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Nature deficit and technology overuse in childhood. A correlational study by gender of its influence on sustainable identity construction in childhood

Déficit de naturaleza y sobreuso de tecnología en la infancia. Un estudio correlacional por género sobre la influencia en la construcción identitaria sostenible de la infancia

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Abstract

This article addresses important aspects of the fragmented bidirectionality between children and nature that currently exists in childhood. The combination of factors to consider as a result of constant socio-environmental crises makes addressing two important points relevant: where children prefer spending their free time and the differences they perceive according to whether the options are more or less artificial/natural; and, on similar lines, whether these decisions and preferences shape other key pieces of their identity, such as their sense of freedom, autonomy, and responsibility. The main aim is to identify their preferences and, based on their perceptions, analyse whether there are differences by gender in how they approach free time: whether they use technology or not, whether they prioritise the street and natural spaces, and whether effects are observed in their identity construction. An anonymous, self-administered quantitative survey using a structured questionnaire was performed. The target population comprised students enrolled in years 5 and 6 of primary school, with a sample of 2586 respondents at a national level. The statistical analysis involved calculating descriptive measures such as means, standard deviations, medians, and interquartile ranges (IR). The Mann-Whitney Utest was also applied and Spearman's correlation coefficient was

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calculated. The results, based on a series of correlational analyses, suggest that there are significant differences by gender in preference for use and spaces, as well as differences in the effects of these preferences on their identity. The possibility of new pedagogical demands and responsibilities for social justice in environmental matters emerging remains open.

Keywords: nature deficit, technology surplus, childhood, identity, autonomy, freedom, responsibility.

Resumen

Este artículo aborda aspectos importantes sobre la bidireccionalidad fragmentada que existe hoy por hoy en la infancia entre el/la niño/a y la naturaleza. Así, la convergencia de factores que considerar como consecuencia de las constantes crisis socioambientales hizo pertinente abordar dos puntos importantes, que son: dónde prefieren pasar los niños y las niñas su tiempo libre y qué diferencias perciben según si las opciones son más o menos artificiales/naturales; y, en esta misma línea, si esas decisiones y preferencias moldean otras piezas clave de su identidad, como el sentimiento de libertad, la autonomía y la responsabilidad. El objetivo fundamental es comprobar sus preferencias y analizar, a partir de sus percepciones, si existen diferencias de género a la hora de afrontar su tiempo libre: si emplean o no tecnología, si priorizan la calle y el espacio natural, y si se observan efectos en su construcción identitaria. La técnica utilizada fue la encuesta cuantitativa anónima y autoadministrada a partir de un cuestionario estructurado. La población objetivo comprendía estudiantes inscritos en los cursos 5.º y 6.º de primaria, con una muestra de 2586 cuestionarios a nivel estatal. El análisis estadístico comprendió el cálculo de medidas descriptivas como medias, desviaciones estándar, medianas y rangos intercuartílicos (RI). Además, se aplicó la prueba U de Mann-Whitney y se llevó a cabo el cálculo del coeficiente de correlación de Spearman. Los resultados, a partir de una serie de análisis correlacionales, apuntan a que existen diferencias significativas por género en cuanto a preferencias de uso y espacios, así como diferencias en la repercusión de esas preferencias en su identidad. Queda entreabierta la posible efervescencia de nuevas exigencias y responsabilidades pedagógicas de justicia social en materia ambiental.

Palabras clave: déficit de naturaleza, superávit de tecnología, infancia, identidad, autonomía, libertad, responsabilidad.

1. Introduction

Human development processes have, for some time, been happening in combination with processes of growth and consumption of resources in a way that no other species has done (Tafalla, 2022). People have accepted that we are rightfully entitled to do this, establishing these processes as legitimate and, more strikingly, desirable. The idea of indefinite growth hovers over the development of humankind and, in contrast, over the increasingly limited world (Stratford, 2019). The environmental, climate, and even civilisational crises that these factors entail hampers sustainable human development. The way we observe the world and the mechanisms through which we coexist and relate to one another has been established under an anthropocentric perspective that leads to a need for a change of perspective (Paulsen et al., 2022). The deterioration of how we live alongside one another requires us to set aside the anthropocentric logic and the anthropocene era and face the social and ecological crisis into which we have drifted from different angles (Martínez, 2023).

