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Validation of an instrument to analyze the cognitive strategies activated by young university students in the face of Fake News in the era of Artificial Intelligence

Validación de un instrumento para analizar las estrategias cognitivas activadas por jóvenes universitarios ante las Fake News en la era de la Inteligencia Artificial

Validação de um instrumento para analisar as estratégias cognitivas ativadas por jovens universitários face às Fake News na era da Inteligência Artificial

验证用于分析大学生应对假新闻的认知策略的工具：人工智能时代的挑战

التحقق من صحة أداة لتحليل الاستراتيجيات المعرفية التي يستخدمها الشباب الجامعيون لمواجهة الأخبار الكاذبة في عصر الذكاء الاصطناعي

Castañeda-Fernández, Jonathan, del Moral-Pérez, M. Esther, López-Bouzas, Nerea

University of Oviedo, Spain

Abstract

The present society faces the challenge and uncertainty generated by the deluge of Fake News (FN) spread on social media. Meanwhile, the emergence of Artificial Intelligence (AI) leads to a state of misinformation that threatens democracies, public health, and the credibility of the media. In this context, the general public, and young people in particular, are not adequately prepared to respond to this issue. Therefore, this research presents the validation of an instrument to understand the cognitive strategies that young people activate when confronted with FN, categorizing them hierarchically according to Bloom's taxonomy. A sample of 543 Spanish university students participated in the validation process. Reliability was calculated using Cronbach's Alpha and McDonald's Omega coefficients. It was validated through exploratory factor analysis with oblique rotation and confirmatory factor analysis using the weighted least squares method. The results demonstrate a high level of internal consistency, ensuring reliability and construct validity. The final instrument consists of 9 variables and 52 items, in accordance with the initial model. Its scientific robustness makes it suitable for understanding the cognitive strategies activated by young people in response to FN. Finally, it should be noted that it can facilitate the design of educational interventions tailored to the identified needs, aiming to provide young people with appropriate strategies to critically respond to FN and the challenges posed by AI in this regard.

Keywords: validation; instrument; cognitive strategies; fake news; artificial intelligence.

Resumen

La sociedad actual se enfrenta al desafío y la incertidumbre generada por el aluvión de *Fake News* (FN) difundidas en las redes sociales. Por su parte, la emergencia de la Inteligencia Artificial (IA) aboca a un estado de desinformación que amenaza a las democracias, la salud pública y la credibilidad de los medios de comunicación. En este contexto, la ciudadanía -en general- y los jóvenes -en particular- no están preparados suficientemente para responder a esta problemática. Así pues, esta investigación presenta la validación de un instrumento para conocer las estrategias cognitivas que los universitarios activan frente a las FN, categorizándolas jerárquicamente, atendiendo a la taxonomía de Bloom. En el proceso de validación participó una muestra de 543 universitarios españoles. La fiabilidad se calculó con el coeficiente Alfa de Cronbach y Omega de McDonald. Se validó mediante el análisis factorial exploratorio de rotación oblicua y el análisis factorial confirmatorio con el método de mínimos cuadrados ponderados. Los resultados demuestran un alto nivel de consistencia interna, garantizando la fiabilidad y validez de constructo. El instrumento final consta de 9 variables y 52 ítems, acorde al modelo de partida. Su robustez científica lo convierte en idóneo para conocer las estrategias cognitivas activadas por los jóvenes ante las FN. Finalmente, cabe señalar que conocer estas estrategias cognitivas puede facilitar el diseño de intervenciones educativas adaptadas a las necesidades detectadas, con el fin de proporcionarles fórmulas adecuadas para que sepan responder críticamente ante las FN y a los retos que plantea la IA a este respecto.

Palabras clave: validación, instrumento, estrategias cognitivas, *fake news*, inteligencia artificial.

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Corresponding author / Autor de contacto: Nerea López Bouzas, University of Oviedo;
C/ Aniceto Sela, 1, 33005. Oviedo, Spain. correo-e: lopeznerea@uniovi.es

