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Deep Learning in Spanish University Students: The Role of Digital Literacy and Critical Thinking

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Abstract

University students use the Internet regularly for study, socialising, and entertainment; moreover, in adolescents and young adults, Internet use increases with age. More than ever before, the wide availability of online information requires critical thinking coupled with skills for evaluating online information, such as verifying the reliability of information and netiquette. These competencies might influence deep learning; however, few studies have analysed all these variables together. In addition, there is an ongoing academic debate as to whether using smartphones at an early age is beneficial for learning. Our study aimed to analyse, according to the age of the first smartphone, to what extent students' critical thinking disposition, netiquette, and evaluation of the reliability of online information predict their capacity for deep learning. Our sample comprised 415 Spanish university students aged 18–36 (M = 19.98 and SD = 4.18). The instruments used were, for the assessment of Deep Learning, the Subscale of the questionnaire Attitudes towards learning of university students CEVAPU (to measure the Critical Thinking Disposition, we used the CTDS scale (Spanish adaptation of Bravo et al., 2020 and also the Competence Scale Evaluation of the reliability of online information (e-CEI) (Denoni & Cebollero-Salinas, 2025; and, finally, to assess Netiquette, the subscale of the questionnaire Evaluation of the quality of cyberbehavior "EsCaCiber" Multiple linear regression results indicated that in those participants who indicated they had acquired a smartphone before the age of thirteen, the two competencies of netiquette and evaluation of online information reliability were more strongly predictive of deep learning than in the group of participants who had their first smartphone when they were thirteen or older. Our study confirms that critical thinking disposition is a factor that favours deep learning in both groups (i.e., smartphone acquisition before and after 13 years old). The social and educational implications are along the lines of fostering a disposition to critical thinking, educating in digital literacy, especially in verifying the reliability of information, and communicating with netiquette for deep learning. Our findings indicate a potential association between critical thinking disposition and a greater propensity for deep learning in both groups (i.e., smartphone acquisition before and after 13 years old). A relevant educational implication of the results seems to indicate that a possible way to achieve deep university learning is to encourage critical thinking, to educate in digital literacy, especially in the verification of the reliability of information and to communicate with netiquette. Some of the limitations of the research design are the use of self-reports, convenience sampling and a cross-sectional design.

Keywords: deep learning; critical thinking; netiquette; data literacy; higher education; smartphone acquisition age; digital literacy

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1. Age of First Mobile Phone and Internet Access

The Internet has transformed human behaviour and habits on a global scale, especially regarding information access, information consumption, modes of learning, communication, and entertainment. According to the UN Children's Foundation, 96% of Europeans ages 15 to 24 were using the Internet in 2019. Although platforms typically set 13 as the minimum age of use, in accordance with national regulations, this requirement is not universally enforced, and many underage users access these platforms worldwide. Smartphones are among the most widely used devices; they tend to serve as the channel through which children and adolescents are introduced to the Internet. At the same time, the age at which children acquire their first smartphone is decreasing, with many owning a device before entering secondary school and spending several hours per day on it (Common Sense Media, 2021; Ofcom, 2023; Sapien Labs, 2025). In 2023, the Spanish National Statistics Institute found that a high percentage of children in Spain ages 10 to 15 were using the Internet (94.7%) and a smartphone (70.6%). The median age at which Spanish children are given their first smartphone is 10.96 years old (Andrade et al., 2021). According to recent National Statistics Institute data, 45.7% of Spanish children already have a smartphone at the age of eleven, 72.1% by age twelve, and 88.2% by age thirteen (INE, 2023). This trend may have unintended consequences. Several recent studies have highlighted that the age at which individuals first gain access to a personal internet-connected device—such as a smartphone—marks a turning point in the type, frequency, and intensity of digital use (Burns & Gottschalk, 2020; Montag & Elhai, 2021). Smartphone acquisition not only enables access to digital content and social media, but also allows for autonomous and continuous use. This distinguishes it from earlier, more restricted forms of digital engagement, such as shared access to computers or tablets. Likewise, studies examining the effects of screen time, social media use, and smartphone access on various mental health outcomes in children have reported negative effects in many cases (R. M. S. Santos et al., 2023). A large-scale recent global study including data from 163 countries found that acquiring a smartphone before the age of 13 is associated with poorer mental health outcomes in early adulthood, including suicidal thoughts, detachment from reality, lower emotional regulation, and reduced self-esteem (Thiagarajan et al., 2025). These correlations are mediated by various factors such as social media exposure, cyberbullying, sleep disruption, and poor family relationships. This pattern is consistently observed across all world regions, with a stronger effect in English-speaking countries. Other studies further indicate that having a smartphone before the age of 11 leads to a higher level of cyber-gossiping, problematic use of the Internet, and other risks such as cyber-aggression (Cebollero-Salinas et al., 2024b, 2025). Overall, technological advancement is constantly bringing about new social tendencies and changes in labour conditions. This, in turn, requires education systems to evolve accordingly. In particular, universities need to adapt to current tendencies and requirements (Cabero-Almenara et al., 2023).