One of the angles from which we can observe, understand, interpret, and take action is education. There is no viable option that does not go hand in hand with the educational as a necessary step (Díaz-Romanillos, 2024). There is no other possible plan. It is crucial to understand that education and the educational cannot be understood or develop in isolation from the living world, but instead must start to be understood from the vital junctures and structures where their path is found. We must continue aspiring to envisage and make an education that goes beyond our material ways of coexisting and offers answers to the eco-social crisis surrounding us, which we must see as both a social challenge and a need, as pertinence and as an educational opportunity (Misiaszek, 2023). As such, we understand the educational to be a situated action from a dialectic triangle between I, you, and the other. The situation, the social space–time in which the educational occurs, forms part of this triangulation that we see as a *tri-a-logue*, a three-way critical dialogue in Derrida's words. And it is in the other, in the *alterum*, where the natural space-time and nature fully enter, in other words, visions, events, belongings, content, environments, landscapes, scenes, gestures, smells, mechanisms, textures, paths, places, etc.

In this sense, education for sustainable development has provided mechanisms, valid ways of thinking and doing education to trace the path on which to construct sustainable childhood development. Environmental and social degradation are interrelated at present, not just through matters such as poverty or economic inequalities, but also in phenomena such as nature deficit and technology surplus (Díaz-Romanillos, 2024). This is an environmental education understood from the paradigm of sustainability in the anthropocene era, in some cases resulting in so-called *pedagogies of stewardship* (Taylor, 2017), which bring together not only environmental interests but also ones relating to the well-being of humans. A model that is directed towards education to favour a sustainable future encouraging social schema that in turn pursue human well-being, understood not just in strictly human terms but also complemented by ethical interests that go beyond the human (Cortina, 2007).

This educational reading of lived reality places us in a phenomenon that does not at first seem to be very important but that, when studied in depth, turns out to be of great importance: nature deficit in childhood. A phenomenon that was named by Louv (2005) and in relation to which studies emphasise different aspects: on the one hand, it results from urban living conditions, from excess hyperconnectivity to screens, affecting aspects of children's development that include their ecological identity; on the other hand, its educational benefits and its importance for early childhood education are stressed and are associated with a multitude of physical, sensory, behavioural, and emotional benefits (Jarvis et al., 2022; Gutiérrez-Pérez et al., 2024). Children are starting to display limited levels of connection with the natural environment, even though science has traditionally shown the importance of everyday links to this setting (Todd, 2024) and its importance for human identity (Humphreys & Blenkinsop, 2018).

We do not seek to demonise technology in itself (García et al., 2021). We are aware that, even in childhood, albeit not excessively early, technology and the people who use it at an educational level display educational benefits (Pattier, 2021; Marcelo et al., 2022). What we wish to emphasise is a phenomenon that does exist and that is starting to have consequences in childhood development: the excess of screens to which children are exposed (L'Ecuyer et al., in-press). In some cases, it can even reach the level of addiction (Villar, 2023). Nonetheless, in this study we only discuss technology as a space that children now overuse, resulting in a social phenomenon we could call *technology surplus*, a social phenomenon that might correlate with nature deficit, a phenomenon or reality that this study centres. Speaking of technology surplus or overuse is nothing more than observing a phenomenon that has been demonstrated. On the basis of this realisation, it is worth studying its possible correlation with another phenomenon that was coined some years ago, namely nature deficit, without vilifying the use of technology per se at a social and cultural level.

This is one of the fundamental challenges we face from an educational perspective. Without contact and links with the natural world, we will find it hard to create a culture of sustainability (Squillacioti et al., 2022). To educate in the face of the climate emergency and environmental deterioration, we must first work towards a reconnection with the natural, and to do so we will need data that show us the current state of the aforementioned phenomenon.

In this work we attempt to find answers to a number of questions that inspire concern at a pedagogical level, on the one hand establishing whether children prefer spending their free time in natural spaces or surrounded by technology, without one option or the other inherently being more optimal for childhood development, and on the other hand analysing whether there are differences between children in how they perceive time in these different spaces, emphasising elements of children's identity that can be more affected, specifically the sense of freedom, autonomy, and responsibility.