Resumo

A sociedade atual enfrenta ao desafio e a incerteza gerada pela avalanche de *Fake News* (FN) difundidas nas redes sociais. Por seu lado, a emergência da Inteligência Artificial (IA) está a conduzir a um estado de desinformação que ameaça as democracias, a saúde pública e a credibilidade dos meios de comunicação social. Neste contexto, os cidadãos - em geral - e os jovens - em particular - não estão suficientemente preparados para responder a este problema. Assim, esta investigação apresenta a validação de um instrumento para conhecer as estratégias cognitivas que os estudantes universitários ativam perante as FN, categorizando-as hierarquicamente, de acordo com a taxonomia de Bloom. Uma amostra de 543 estudantes universitários espanhóis participou no processo de validação. A fiabilidade foi calculada com o coeficiente Alfa de Cronbach e Omega de McDonald. Foi validado através da análise fatorial exploratória de rotação oblíqua e da análise fatorial confirmatória com o método dos mínimos quadrados ponderados. Os resultados demonstram um elevado nível de consistência interna, garantindo a fiabilidade e validade de construto. O instrumento final é composto por 9 variáveis e 52 itens, em conformidade com o modelo de partida. A sua robustez científica torna-o ideal para conhecer as estratégias cognitivas ativadas pelos jovens face às FN. Por fim, é de salientar que conhecer estas estratégias cognitivas pode facilitar a conceção de intervenções educativas adaptadas às necessidades detetadas, a fim de lhes fornecer fórmulas adequadas para saberem responder criticamente face às FN e aos desafios colocados pela IA a este respeito.

Palavras-chave: validação, instrumento, estratégias cognitivas, *fake news*, inteligência artificial.

摘要

当今社会正面临由社交媒体传播的大量**假新闻（Fake News, FN）**带来的挑战与不确定性。此外，人工智能（AI）的兴起进一步加剧了信息误导的现象，对民主、公共健康和媒体可信性构成威胁。在这一背景下，全社会，尤其是年轻人，尚未充分准备应对这一问题。因此，本研究旨在验证一项工具，用于了解大学生面对假新闻时激活的认知策略，并根据布鲁姆分类法对这些策略进行分层分类。

研究样本包括来自西班牙的543名大学生。工具的可靠性通过克朗巴赫α系数和麦克唐纳Ω系数进行评估。通过斜交旋转的探索性因子分析和加权最小二乘法的验证性因子分析进行效度验证。结果显示，该工具具有较高的内部一致性，并且验证了其构念的可靠性和有效性。最终版本包括9个变量和52个条目，与初始模型一致。

该工具的科学稳健性使其成为分析大学生应对假新闻认知策略的理想选择。研究还指出，了解这些认知策略有助于设计针对性教育干预，满足发现的需求，帮助年轻人培养批判性思维，以有效应对假新闻及人工智能带来的相关挑战。

关键词：验证、工具、认知策略、假新闻、人工智能

ملخص

المنتشرة عبر وسائل التواصل الاجتماعي. في الوقت ذاته، (Fake News) لمجتمع الحالي يواجه تحديًا وعدم يقين ناتجًا عن سيل من الأخبار الكاذبة إلى حالة من التضليل تهدد الديمقراطيات، والصحة العامة، ومصداقية وسائل الإعلام. في هذا السياق، يظهر أن (AI) أدى ظهور الذكاء الاصطناعي تقدم هذه الدراسة التحقق من صحة أداة تهدف إلى .المواطنين بشكل عام، والشباب بشكل خاص، ليسوا مستعدين بشكل كافٍ لمواجهة هذه المشكلة ، مع تصنيفها بشكل هرمي استنادًا إلى (Fake News) تحليل الاستراتيجيات المعرفية التي يُفعّلها الطلاب الجامعيون عند التعامل مع الأخبار الكاذبة تصنيف بلوم. شارك في عملية التحقق من الصحة عينة مكونة من 543 طالبًا جامعيًا من إسبانيا. تم حساب الموثوقية باستخدام معامل ألفا كرونباخ ومعامل أوميغا ماكدونالد. تم التحقق من الصلاحية من خلال التحليل العاملي الاستكشافي باستخدام الدوران المائل والتحليل العاملي التأكيدي باستخدام يتألف الأداة النهائية .طريقة أقل المربعات الموزونة. أظهرت النتائج مستوى عالٍ من الاتساق الداخلي، مما يضمن موثوقية الأداة وصلاحيتها البنيوية من 9 متغيرات و52 بندًا، بما يتماشى مع النموذج الأولي. تجعل متانتها العلمية منها أداة مثالية لفهم الاستراتيجيات المعرفية التي يستخدمها الشباب عند ختامًا، يُشار إلى أن فهم هذه الاستراتيجيات المعرفية يمكن أن يُسهم في تصميم تدخلات تعليمية مُكيَّفة لتلبية .(Fake News) مواجهة الأخبار الكاذبة الاحتياجات المكتشفة. يهدف ذلك إلى تزويد الشباب بأدوات تساعدهم على الاستجابة النقدية للأخبار الكاذبة ولمواجهة التحديات التي يطرحها الذكاء الاصطناعي في هذا

الكلمات الدالة : السياقالتحقق من الصحة، أداة، استراتيجيات معرفية، الأخبار الكاذبة، الذكاء الاصطناعي