In the digital era, learning goes beyond the mere assimilation of data to become the active and critical construction of knowledge. This study integrates three fundamental pedagogical dimensions to address this challenge: deep learning, digital literacy, and critical thinking. These dimensions do not operate in isolation; they are synergistically intertwined. Deep learning, understood as the ability to comprehend, apply, and generate new ideas, constitutes the essential pedagogical purpose. To achieve this goal in a digital ecosystem, digital literacy is required. This goes beyond technical skills to include the ability to ethically evaluate and produce information. In this process, critical thinking acts as the indispensable bridge, allowing students to question the reliability of sources, deconstruct arguments, and discern misinformation.

1.1. Digital Literacy for Assessing Online Information: Netiquette and Evaluation of Information Reliability

Widespread access to information via the Internet leads to excess informational input; dealing with a glut of information requires critical thinking and a series of competencies for the assessment of online content, including netiquette and the evaluation of information reliability.

Important data literacy skills include the capacity to navigate and search the Internet, filter results, and evaluate the reliability of online information. Internet users should also be able to store, organise, and retrieve the information they find online (Ministerio de Educación y Formación Profesional, 2022). Nowadays, general characteristics of the information and communication society and the emergence of artificial intelligence imply that the individual is confronted with a large amount of information that can be easily manipulated and thus needs to be verified (Sánchez Gonzales & Alonso-González, 2024). Evaluation of online information reliability, therefore, emerges as a key competency (Cuesta & Espitia, 2020). Several authors have pointed out the need for university students to acquire it with the aim of reinforcing their learning abilities (Cabero-Almenara et al., 2023; Silva Quiroz et al., 2023).

Another useful competency for the evaluation of online information is netiquette. It is defined as the set of civilised norms and behaviours that allow an individual to use the Internet appropriately (Shea, 1994). Netiquette, as a digital competency, is listed in the area of communication and collaboration competencies (Ministerio de Educación y Formación Profesional, 2022). Since ICT (information and communication) technologies have profoundly modified the way human beings socialise, interact, and communicate, it has become necessary to know, understand, and apply netiquette in daily life (Cebollero-Salinas et al., 2022a). This implies that people should treat one another respectfully on social media, showing consideration for other users' privacy and helping to create a generally positive atmosphere (Flores, 2010; Cebollero-Salinas et al., 2022a). This, in turn, requires Internet users to have the capacity to evaluate the reliability of information they encounter in terms of form and content. Researchers have found that netiquette mitigates antisocial behaviour, such as cyberbullying (Ang, 2015), and Internet abuse, against which netiquette plays an outstanding protective role (Yudes-Gómez et al., 2018). To our knowledge, no previous studies have considered these factors in relation to age. It would be plausible to assume that young people's capacity to develop cognitive coping strategies and emotional self-regulation would increase with age (A. C. Santos et al., 2021). This, in turn, would facilitate their ability to evaluate online information.

Other research teams have noted that sex can be a differentiating factor, given that girls achieve higher netiquette scores than boys (Cebollero-Salinas et al., 2022b). Nevertheless, netiquette research has generally focused on proposed guidelines designed to guarantee adequate online communication (Hammond & Moseley, 2018), for instance, in online exchanges between students and teachers (Linek & Ostermaier-Grabow, 2018). However, just as in the case of the evaluation of online information reliability, no quantitative study has assessed the extent to which netiquette predicts deep learning. As netiquette is an adaptative behaviour, we hypothesise that these two competencies—netiquette and the evaluation of online information reliability—favour and encourage deep learning.

1.2. Critical Thinking Disposition

The scientific literature on critical thinking has been abundant in recent years, and researchers have ascertained several of this construct's dimensions. Among these, they have pinpointed the ability to reflect and specify what to believe and what to do (Ennis, 1987), the capacity to argue in a reasoned manner, to evaluate informational input based on evidence, and to differentiate among opinions; all of these abilities involve interpretation, analysis, inference, evaluation, and explanation (Facione, 1990; Jiménez-Aleixandre, 2010). On the other

hand, authors including Poondej and Lerdpornkulrat (2015) argue that these skills require a particular disposition, i.e., a willingness to apply them: a desire to seek the truth, an open and flexible mind, impartial evaluation, a systematic approach, and diligence in the search for information (Boghossian et al., 2017). In this regard, it is important to distinguish between the two constructs. Critical thinking disposition is characterized by what Facione and Facione (1992) referred to as "habits of mind"—an internal motivation to engage in critical thinking. Critical thinking skills, on the other hand, involve the actual ability to apply techniques for analyzing, evaluating, inferring, and reasoning (Valenzuela et al., 2023). As Facione (1990) argues, disposition predisposes individuals to use critical thinking skills; however, having such a disposition does not necessarily mean that the individual possesses the skills themselves, but rather that they value their use.

However, when students' critical thinking and critical thinking disposition are confronted with a series of phenomena associated with the virtual environment, their ability to deal adequately with online information is low (Machete & Turpin, 2020). The research team of McGrew et al. (2018) found that students in vocational training failed to consider superficial elements, such as the appearance of the page and the photos, as well as more profound issues, such as conflicts of interest or the author's motivation, nor did they tend to corroborate the information they encountered by confronting it with external sources. Interestingly, students do not tend to perceive that ICTs (information and communication technologies) should be used by applying reflection, analysis, and critical thinking (Muñoz-Repiso & Tejedor, 2017). A systematic literature review showed that university students possess abilities associated with critical thinking, but they do not display a proactive attitude that would allow them to apply those abilities online on a daily basis (Caballero-García & Sánchez, 2023). Likewise, some studies suggest that while critical thinking is important, it is not sufficient to promote digital literacy. They argue that without adequate teacher training, updated methodologies, and institutional support, critical thinking alone does not necessarily translate into its effective application in navigating the digital world (Cosi Cruz et al., 2023; Jiménez-Rojo, 2020). The relationship between technology use and learning outcomes tends to be weak when broader systemic challenges are present, such as outdated infrastructure and limited investment. Therefore, critical thinking must be embedded within a broader framework of global educational reforms in order to effectively enhance digital literacy.