2. Presenting the question, or *touching grass*

The visceral movement that children display towards nature during early childhood and adolescence warns that we overlook symbiotic irritations between us, human beings, and the natural or more-than-human world. Although it is assumed that our society communicates to and teaches children that we all form part of an integrated and holistic world-system made up of other living and non-living systems, children still exclude humans from their representations of nature (Wilson, 2019). These fragmentations are undoubtedly worth understanding from the subjective imbalance of the symptomatological and are worth addressing as though they were an intimate, individual, and personal problem. Abandonment of the *I* towards a system of life that is not dichotomising but rather ecologising. A series of anomalies that, as Louv (2005) would say, indicate a nature deficit.

Faced with a global dimension of this type, the pedagogical disorder that we said we would tackle is the existence of a certain tendency to avoid the natural in these early ages. That is to say, children prematurely understand how to cast off an identity with the Earth in order to choose other more modern alternatives. For this reason, we must continue to ask whether more artificial alternatives are more intelligent, such as technological ones (García et al., 2021; Martín & Muñoz, 2023). To provide more concrete examples, we will focus on the systematic review by Gutiérrez-Pérez *et al*. (2024), while part of the results will be based on other evidence that we know. Our confidence is because the aforementioned systematic review, which is based on the SALSA framework (search, appraisal, synthesis, and analysis), shares with the present monographic work an inspiration in the NATEC-ID and NATUR-TEC Kids LivingLab projects.

So, as noted above, nature positively influences emotional and social development in early childhood. And when this happens it also means that children's conventional expectations of themselves, where they live, and the time they spend in it can be said to be disrupted. The work of Chiumento *et al*. (2018), for example, shows that using social therapeutic horticulture (STH) when working with this age group gives satisfactory results regarding improved perception of nature. And contributions such as the one by Adams and Beauchamp (2021) show that natural spaces influence children's concept of time. In other words, there is a tendency for them to continue with periods of calm. Therefore, it is worth adding a fairly simple justification to this second detail: stopping, breathing, and slowing down. Or as Shahjahan (2015) would say, with a certain disruptive tone, leaving room for "being lazy" (p. 2) and decolonising the implicit productivity of the time of the educational per se, thus fostering the ability to re-wild the imagination (Kuchta, 2022) and encouraging children to surprise themselves with other ways of understanding life through the experiences of learning with nature. Something that with some intensity shows that slow pedagogies (Payne & Wattchow, 2008) apply themselves more thoroughly to these

aesthetic immersions that speak to us of colours, smells, learning through playing with mud (Mycock, 2019), and many other aspects.

Some notes on relaxation, well-being, and happiness that agree with the results of other literature reviews that centre on analysing creativity and outdoor education in the primary stage (Guerra et al., 2021). Furthermore, providing other common points, the study by Jarvis et al. (2022) found that *green* surfaces had a positive influence on the different dimensions of child development depending on the type and volume of natural cover, that is to say, whether they were wild areas, wooded areas, or grass-covered areas. And there are also the findings of González-Tapia et al. (2022) where feelings of belonging converge with nature and pro-environmental or pro-social behaviours. These results represent strong backing for the common interests that unite us as a community to argue for situations of ecological and social justice.

Two aims that combine in research in solid commitments to all voices, something reflected in equitable samples of participants when questions arise about the implications of the natural in these early stages (Adams & Beauchamp, 2021; Amoly et al., 2014; Askerlund & Almers, 2016; Chiumento et al., 2018; González-Tapia et al., 2022; Huynh et al., 2013; Jarvis et al., 2022; Luís et al., 2020; Pollin & Retzlaff-Fürst, 2021). However, these commitments are not limited to the formal aspect of the method, but nature shows that the spaces and conditions that sustain us are neutral and ideal for cathartic play in childhood without implicit social constructions (Änggård, 2016).

It should be said that as well as influencing the attributes that are at play in the construction of children's identity, nature also tips the balance towards the positive, providing touches of improvement in these stages that construct the subject. Albeit, of course, without setting aside its contribution to changed behaviour from an axiological dimension. Because in this latter case, nature strengthens the system of human values through an ethics centred on interests that go beyond us.