Introduction

Society today is challenged by a deluge of fake news (FN)—fabricated information converted into news-like stories that are untrue, leading to citizens experiencing a dangerous atmosphere of uncertainty. A state

of misinformation (Egelhofer & Lecheler, 2019) has proliferated with the emergence of artificial intelligence (AI) (Otero, 2022; Ufarte et al., 2021), with deception and manipulation threatening democracy, public health, and the credibility of the media (Ruffo et al., 2023; Wang & Huang, 2021), no doubt concealing the socioeconomic and political interests encouraging it (Bragarnich, 2022). Furthermore, the spread of misinformation is enhanced by the viral effects of social networks (SNs), which affect reality, making public opinion accept it as true (Hernández, 2020). This happened during the COVID-19 pandemic (Román et al., 2020), it happens with climate change denial (Al-Rawi et al., 2021), and it happens with advocates in the health and beauty industry (De Regt et al., 2020), among others.

Young people are the specific sector of the population that faces the greatest exposure to FN given the amount of time they spend on SNs (Iglesias et al., 2023; Montero et al., 2022; Murciano et al., 2022), where the information that they search for or receive is not always verified or true (Mendiguren et al., 2020) and may even have been created by AI without any basis in fact. In addition, SN algorithms analyze users' personality traits, beliefs, and opinions about controversial topics (Zimmer et al., 2019), serving them only stories in line with their targeting. This affects subjects' perceptions of reality, leading them to live in a bubble (Burbach et al., 2019) and limiting their critical thinking. The impossibility of getting different information, along with an inability to test the information they do receive—either due to lack of education or strategies to do so—is a particular risk factor for the young audience who are in a key period of developing their autonomy and critical skills.

Various studies have been undertaken in this regard, some focused on aspects such as the emotional impact of fake news and it going viral (Horner et al., 2022) and the influence of FN on consumption of certain brands (Borges et al., 2020). In addition, the use of images to make FN more persuasive is a great challenge (Luo et al., 2022). AI tools are producing fake images that are ever more realistic, which leads to permanent skepticism (Otero, 2022; Ufarte et al., 2021). In such an uncertain context, there is growing concern, particularly about young people's education, which has produced educational activities at various educational levels, including secondary (López-Flamarique & Planillo, 2021) and higher education (Pérez-Escoda et al., 2022), aimed at stimulating and activating students' media skills—the combination of skills and abilities that allow them to analyze and critically interpret the information they receive through social media (Lim & Tan, 2020).

Clearly, university students face a changing ecosystem (McDougall et al., 2019), and future teachers in particular are a key part of educating future generations, which is why giving them the necessary skills is a priority to ensure thoughtful, critical citizens in the future. This means that identifying the strategies that future teachers use in the face of FN may be a valuable starting point, diagnostically speaking, to identify gaps in their training and—in the short term—come up with interventions that help strengthen their media skills. The present study presents the validation of an instrument that collects their opinions, thoughts and reactions in order to identify the cognitive strategies that they employ when dealing with FN created and spread with AI.

Cognitive strategies against fake news

People's cognitive strategies are identified with the regulation of mental and decision-making processes that are activated in order to respond appropriately to problems that they face throughout life (Bernal et al., 2019). This presupposes the declarative and procedural knowledge of the type of response to make—in other words, what they have to do and how to do it—in order to guide and organize their behavior (Meza, 1979). In this case, that would concern how they address the task of identifying the veracity of news or information they receive and the problems that arise from FN spread by SNs. These processes involve the activation of abilities aimed at selecting,

acquiring, processing, storing, applying, and ethically assessing information received (Saltor et al., 2023). Bronstein et al. (2021) noted that the intuitive analytical reasoning strategies subjects employ when faced with FN affect their beliefs, underscoring the need to examine the processes involved.

