfully, teachers must keep in mind that learning is a process and they should encourage students to involve themselves in it. Furthermore, teachers should develop various assessments such as portfolios, peer assessment, self-reports, etc. They are encouraged to be engaged in the assessments and discuss the learning process with students.

Chapter Nine introduces the eighth essential: promote English language teachers as co-learners. Second language teachers should establish the notion of life-long learning. They learn from students and their colleagues as well as depend more on themselves, their colleagues and students during their professional development. Just as students are given more opportunities to manage their own learning, it is the same for teachers. They as co-learners take more control of their own teaching and develop their own professional growth paths. They are encouraged to innovate through critical thinking and their own research, that is, they should also integrate the other seven essentials mentioned in the previous chapters and put them into practice in curriculum design and implementation so that they can learn how to attain the teaching objectives maximally. To embody this essential in classroom, some implications have aroused interest such as reflective practice, peer coaching, action research and other forms of classroom investigation. These classroom implications visualize teachers' role as co-learners as they may act as searchers for knowledge, researchers, models of effective learners, etc. Students should also collaborate with teachers and transform their traditional cognition towards teachers' roles in class.

Chapter Ten discusses how to facilitate the implementation of the eight essentials with the help of technology and cooperation. The advances in technology make it accessible for students and teachers to join online communities where they can create and share resources as well as catalyzes the implementation of the eight essentials within CLT. However, the negative impacts of technology should also be cautioned. Meanwhile, it poses challenges for teachers to keep up with technologies outside of class. Furthermore, the uneven distribution of technology in schools should be noticed. Cooperation is another activator for the implementation of the eight essentials. Teachers cooperating with their peers gain better understanding of the principles behind effective groups and employ reflective practice through which they receive feedback and direct their future teaching.

Chapter Eleven draws this book to a conclusion. First, the eight essentials are reviewed and integrated. In order to successfully implement these eight essentials within CLT, the authors state that second language teachers and learners should take a whole view of them since they are connected and dependent on each other. Second, having taken a big picture of the eight essentials, teachers are encouraged to reflect on their work. They introspect whether the eight essentials are fused into the classroom and how they can implement the eight essentials as a synergistic whole within CLT.

Evaluation

As the title suggests, this book mainly introduces how the eight essentials contribute to successful English language teaching. The authors have achieved their intentions through the well-structured layout in the book. Concerning the introduction of the eight essentials, they first create a real-life context in class to introduce the topic at the beginning of each chapter, which orients the readers' attention towards the essentials. Then the interpretations of the essentials are introduced to make readers take an in-depth knowledge of them. After interpreting the essentials, the book comes to the central part. Classroom implications including the activities and the learning environment congruent with the essentials are introduced. This part gives examples of how the essentials can be implemented in the classroom. The following section shows the teachers' role and learners' role to make the essentials better implemented. Finally, questions are proposed to make teachers reflect on themselves. The layout of each chapter enables teachers to take a whole view of the essentials. i.e., what are they, why should they be fused into class and how can they be successfully implemented in class?

This book is written in the hope that readers will carefully consider the eight essentials and form their own ideas and paths, especially EFL or ESL teachers. They will find the book valuable as they will maintain a sense of fulfillment through collaboration with their colleagues and students as well as reflect on themselves once the eight essentials are implemented as a whole in class. This book is also applicable to other second language teachers as the eight essentials are essential in language learning classrooms.

The eight essentials are quite fit well with the principles within the CLT. Neither of the essentials is exclusive to the CLT principles. As Richards &

Rodgers (2008) advocate, the principles of CLT view language learning from the communicative view and can be the scaffolding of a variety of classroom procedures. The implementation of the eight interconnected essentials is the reflection of the CLT principles, indicating learners' independence and contribution through active collaboration with their peers, active construct of knowledge through curriculum integration and inclusiveness for diversity, as well as fluent communication through various forms of assessment and teachers' participation.

When it comes to the deficiency of the book, it will be more perfect if modules of lesson plan are included. As theories and essentials are introduced in the book, it is necessary to put them into practice. Spratt et al. (2011) hold, "a lesson plan is a set of notes that helps us to think through what we are going to teach and how we are going to teach it" (p.133). It reflects what teachers want learners to do and how they enable learners to do it. The lesson plan should reveal how the eight essentials are penetrated through the teaching procedures and how they serve the teaching objectives. The lesson plan activates the eight essentials within CLT, and thus makes them more vivid as readers will explicitly perceive how the eight essentials run through the whole lessons successfully, which strengthens readers' understanding of the eight essentials and apply them in second language teaching.

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