We focus then on how to address the technology surplus and lack of contact with nature in the early years of life, something that is an unresolved issue within pedagogy to try to redirect circumstances before it is too late. In this regard, it is sufficient to note that the technological expansion that has followed globalisation has made it increasingly uncommon to see children unhurriedly enjoying their right to play in spaces (we no longer say in the open air, which of course also concerns what we address, but in general) free from technological devices (Correa et al., 2023). Even so, disregard for the natural is not something that has appeared before us from one day to the next focussing exclusively on these early stages. Instead, problems in relating to nature are a concrete expression of the effects of a lack of empathy towards the social and the environmental. There have always been deficit crises from time immemorial. Today, in fact, we might be seeing the maximum expression of them, represented by the name given to our era: the anthropocene (Díaz-Romanillos, 2024; Figueras & Torrents, 2022), or as Haraway (2020) would say, the *cthulucene*. More or less proponents of these post-human denominations that emerge as we advance (Gaviria, 2024), the spirit that is expected is that time passes and over recent decades these issues of the lack of environmental conscience at early ages already seem to have gained a central position. Issues that have, of course, contributed to a variety of educational proposals to try to bring young children to the natural world (De Tapia & Salvado, 2022).

Now more than ever, education and the educational must become involved with each other given the potential impact of this phenomenon and the way in which we conceive our being and presence in society. In our view, environmental education should not just be branded as for sustainable development, as we agree with Díaz-Romanillos (2024) that this term is insufficient; instead, it should start from socio-bio-centric concepts, situated in the historical and social context of eco-social crisis which we inhabit. An education based on the *alterum* as the foundation of an ethical conception built on the common good, on the collective, and on ecological democracy, broadening the

concept of ethical community. An approach used more than half a century ago by Leopold (1948; 2017) in his ethics of the Earth and later Sosa (2000) and more recently Latour (2022) and Muñoz-Rodríguez (2022). Humankind's relationship with nature as a species is based on an expansion of traditional ethics, insisting that the natural and nature form an interdependent biotic community. Our understanding of the educational must transcend superficial conceptions that take measures to repair one-off problems or harms, moving to a deep, binding education on the line of the deep-ecology movement (Naes, 1986), inspired by Spinoza and Heidegger, that proposes a need for a new way to understand the world, society and human reality. Otherwise, we will be unable to overcome the nature deficit we speak of in childhood.

3. Methodology

An anonymous, self-administered survey was administered under supervision using a paper questionnaire. The target population comprised students from years 5 and 6 of primary education, with a sample of 2586 respondents. The sampling error was estimated to be ± 1.93% with a confidence interval of 95.5%. The questionnaire predominantly comprised closed questions along with some open ones and was validated by means of a pre-test with 15 interviews. Multi-stage sampling stratified by clusters was used, with proportionate random selection of primary sampling units and simple random selection of ultimate sampling units. Sex and age quotas were applied. The items were evaluated on an 11-point Likert scale (0–10) (Bisquerra & Pérez-Escoda, 2015).

Before final coding, a pilot study was performed with 15 participants within the target age range to modify the questionnaire. The questions were refined, eliminating redundancies and adding clarifying labels on the basis of the comments and experiences obtained. Sampling was done in two stages, using a stratified cluster method with Spain's autonomous regions divided into four zones: centre, north-east, east, and south. The sampling locations (primary schools) were selected taking into account variables such as *geographical area*, *socio-economic position*, and *ownership of the school* based on the networks of institutional contact of the research team. The final sample, after filtration, comprised 2586 units.

3.1. Statistical analysis

The statistical analysis involved calculating descriptive measures such as means, standard deviations, medians, and interquartile ranges (IR) to describe the data in detail. To assess differences between boys and girls, the Mann-Whitney U test was used owing to the skew of the data, using *p*-values to determine the significance of these differences in each context. The Spearman correlation coefficient was also calculated to analyse the association between two ordinal variables, providing a deeper comprehension of the relationship between these variables in both gender groups.

4. Results

The sample comprised 1244 girls (48.1%) and 1286 boys (49.7%) from years 5 (n = 1206, 46.6%) and 6 of primary education (n = 1373, 53.1%). Table 1 shows a descriptive analysis of the principal variables considered in the study broken down by gender (boys and girls) and with the overall value for all participants. A significant difference between girls and boys in the preference for natural sites is observed (p = 0.013), with girls enjoying these places more. Boys display a greater preference than girls for technology and the internet, a difference that is significant (p <0.001). Time spent using technology is significantly greater in boys than in girls, however, boys have a greater preference for going into the street compared to the girls, with a significant difference (p <0.001) (Table 1).