Critical thinking disposition in university students has not been found to be differentiated significantly by sex in previous studies (Fernández-Vilanova & Soláz-Portolés, 2022). However, one of its dimensions, i.e., confidence in reasoning and formulating judgments, is more pronounced in males (Escurra & Delgado, 2008). Another recent study suggested that a series of partial variables determine critical thinking disposition according to sex: netiquette in females and the evaluation of online information in males (Denoni & Cebollero-Salinas, 2025). Regarding the age factor, certain studies suggest that critical thinking disposition increases up to adolescence (Frisby, 1991), given that adolescence is the period when abstract thinking starts to develop, thus leading to an increase in critical capacity (Casas Rivero & Ceñal González Fierro, 2005).

However, several studies coincide in finding evidence of the positive influence of educational interventions in the development of critical thinking disposition in students (Caballero-García & Sánchez, 2023). Such interventions need to take into account the virtual environment in which students share and communicate; they should also consider students' netiquette abilities and their capacity to evaluate the reliability of online information. Indeed, the evaluation of the veracity of online information (particularly in males) and netiquette (particularly in females) tend to predict students' critical thinking disposition (Denoni & Cebollero-Salinas, 2025). Moreover, critical thinking abilities seem to relate to one

specific educational challenge: deep learning (Morales Bueno, 2018). Therefore, we suggest that critical thinking disposition, in particular, is significantly related to deep learning.

1.3. Deep Learning

Deep learning is one of the essential challenges faced by 21st-century educational institutions. Apart from its evident importance for students' personal development, it plays an outstanding role in acquiring further abilities and capacities, such as problem-solving, collaborative learning, and innovation. The role of deep learning has become particularly crucial at the current technological crossroads where the incursion of artificial intelligence in the educational field not only presents some opportunities but also a series of risks and potential dangers (Selwyn et al., 2022; Cebollero-Salinas et al., 2024a).

The concept of Deep Learning emerged in the 1970s in the fields of cognitive psychology and education. The concept initially focused on the learning process, describing optimal mental operations that underlie deep learning in a series of explanatory models (Quiroga & Lara, 2023). One of the most prominent publications in the field of deep learning was the investigation by Marton and Säljö (1976) on learning strategies. Based on those authors' analysis, researchers have tended to associate deep learning with global comprehension in contrast with superficial learning, described as a mere reproduction of information (Quiroga & Lara, 2023). Deep learning has been defined as a methodological process in which students apply self-management abilities, enabling them to acquire learning content in a meaningful way that will subsequently allow them to apply and transform that content in many different contexts.

In the last decade, research publications on deep learning have closely associated this construct with thinking abilities (Alcaino & Goñi, 2016). Valle et al. (2009) found that students with a predominantly deep focus had better chances of success and achieved better academic performance than those who adopted a superficial approach (Simón Medina et al., 2023). Further studies found that self-efficacy, self-regulation, and deep learning, taken together, are good predictors of high academic performance; for instance, Pérez et al. (2013) and Panadero et al. (2021) showed that a more pronounced degree of effort, self-efficacy, and learning-oriented self-regulation led to increased use of deep learning strategies. Further studies have associated deep learning with critical thinking abilities (Morales Bueno, 2018). However, to the best of our knowledge, no study has related deep learning with the two Internet-specific abilities of netiquette, on the one hand, and the evaluation of reliability of online information, on the other.

If we want to further explore the relationship between digital technologies and learning, particularly deep learning, we should join Pattier and Reyero (2022) in asking ourselves what type of learning is most appropriately suited to novel technologies. Pedagogical course design should indeed adapt itself to new technologies, but it should approach them in a way that encourages quality deep learning (Rush, 2011).

To summarise, the three variables (1) critical thinking disposition, (2) netiquette, and (3) the capacity to evaluate the reliability of online information are fundamental competencies for today's university students, given that they have to navigate an information-saturated digital environment and participate in digital learning communities. The linkage of the analysis constructs, although in a biased way, has been evidenced in different studies. Denoni and Cebollero-Salinas (2025) have demonstrated the connection that exists between netiquette, the evaluation of the reliability of information and the disposition to critical thinking, with age and sex influencing these processes. In this sense, reviews by Jiménez-Rojo (2020) and López-González et al. (2023) emphasize that critical thinking constitutes the basis of information competence and media literacy that together with other research indicating the need for the integration of digital competencies, both technologi-

cal and pedagogical and ethical (Díaz-García et al., 2020; Martínez-Gonzalez et al., 2018), promote deep learning approaches. When the disposition to critical thinking is put at the service of digital competencies such as assessing the reliability of information and netiquette it seems to suggest that deep learning emerges thus managing to reflect, transfer and build relevant and meaningful knowledge capable of transforming reality. However, the literature has not yet established whether deep learning can be enhanced through digital competencies that support information evaluation and critical thinking (Figure 1).