Table 1. Descriptive analysis of preferences and behaviours by gender.

	Total	**Girls**	**Boys**	
	Mean ± SD Median (IR)	Mean ± SD Median (IR)	Mean ± SD Median (IR))	*p*-value
Liking for going to places with nature (trees, grass, plants, gardens, woodland, mountains, rivers, beach, etc.) when they have time	8.22 ± 1.91 9 (7-10)	8.35 ± 1.79 9 (7-10)	8.12 ± 2.00 6 (5-8)	0.013
Perception of time (little–a lot) spent in sites with nature	6.19 ± 2.31 6 (5-8)	6.22 ± 2.24 6 (5-8)	6.17 ± 2.34 6 (5-8)	0.718
Liking for being with technology and the internet (mobile phones, tablets, consoles, social networks) when they have time,	6.94 ± 2.37 7 (5-9)	6.51 ± 2.33 7 (5-8)	7.35 ± 2.32 8 (6-9)	< 0.001
Perception of time (a little-a lot) spent using technology and the internet	6.94 ± 2.37 7 (5-9)	5.39 ± 2.27 5 (4-7)	6.00 ± 2.34 6 (5-8)	< 0.001
Ability to choose: going into the street vs staying at home surrounded by screens	2.14 ± 2.50 1 (0-4)	1.71 ± 2.12 1 (0-3)	2.52 ± 2.73 2 (0-5)	< 0.001

Note: SD = standard deviation; IR = interquartile range.

4.1. Analysis of the association between preferences and behaviours by gender

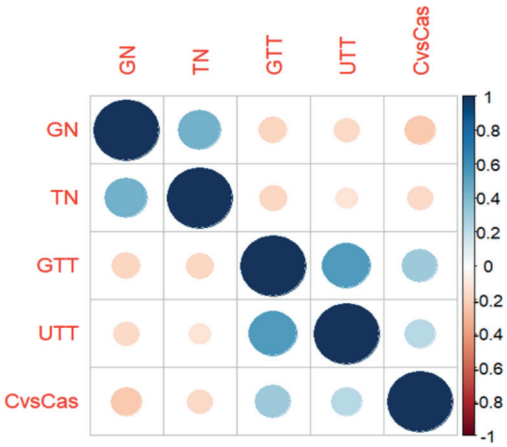
The results show a positive and significant correlation (r = 0.426**) between liking nature and time spent in natural settings, which suggests that people who enjoy nature more tend to spend more time in it. A negative and significant correlation was also found between enjoying nature and interest in technology and the internet (r = -0.187**), indicating that people who prefer nature tend to be less interested in technology. Likewise, a negative and significant correlation is observed between enjoying nature and time spent on technology and the internet (r = -0.147**), suggesting that people who enjoy nature the most tend to spend less time using technology. Finally, a negative and significant correlation was shown between the preference for nature and the inclination to stay at home surrounded by screens instead of going out into the street (r = -0.250**), indicating that people who prefer nature tend to stay at home with technology less.

The results show that for girls there is a positive and significant correlation between liking nature and time in natural settings (r = 0.421**). Furthermore, a negative and significant correlation is observed between liking nature and interest in technology (r = -0.180**), as well as between liking nature and time dedicated to technology (r = -0.140**). Finally, there is a negative and significant correlation between liking nature and preference for staying at home (r = -0.245**). For boys, a positive and significant correlation was also found between liking nature and time in natural settings (r = 0.431**), and a negative and significant correlation

between liking nature and interest in technology (r = -0.193**). Furthermore, there is a negative and significant correlation between liking nature and time dedicated to technology (r = -0.154**) and between liking nature and the preference for staying at home (r = -0.255**).

The figure presents the correlation between five variables that address both the preferences and the behaviours relating to nature and technology. The first variable, LN (liking nature), evaluates interest in being in natural settings, while NT (nature time) quantifies time dedicated to these settings. On the other hand, LT (liking technology) describes the affinity for technology and the internet, and UT (use of technology) indicates the amount of time dedicated to these devices. Finally, HvsSt (house screens vs street) reflects the preference for staying at home or going out into the street surrounded by screens. The analysis of correlations between these variables offers insights into how preferences and individual behaviours regarding nature and technology are related.

FIGURE 1. Correlation between variables of interest.



Note: LN = liking nature: preference for being in natural settings (trees, grass, mountains, beach, etc.); NT = nature time: time spent on activities in nature.; LT = liking technology: affinity for use of technology and the internet (mobile phones, tablets, social networks, etc.); UT = use of technology: amount of time spent on technology and the internet; HvsSt = house vs street screens - preference for staying at home surrounded by screens or going out into the street.

4.2. Association between preference for technology and connection with nature

The results show a significant negative correlation between a preference for staying at home surrounded by screens and time spent in natural settings (r = -0.184**). This relationship is significant both for girls (r = -0.164**) and boys (r = -0.196**), suggesting that people who have a greater inclination towards technology tend to spend less time enjoying nature. This implies a potential deficit in liking nature among individuals who prefer to spend more time in digital settings, which could affect their physical and emotional well-being. A certain nature deficit can be intuited among those who opt to stay at home with technology, which translates into a shortage of opportunities to enjoy and benefit from the potential of natural spaces.

Furthermore, a significant and positive relationship is observed between a preference for staying at home surrounded by screens and time spent using technology and the internet (r = 0.196**), which suggests that people who prefer digital settings tend to spend more time using electronic devices. This tendency is observed both in girls (r = 0.160**) and in boys (r = 0.208**), indicating that both genders display a greater dedication to the use of technology and the internet when they have a preference for staying at home.

These findings underline a possible relationship between a preference for digital settings and a weaker connection to nature, something that could have implications for health and well-being. A disconnection from nature could be regarded as a deficit, as individuals do not take advantage of the resources and benefits offered by contact with the natural world. Consequently, these results could be used to identify a need to promote a better appreciation of and connection with nature among those who display a preference for the digital setting.

4.3. Analysis of the perception of time and desire in contexts of nature and technology

The next table provides a descriptive analysis of how perceptions and behaviours vary by gender in two contexts: when participants are in places surrounded by nature and when they are using technology and the internet. The descriptive analysis shows significant differences in the perceptions and desires of boys and girls in contexts of nature and use of technology. Girls enjoy time in nature more and have less desire to return home (median of 8 and 7.55 respectively), compared with boys (median of 8 and 6.95), with *p*-values of 0.004 and 0.000. In the context of technology, boys find that time passes faster and they would prefer to continue using technology (median of 8 and 5.65), compared with girls (median of 7 and 5.02), with *p*-values of 0.000 in both cases (Table 2).

Table 2. Descriptive analysis of preferences and behaviour by gender.

	Total	**Girls**	**Boys**	
	Mean ± SD Median (IR)	Mean ± SD Median (IR)	Mean ± SD Median (IR)	*p*-value
When I am in places surrounded by nature: time passes slowly/quickly	7,05 ± 2,76 8 (5-9)	7.31 ± 2.49 8 (6-9)	6.83 ± 2.97 8 (5-10)	0.004
When I am in places surrounded by nature: I want to go home / I do not want to go home	7.23 ± 2.50 8(5-9)	7.55 ± 2.29 8 (6-10)	6.95 ± 2.66 7 (5-9)	0.000
When I use technology and the internet: time passes slowly / time passes quickly	7.07 ± 2.64 7 (5-10)	6.67 ± 2.53 7 (5-9)	7.43 ± 2.68 8 (6-10)	0.000
When I use technology and the internet: I want to stop using it and do other things / I would use it all the time	5.34 ± 2.36 7 (5-10)	5.02 ± 2.18 5 (4-6)	5.65 ± 4.00 5 (4-7)	0.000

Note: SD = standard deviation; IR = interquartile range.

An association was found between the perception of time in nature ("time passes slowly–time passes quickly") and the desire to continue using technology ("I want to stop using it and do other things–I would use it all the time"), with a correlation coefficient of $r = -0.167^{**}$. When calculating correlation coefficients by gender, it was found that for girls it was $r = -0.186^{**}$ and for boys it was $r = -0.127^{**}$. This suggests that for girls and boys alike there is a similar negative correlation between the perception of time in nature and the desire to use technology. This means that as they perceive that time passes quicker in nature, it is more likely that they will want to stop using technology and do other things.