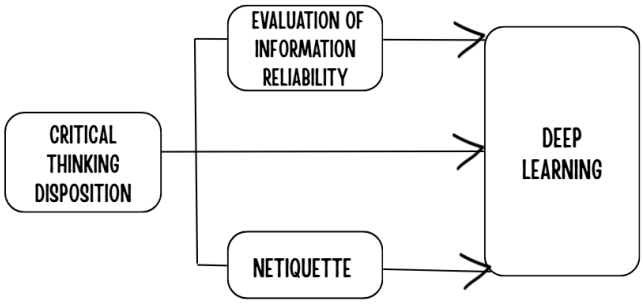

Figure 1. Variables.

Finally, while social media platforms set 13 as the minimum age of use—and this is often also the age at which children first acquire a mobile phone—there is growing concern about users gaining access at earlier ages (INE, 2023; Thiagarajan et al., 2025). This underscores the need to explore and open new lines of research on these issues.

Hence, the objective of this study is to analyze, according to the age of obtaining the first Smartphone, to what extent one's disposition to the evaluation of the reliability of online information, netiquette, critical thinking, age and sex predicts deep learning (Figure 2). All this will allow the design of more adapted strategies to promote deep learning by incorporating the online environment.

Thus the working hypotheses are:

H1: *The variables (disposition to critical thinking no) Critical Thinking Disposition, netiquette, information evaluation, age and (gender no) sex predict deep learning.*

H2: *The above variables will predict deep learning differently depending on the age at which they accessed a cell phone (before or after the age of 13).*

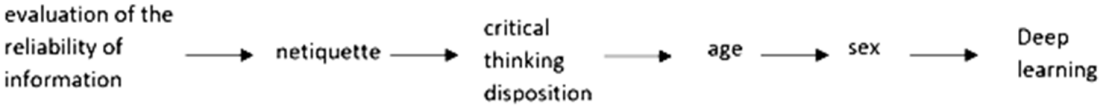

Figure 2. Deep learning predictive model.

2. Method

2.1. Sample

Participants in our study were 415 students enrolled in University of Zaragoza ages 17 to 36 (M = 19.98 and SD = 4.18). Of these participants, 299 were female (72.2%) and 116 were male (27.8%). Participants represented a range of disciplines, such as education (45%), health (30%), and engineering (25%). In the total sample, 52.2% of participants had owned a smartphone before the age of 13, while 47.8% were given their own smartphone at age thirteen or older. Our sample was selected by convenience according to accessibility.

2.2. Tools

Deep Learning Questionnaire, a subscale of the questionnaire "University students' attitudes to learning" CEVAPU, by Gargallo López et al., 2007). The Deep Learning Questionnaire consists of 7 items on a Likert-type scale with five response options, ranging from 1 = thoroughly disagree to 5 = thoroughly agree. For example: "I find it's important to learn to relate the content featured in different course subjects," and "I like to study subjects more thoroughly in order to gain maximum intellectual gain". This tool's internal score consistency (Cronbach's α) in our sample was 0.86.

Critical Thinking Disposition Scale or CTDS, a Spanish adaptation by Bravo et al. (2020) of the original questionnaire in English by Sosu (2013). It consists of 11 items that measure two components of critical thinking disposition: critical openness (for example, "I usually try to think about the bigger picture during a discussion") and reflective scepticism (for example, "I often re-evaluate my experiences so that I can learn from them"). Each item is scored on a Likert-type 5-point scale (1 = Totally agree; 5 = Totally disagree). Approximately four minutes are required to fill out this questionnaire. In the present sample, the internal consistency (Cronbach's α) of scores on this scale was 0.86.

Evaluation of Reliability of Online Information Competency Scale (e-CEI). We designed a questionnaire that assesses the knowledge, attitudes, and skills that enable an individual to evaluate the information they are searching for, receiving, or forwarding (posting) online. To develop this tool, we based ourselves on a series of criteria established by the Spanish Ministry of Education to assess digital competency in teachers (Ministerio de Educación y Formación Profesional, 2022) and on the main strategies enumerated by the Spanish National Cybersecurity Institute (INCIBE) for the verification of information. The content validity of the scale items was assessed by four experts in digital competence. They also evaluated the clarity and relevance of the items, resulting in a Cohen's Kappa coefficient of 0.9. The scale was administered to the study participants along with the other questionnaires. Subsequently, a factorial analysis was conducted, beginning with an Exploratory Factor Analysis (EFA), followed by a Confirmatory Factor Analysis (CFA), which resulted in a validated scale. The e-CEI questionnaire consists of eight items featuring six response options ranging from 1 = never to 6 = always (e.g., "Before forwarding a video or comment I have viewed, I stop to check its veracity"; "When I view a news item, I check to see that it is not fake by investigating other credible media to see if they have featured the same item"). Confirmatory factor analysis (CFA) yielded a one-factor solution and optimal data fit: $X^2/gL = 1.98$ $p < 0.0001$; CFI = 0.994; TLI = 0.992; RMSEA = 0.101. The reliability and convergent validity values were optimal: Cronbach's alpha = 0.90, AVE = 0.77.