4.4. Analysis of the identifying elements of freedom, autonomy, and responsibility

The following table analyses perceptions and behaviours relating to nature and technology in boys and girls. It is noted that there are no significant differences by gender in the perceived danger of natural spaces or in the choice of outdoor activities. However, a notable difference in perceived parental control of time in nature is found, with this being stricter for girls than for boys (p = 0.030). Moreover, boys and girls alike display significant differences in their perception of the risks associated with technology and the internet, with girls expressing greater concern (p = 0.000) (Table 3).

TABLE 3. Descriptive analysis of perceptions and behaviours relating to nature and technology in boys and girls.

	Total	**Girls**	**Boys**	
	Mean ± SD Median (IR)	Mean ± SD Median (IR)	Mean ± SD Median (IR))	*p*-value
You usually choose what to do when you are in these spaces with nature	5.91 ± 2.64 6 (5-8)	6.06 ± 2.44 6 (5-8)	5.80 ± 2.79 6 (4-8)	0.106
You think that spaces with nature are dangerous for a child of your age	2.25 ± 2.26 2(0-4)	2.25 ± 2.18 2(0-4)	2.23 ± 2.32 2 (0-4)	0.269
Grown-ups (my parents or the people I live with) control the time I spend in nature and what I can do	4.54 ± 2.91 5 (2-7)	4.39 ± 2.78 5 (2-6)	4.64 ± 3.02 5 (2-7)	0.030
You usually choose what to do, where to go	6.06 ± 2.36 7 (5-10)	5.82 ± 2.73 6 (4-8)	6.31 ± 2.94 7 (5-9)	0.000
You think that technology and the internet are dangerous for a child of your age	5.42 ± 2.47 7 (5-10)	5.73 ± 2.25 6 (5-7)	5.11 ± 2.61 7 (5-9)	0.000
Grown-ups (my parents or the people I live with) control the time I use technology and the sites I can visit	5.81 ± 2.80 6(4-8)	5.78 ± 2.71 6 (4-8)	5.82 ± 2.88 6 (4-0)	0.309

Note: SD = standard deviation; IR = interquartile range.

The correlations between the tendency to choose activities in natural spaces and other variables show some interesting patterns. Firstly, there is a significant negative correlation between freedom of choice in nature and the perceived danger of these spaces (r = -0.075**), suggesting that people who choose more actively do not perceive these settings as dangerous. There is also a similar negative correlation with the level of parental control over

outdoor activities (r = -0.054**), suggesting that people who perceive more freedom to decide are less subject to strict control. Furthermore, a significant positive correlation was found between freedom of choice in nature and autonomy in the choice of activities and places (r = 0.150**), suggesting that those who choose more in nature also tend to have more autonomy in general. No substantial correlations were found with perception of risks associated with technology and the internet nor with parental control of use of technology, which suggests that these variables are independent of freedom of choice in natural settings.

5. Discussion and conclusions

It is not technology that restricts the bidirectionality that should exist harmoniously between the child and nature; rather, it is what is distinctively human, which is actually between the two opposing poles, that repels feelings of belonging in the natural world through this constructed artificiality. From individuality, we can see that young children misunderstand (which in a way is also a form of learning) how, in line with the possibilities their society offers them, there is a technological opposite of rare materials that we have decided is unstoppable and which thinks and (to a certain extent) speaks in a similar way to our species and more productively. Consequently, uncoupling and fragmenting these networks that with little or no sustainability we have fed with an artificial *other*, is no easy task. In this analysis we have sought to demonstrate that something can still be added from an inclusive perspective to the topic and question of nature deficit and technology surplus, taking into account what we already knew from previous research.

With regards to the objective that focussed on establishing these preferences and behaviours by gender, it is apparent that boys display a greater preference than girls for technology and the internet, and that boys' perception is that they use it more intensively. These results should be no surprise as they were already been found by other studies (Guevara-Arayón, 2020; Sabater & Fernández, 2015; Serrate et al., 2023) that highlight gender differences in access to and use of technology, often largely deriving from the market's offer of applications and networks aimed at both sexes in the group in question. In contrast to what we might expect, it may seem surprising that there is data indicating that boys display a greater preference than girls for going out into the street rather than staying at home surrounded by screens. Especially because in this stage of childhood, it is normal to prefer to occupy space outdoors in parks and squares interacting (playing) with others, as part of the socialisation process. Perhaps for this reason we should continue to pay attention to the results obtained relating to the possibly stronger addictive effects of technology on boys than on girls, based on indicators that show that boys find time goes faster when they are surrounded by screens. This means that if they could choose regarding some of the causes that shape their experience of technology, they would prefer to continue using it even after the time limit or restriction that adults have set for them to use it responsibly.

Focussing on gender differences again, girls display more liking for and enjoyment of time spent in nature than boys do, as well as less desire to return home when they complete their free time in these spaces. Going a little further, results keep appearing that indicate that public spaces, natural and digital alike, are perceived as dangerous, an indicator that is significantly representative at a greater percentage in girls than in boys. In fact, we could go on to add that girls also perceive greater parental control in these public spaces, especially in natural spaces. Considering these findings, this could be because families are more protective of girls because of their gender, meaning that this situation is shaped by a more complex perception of risk at a social level and protective constraints that have been passed down with a certain hegemonic tradition in family units that generally reproduce different patterns with their daughters than the ones they follow with their sons. Even so, we also observe that boys and girls who tend to display greater freedom of choice of activities in any space (whether natural or digital) perceive these spaces to be less dangerous and, interestingly, respondents who report greater freedom of choice in natural spaces are subject to less control and restriction

by adults. Affecting the regulation of behaviour a little more, we can see that respondents who choose nature more also tend to have more autonomy in general. This means that a good pattern of teaching that enables children to participate in decision making throughout their process of socialisation helps with appropriate autonomous construction of their identity and regulates the spaces that they occupy and the time they dedicate to these spaces.

In both cases, it is apparent that children who report enjoying nature more tend to spend more time in it and show less preference for staying at home. As a result, we have been able to establish that the more people like nature and natural spaces, the less their interest in technology and the time they spend on it. These results should make us aware of the necessary responsibility of public authorities and administrations as well as families and the education system in general to strengthen nature as a space that belongs to children by right, where appropriate and better childhood development is favoured while at the same time guaranteeing sustainable advances in the process of socialisation (Caballero et al., 2024; Gutiérrez et al., 2024; Muñoz-Rodríguez, 2021). Regarding possibilities for future work, we should perhaps say that the behaviour of these other educating agents is something that we well know can boost or hinder any outlook based on the predominant world views regarding nature in childhood and their direct implications for educational practice.

The present work has some methodological limitations that should be noted, such as the sample being limited to a specific geographical and educational context. Although a broad sample of students from years 5 and 6 of primary education from particular autonomous regions of Spain was taken, the results cannot be generalised to other geographical, educational, or cultural contexts. For example, results might vary in other countries or regions or among students from different educational stages. There are also the sex and age quotas and the possible control for other socio-demographic variables given that, although these were controlled for, we did not consider controlling for other socio-demographic variables (such as *socio-economic level*, *ethnicity*, or *family characteristics*) that could influence use of technology or the connection to nature, which introduces potential bias into the results.

As possible future studies, it is necessary to bear in mind the need to consider mixed methods that combine quantitative and qualitative results and add verbal explanations by the children relating to the questions analysed, as well as longitudinal studies that make it possible to observe changes over the lifespan of the participating sample. It would also be of interest to test this information with families' perceptions of the link that their sons and daughters display with screens and with nature and to consider the differences.

We would however like to conclude with the most important pair: aspiring to re-nature educational processes is something legitimate, a human right with implications for human identity. However, it must be done considering the inherent complexities of our social condition (in this case, the gender differences we have identified in this work that are below the surface in childhood) and we must keep ourselves up to date pedagogically with fair prevention and intervention in what happens in educational reality with the nature–technology pairing. This should be an invitation to reflection, because at least for the moment the greatest guarantee that we anticipate is that if we wish to be part of a more sustainable world, an example is needed of how to channel these provisions, and that is a question for the first page of the instructions.

Authors' contributions

Sara Serrate-González: Conceptualisation; Writing (original draft); Writing (review and editing); Visualisation.

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