Netiquette (Ortega et al., 2012), a subscale of the questionnaire "Evaluation of cyberbehaviour quality" «EsCaCiber») (Ortega et al., 2012), designed as a measurement scale in adolescents. Entitled "responsible use," the netiquette subscale features four Likert-type items with five frequency response options (ranging from 0 = never to 4 = always). This subscale is designed to assess the way individuals deal with online information in terms of communicating it with respect. For example, "I treat others with respect on social media," and in terms of protecting their privacy, "When I publish something by someone else, I ask them for permission." In terms of creating an enjoyable atmosphere on the Internet, e.g., "If I feel aggressed on social networks, I try to respond calmly and not violently". In our study, this subscale's internal consistency was $\alpha = 0.79$.

Sociodemographic data: We asked participants to disclose their sex, current age, and the age at which they had owned a smartphone for the first time.

2.3. Data Analysis

We started by applying the Kolmogorov–Smirnov test to assess normal data distribution. Although the test showed a non-normal sample, we proceeded to apply parametric tests, given that Box et al. (2005), Blanca et al. (2017); Schmider et al. (2010) and Rasch and Guiard (2004) have shown that in sufficiently large sample sizes, distributions of means tend to approximate normal distribution, thereby allowing for the application of parametric statistics. Moreover, the skewness and kurtosis values did not indicate any extreme values. We recoded the "first smartphone acquisition age" variable into two groups: those who had possessed a smartphone before the age of 13 (52.2%) and those who obtained it at age 13 or later (48.8%).

This allowed us to subject our study variables to descriptive analysis. Applying ANOVA and the Brown-Forsythe test, we assessed significant differences between the two groups, which were differentiated according to the age of smartphone acquisition. Regarding effect size (η^2) in ANOVA tests, three cutoff points are used to interpret the magnitude of the effect based on the values of the eta-squared statistic, as indicated by Cohen (1992) small effect for values below 0.06, medium effect for values between 0.06 and 0.14, and large effect for values above 0.14. To analyse relationships among variables, we applied bivariate correlation (Pearson's r) and compared subsamples by applying Fisher's "z transformation" of the correlation coefficient. We then analysed the variables' capacity to predict the age at which participants had acquired their first smartphone by applying Multiple Linear Regression and introducing the age and sex variables. To this end, the assumptions of regression were assessed, including linearity, homoscedasticity, normality of residuals, and absence of multicollinearity. Specifically, to avoid potential multicollinearity issues, the stepwise method was applied within each block. Indicators of compliance with multiple regression assumptions were taken into account: independence (with Durbin-Watson values between 1.5 and 2.5); absence of collinearity (with variance proportions <0.5, condition indices below 20, eigenvalues close to 0, and VIF values slightly above 1); normality; and visual inspection of homoscedasticity and linearity plots (Pardo & Ruiz, 2005). All these assumptions were met in our sample.

To evaluate the contribution of new variables, we gradually incorporated the variables in blocks, in the following order. Step 1: evaluation of online information. Step 2: netiquette. Step 3: critical thinking disposition. Step 4: age. Step 5: sex. We included age and gender as covariates in the multiple linear regression models in order to control for their potential influence on deep learning and the other dependent variables. Results were calculated using the SPSS v26 statistics programme.

3. Results

3.1. Descriptive Statistics and Relationships Among Study Variables According to Age of Smartphone Acquisition

The variables' differences in means featured certain discrepancies (Table 1). Participants who had acquired their first smartphone at age 13 or older achieved higher deep learning scores, although with a small effect size. Those who had acquired their first smartphone before the age of 13 scored higher on netiquette with a medium effect size ($\eta^2 = 0.49$). In the case of Evaluation of online information reliability and critical thinking disposition, the differences were not statistically significant.

Table 2 displays the age at which participants indicated they had been given their first smartphone. A considerable increase can be observed at age 12; however, almost 20% of participants had already possessed a device earlier. Thus, before the age of 13, 52.2% of participants had possessed a smartphone.

Table 1. Descriptive analyses of the sample, comparing several variables.

	M (SD) N = 415	First Smartphone at <0.13 Years M (SD) N = 229	Skewness	Kurtosis	First Smartphone at ≥13 Years M (SD) N = 186	Skewness	Kurtosis	F	η^2
Deep learning	27.0 (±3.36)	27.09 (±3.66)	0.68	2.02	27.33 (±3.30)	−0.41	0.83	2.23 **	0.032
Critical thinking disposition	44.11 (±6.50)	44.00 (±5.11)	−1.21	2.28	44.24 (±4.56)	−0.32	0.45	1.78	0.099
Evaluation of online information reliability	34.85 (±4.70)	34.80 (±6.57)	−0.34	−0.38	34.81 (±6.80)	−0.65	0.10	0.06	0.273
Netiquette	13.08 (±2.27)	13.24 (±2.64)	−0.66	0.69	12.91 (3.07)	−0.1.12	2.13	1.94 **	0.049
Age	19.88 (±4.63)	18.50 (±1.67)	1.7	2.43	21.81 (±5.45)	1.32	1.42	104.47 **	0.000

Note: ** $p < 0.01$.

Table 2. Descriptive of the age of first smartphone acquisition.

Age of First Smartphone Acquisition	%
Age 9	3.1
Age 10	3.1
Age 11	13.3
Age 12	32.7
Age 13	25.3
Age 14	9.9
Age 15	2.7
Age 16	3.5
Age 17	6.5

3.2. Correlations

Table 3 shows the correlations among variables differentiated according to the age of first smartphone acquisition. Although the overall pattern of relationships between variables is similar in both groups, the correlations tend to be stronger in the group with early mobile phone access. In both age groups, deep learning correlated with critical thinking, as well as with the two behaviours associated with information evaluation: "evaluation of online information reliability" and "netiquette." Values were medium-low but higher in the group "before the age of 13". Among all correlations, the relationship between critical thinking disposition and deep learning stands out (0.697 ** vs. 0.560 **); however, the differences between the two groups are not statistically significant. The results also indicate that deep learning is not associated with either sex or age.

In the relationships among the remaining variables, it is notable that critical thinking disposition was also related to online behaviours; the correlation was somewhat higher in the "12 or younger" group. Netiquette and the evaluation of online information reliability correlated in both groups with somewhat lower values (0.235 ** vs. 0.189 *), and those differences did not achieve statistical significance.

Table 3. Correlations among variables.

	1	2	3	4	5	6
First Smartphone < 0.13 Years Old						
1. Deep learning		0.331 **	0.367 **	0.697 **	0.051	−0.116
2. Evaluation of online information reliability	0.224 **		0.235 **	0.431 **	0.063	−0.025
3. Netiquette	0.248 **	0.189 *		0.326 **	−0.085	−0.191 **
4. Critical thinking disposition	0.560 **	0.363 **	0.313 **		−0.151 *	−0.062
5. Age	0.124	0.190 **	−0.023	0.248 **		0.119
6. Sex	−0.015	0.049	−0.235 **	−0.046	−0.161 *	
First smartphone ≥ 13 years old						

Note: * $p < 0.05$, ** $p < 0.01$.

3.3. Predictive Variables of Deep Learning

Tables 4 and 5 gather the results of linear regression analysis, differentiated according to the two groups of ages at which participants had their first smartphone, directly addressing the study's objectives and hypotheses. The study variables predicted 49.8% of deep learning in the "age 12 or younger" group, and 31% in the "13 or older" age group. The stepwise inclusion of variables in the models results in a substantial increase in the explained variance (R^2). This pattern indicates that digital and critical thinking competencies jointly contribute in a meaningful way, supporting the need for integrated approaches to understand and foster these types of learning.

Among the variables predicting/explaining deep learning, age and sex did not provide any contribution in the two models, whereas a significant contribution was provided by the variables "critical thinking disposition," "netiquette", and "evaluation of online information reliability".

Table 4. Multiple linear regression analysis of the group who had their first smartphone before the age of 13.

		B	SE B	β	R^2	ΔR^2	F	Confidence Interval for β (95%)		VIF
								Inner Limit	Upper Limit	
Model 1	Evaluation of online information reliability	0.17	0.03	0.33	0.106	0.110	27.63 **	0.111	0.243	1.043
Model 2	Evaluation of online information reliability	0.14	0.03	0.26	0.191	0.089	25.66 **	0.273	0.129	1.058
	Netiquette	0.45	0.09	0.30				0.169	0.314	1.058
Model 3	Evaluation of online information reliability	0.01	0.03	0.22	0.498	0.306	139.43 **	0.043	0.067	1.243
	Netiquette	0.23	0.07	0.15				0.083	0.173	1.133
	Critical thinking disposition	0.41	0.03	0.63				0.146	0.184	1.314

Note: ** $p < 0.01$.

Comparing the two regressions, we found certain resemblances. Critical thinking disposition was the factor with the strongest predictive value (30.6% in the before the age of 13 group and 22% in the "13 or older" group). In terms of predictive strength, it was followed by evaluation of online information reliability and netiquette. Both analyses show Variance Inflation Factor (VIF) values consistently near 1 for all predictors, suggesting a lack of multicollinearity and bolstering the reliability of the model's coefficient estimates. However, notable differences emerged between the groups (Tables 4 and 5). Among individuals who first accessed a mobile device before the age of 13, the predictive power of online information reliability assessment was significantly greater. This variable's contribution to the model was nearly threefold that of the group who accessed a mobile device after age 13 (accounting for 11% versus 5% of the explained variance, respectively). Similarly, the impact of netiquette in the early-access group was double that observed in the later-access group (8.9% versus 4%). Conversely, in the later-access group, netiquette emerged as a more salient predictor than online information reliability assessment, reversing the pattern observed in the early-access group.

Table 5. Multiple linear regression analysis of the group who had their first smartphone from age 13 on.

		B	SE B	β	R^2	ΔR^2	F	Confidence Interval for β (95%)		VIF
								Inner Limit	Upper Limit	
Model 1	Evaluation of online information reliability	0.11	0.04	0.22	0.045	0.05	9.733 **	0.111	0.243	1.015
Model 2	Evaluation of online information reliability	0.09	0.04	0.18	0.085	0.04	8.866 **	0.273	0.129	1.037
	Netiquette	0.23	0.08	0.21				0.169	0.314	1.037
Model 3	Evaluation of online information reliability	0.01	0.03	0.02	0.310	0.22	59.143 **	0.053	0.073	1.157
	Netiquette	0.06	0.07	0.05				0.084	0.168	1.144
	Critical thinking disposition	0.39	0.05	0.53				0.163	0.198	1.214

Note: ** $p < 0.01$.

4. Discussion and Conclusions

Our study aimed to analyse the extent to which age, sex, critical thinking disposition, netiquette, and evaluation of online information reliability predict deep learning, considering the age at which the first smartphone was owned. Our results suggest that critical thinking disposition, netiquette, and evaluation of online information reliability predict deep learning, but to different degrees according to the age of smartphone acquisition. However, in the groups in our sample, the variables age and sex did not appear to influence any of the other variables.

Our first hypothesis, H1, was confirmed. The findings indicate that in both groups, categorized by the age of first mobile phone access, deep learning is predicted by a combination of everyday online competencies—specifically, the ability to assess the reliability of online information and netiquette—in conjunction with a critical thinking disposition. The findings imply that it may be beneficial for educators to teach and integrate these competencies, a practice supported by the guidelines of European and global institutions (UNICEF, 2017; Vuorikari et al., 2022) and as suggested in previous studies (Cabero-Almenara et al., 2023; Silva Quiroz et al., 2023). Moreover, those constructs provide benefits for learning and for an individual's personal and social development (Ang, 2015; Yudes-Gómez et al., 2018). The findings indicate that evaluating online information may not be merely a technical step within digital learning. It is a crucial pedagogical component linking to learning theories that promote critical, active, and autonomous students. The ability to discern between reliable and unreliable information is an essential skill that digital learning should cultivate, not just for academic success but also for effective participation in the information society (Castañeda et al., 2021).

However, age and sex did not predict deep learning. In other words, the fact that young males and young females have diverging motivations to use the Internet (Cebollero-Salinas et al., 2021) did not appear to influence their mode of learning. This could be related to the increased self-regulatory capacity young adults develop at university age (A. C. Santos et al., 2021). Moreover, our results suggested that, independently of sex and age, all university students need to develop the two online competencies featured as variables in our study (netiquette and evaluation of information reliability); moreover, they need to enhance their critical thinking disposition (in which the two online competencies play an essential role; Denoni and Cebollero-Salinas (2025). Other authors, including Pattier and Reyero (2022), have noted that when students can navigate the online world by evaluating information and remaining critical toward input, this helps them develop more significant, profound learning.

Hypothesis 2 (H2), according to which the predictive variables should have different weights according to the age when participants acquired their first smartphone, likewise seems to be confirmed. Our results showed that the earlier participants had access to the online world, the earlier their deep learning depended on variables associated with the online environment, such as netiquette and evaluating online information reliability. However, in those who had their first smartphone at an older age (13 or older), those variables were less determinant, although still present. This result leads us to surmise that acquiring a smartphone device at an early age might not be beneficial (Cebollero-Salinas et al., 2025). Likewise, variables such as socioeconomic and cultural status, as well as parental mediation could have some influence (Cebollero-Salinas et al., 2021; Elboj et al., 2023; Rial Boubeta et al., 2015). Research indicates that the socioeconomic and cultural context in which children and adolescents develop significantly influences their educational outcomes and opportunities (Tahull Fort & Montero Plaza, 2021; Symeou, 2006). Thus, higher socioeconomic status is associated with greater access to educational, technological and cultural resources, which facilitates learning and skill acquisition (Tahull Fort & Montero Plaza, 2021). Likewise, family

cultural capital provides valuable models and stimuli that foster intellectual curiosity and motivation (Symeou, 2006). In this way, parental mediation plays a crucial role, as parents act as intermediaries between their children and their environment, influencing cultural consumption habits and attitudes towards learning (Guaillas García et al., 2024). In this sense, the quality of family interactions can enhance or limit the development of social and emotional skills, impacting overall well-being. Studies have shown that these factors interact in a complex way, contributing to the differences observed in educational and social contexts (García-Aracil et al., 2016). It confirms findings suggesting that deep learning at later ages can be explained by other variables, such as thinking abilities, self-efficacy, and self-regulation (Alcaino & Goñi, 2016; Simón Medina et al., 2023; Gaeta-González et al., 2025). In line with those findings, our descriptive results show that those participants who obtained their first smartphone at age thirteen or older tend to display deeper learning tendencies than those who obtained their first smartphone at age twelve or younger. This can also be explained from the evolutionary psychology angle, as thirteen is the age after which humans start developing a more abstract thinking approach (Casas Rivero & Ceñal González Fierro, 2005).

These findings have important educational implications. First, they point to the relevance of educating students in data literacy, enabling them to act online with netiquette and verifying the reliability of the information they encounter, with the overriding aim of achieving deep learning. Universities provide a privileged environment that allows educators to conduct research on students' level of learning, based on which they can develop innovative strategies, methodologies, and applications (such as collective intelligence) designed to encourage students' critical thinking disposition (Orejudo et al., 2022; Cebollero-Salinas et al., 2024a). Likewise, the evaluation of the reliability of information now has the powerful tool of artificial intelligence. Some studies highlight its usefulness for verifying information (Montoro-Montarroso et al., 2023; Sánchez Gonzales & Alonso-González, 2024). Conversely, these studies also highlight the inherent risk of AI systems producing inaccurate or fabricated information. These incorrect or invented responses are known as hallucinations. Hallucinations are AI results that may seem credible, but in reality are false, fictitious, or lack any basis in real data. Second, these results reveal that deep learning in later adolescence and early adulthood might only be encouraged if early smartphone possession is accompanied by the acquisition of further necessary competencies (González-Gómez et al., 2024). We thus recommend that research in this field be further extended, aiming to establish strategies and guidelines for smartphone use at an early age (Cebollero-Salinas et al., 2025). Pre-service teacher training at university level should emphasise those same aspects (Gabarre-González et al., 2024).

Our study's results should be considered in the light of its limitations. A primary limitation of this study is the potential for bias. The reliance on self-report instruments for data collection may have introduced a social desirability bias, which future research could address by employing qualitative methods. Furthermore, as a convenience sample was utilized, the findings should be interpreted with caution. Replication with a randomized sample would be necessary to reduce sampling bias and enhance the representativeness of the results. Moreover, we supposed that possession of a smartphone implied that the device had actually been used and that subjects who possessed such a device at an earlier age acquired a greater amount of experience on the Internet; that supposition would need to be addressed and contrasted. To generalise results, our study would need to be replicated in other contexts on random samples. Another limitation to consider would be that the brevity of the netiquette scale, which is composed of only four items, may not fully capture the complexity and multidimensionality of the netiquette construct. This could limit its content validity. Therefore, any findings associated with this scale should be

interpreted with caution. While we included age and sex as covariates in our multiple linear regression models to control for their potential influence, future studies could benefit from differentiated analyses by sex and across distinct age groups to deepen our understanding of how these variables affect the outcomes. A further limitation is the study's cross-sectional design. A longitudinal study would be valuable for clarifying potential causality among the variables. Additionally, the quantitative methodology of this article could be enriched with a qualitative perspective, thereby constituting a mixed-methods and holistic approach to the research. Finally, as deep learning involves several individual, methodological, and contextual aspects, including emotional intelligence (Cebollero-Salinas et al., 2022b) and family supervision of technology use (Elboj et al., 2023), those aspects would require further analysis.

Nevertheless, our results have important research value. They have provided evidence relating deep learning to concrete, Internet-oriented competencies (such as netiquette and the evaluation of information reliability). Furthermore, our study has confirmed the necessity and importance of working on competencies such as critical thinking at a university level (Morales Bueno, 2018; Denoni & Cebollero-Salinas, 2025), particularly given students' widespread, intensive Internet use. Another new finding is the evidence that an individual's learning mode (deep or superficial) is affected by the age when they acquired their first smartphone.

In conclusion, our investigation has shown that in the current context where virtual environments are omnipresent, promoting in-depth learning at university requires the development of online skills such as netiquette and the verification of online information, particularly in university students who started using a smartphone before the onset of adolescence. In light of these findings, we underscore the importance of fostering a disposition for critical thinking and promoting digital literacy—particularly in online information reliability assessment and netiquette—as essential for achieving deep learning. The inclusion of formative seminars in the first course and the use of thinking routines for the evaluation of information throughout the university career are some of the proposals that we believe can contribute to achieve this deep learning that the disposition to critical thinking and digital literacy generate. Likewise, some of the prospects that we consider of interest in this regard are the mixed-cut studies that allow from qualitative and quantitative methodologies to address the development of the constructs of analysis in a holistic manner. We also believe that longitudinal studies will allow us to investigate hypotheses that involve long-term learning, such as that deep learning worked from digital literacy and the promotion of a critical thinking disposition generate deep learning that lasts over the years.

In line with the study's objectives, the results not only offer a better understanding of how certain digital skills and cognitive dispositions relate to deep learning, but also provide a glimpse into concrete educational implications. The systematic integration of critical thinking and online information analysis into educational curricula is fundamental for the development of media and digital literacy. Implementing rubrics, research projects, and fact-checking tools across all subjects allows students to not only consume information but also synthesize it and use it ethically to build coherent arguments and participate actively and responsibly in the information society. For example, it would be interesting to promote practical skills, such as using fact-checking tools that allow them to efficiently contrast and trace information, as well as the deconstruction of arguments, including the identification of logical fallacies and the evaluation of persuasive rhetoric. In addition, it is suggested to incorporate active methodologies based on art and critical pedagogy—such as the use of digital narratives, creative projects, or media analysis—that foster a deeper, more meaningful learning experience connected to students' digital reality. These proposals can be especially useful for designing teaching interventions that respond to the current challenges of higher education in environments increasingly mediated by technology.

Together, these skills would allow students to transition from passive consumers to ethical producers of knowledge, thus strengthening their autonomy and their ability to navigate the digital environment responsibly (Area-Moreira & Pessoa, 2012).

The systematic integration of critical thinking and online information analysis into educational curricula is essential for developing media and digital literacy. Implementing rubrics, research projects, and fact-checking tools across all subjects allows students to not only consume information but also to synthesize it and use it ethically to build coherent arguments and participate actively and responsibly in the information society. Furthermore, the integration of artificial intelligence (AI) into the educational environment promises to revolutionize teaching by offering personalized learning tools and automating certain tasks. However, its adoption presents significant ethical and pedagogical challenges that require critical reflection; one of the main challenges, along with privacy and data security, is the verification of information and critical thinking in order to be ethical.

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