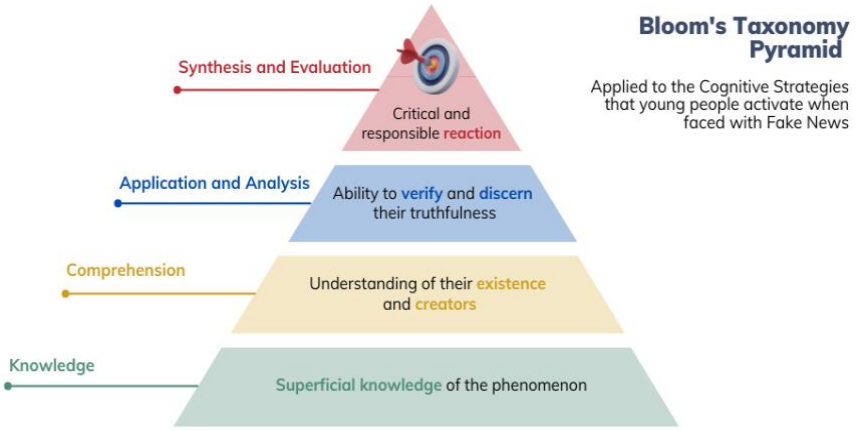
The cognitive strategies deployed against FN can be categorized hierarchically, using Bloom's classic taxonomy, for example (Bloom et al., 1956). First, it is necessary to determine whether subjects know what FN stories are, if they can identify them, and if they are aware that they receive them through SNs every day. This indicates their basic skills linked to *knowledge* of the phenomenon related to false news stories and hoaxes, etc. It is also interesting to determine whether subjects can recognize the different types of FN that circulate on SNs and discern the different forms they take, whether it is out-of-context satirical content, clickbait, contains images with misleading framing, or presents deceptive information, etc. (López-Flamarique & Planillo, 2021).

It is also important to understand subjects' *comprehension* of FN. More specifically, whether they can identify the environments where misleading, biased, or manipulated information proliferates (Mendiguren et al., 2020). This would include testing their ability to think about the causes or interests behind the creation of these news stories, which may be linked to profit, political or ideological manipulation, capturing an audience or consumers, producing controversy or social panic, discrediting people or institutions, or providing a smokescreen for other news items (Rath et al., 2019). It is important to determine whether people can distinguish those responsible for FN going viral and understand their fundamental role in persuading the different sectors of the population about a given topic.

In addition, it is essential to detect the strategies aimed at *application* and *analysis* that young people employ when dealing with FN, given that these strategies can affect their behavior and have negative impacts, as noted by Greene and Murphy (2021) and Wang et al. (2022). More specifically, identifying criteria that subjects use to give credibility to the information they receive is key. How do they prioritize identifying the spokesperson. In other words, is it a specialist (a scientist or recognized body)? Is it personal testimony? Is there corroborating audiovisual content? Or is credibility linked to the fact that it was forwarded by someone the subject knows (Del Moral et al., 2021). Similarly, it is interesting to examine the elements of the information being received that make subjects doubt its veracity (Bronstein et al., 2021), whether that is the lack of an author or publication date, the omission of a credible source, controversial or socially sensational data, appearing to be clickbait, using discriminatory or offensive language, or being badly written and containing spelling mistakes or grammatical errors.

Lastly, it is important to analyze the higher cognitive strategies deployed in the face of FN, which appear in people's abilities related to *synthesis* and *evaluation* (Orhan, 2023). This may be inferred from their reactions to receiving this kind of information (Greene & Murphy, 2021), whether they choose to read the whole thing to determine whether it is true, check the source or author, check links, consult other people, spread the information on the internet, compare it with other sources, or simply ignore it. Another indicator that may shed light on people's levels of critical analysis and self-regulation of SN behavior is whether they can give reasons that drive them to spread these stories (Batailler et al., 2022; Britt et al., 2019). Perhaps they think that others might find such stories useful, have a personal impact, contain sensitive or shocking information, reinforce their thinking or ideological convictions, or it may be a form of entertainment. Figure 1 shows the cognitive strategies that young people deploy when faced with FN, following Bloom's taxonomy.

Figure 1. Stratification of cognitive processes deployed against fake news.



There is no doubt about the importance of identifying ideal cognitive strategies that people should deploy when faced with FN in order to avoid falling prey to manipulation. Along these lines, the present study proposes an instrument for analyzing the different process that young people use when dealing with this issue. More specifically, and with an educational perspective—given the crucial role of future teachers in training new generations—the study focuses on students in this sector to identify possible educational gaps and to subsequently help design interventions to plug those gaps, providing students with the strategies they will need to properly deal with the flood of FN that they face every day.

Methodology

Objective

This study aims to validate an instrument for identifying the cognitive strategies that young people deploy when dealing with FN that they receive via SNs.

Sample

The study sample comprised students in the faculties of education at the University of Oviedo and the University of Valencia. Sampling was intentional, non-probabilistic, applying incidental or convenience criteria based on students on these courses being available to complete the questionnaire (academic year 2022/2023), following Hernández-Sampieri et al. (2014). The sample was made up of 543 Spanish students: 49.5% from the University of Valencia, 50.5% from the University of Oviedo. The distribution by course was as follows: Education/Pedagogy (28.4%), Infant Education Teaching (24.1%), Primary School Teaching (20.8%), Social Education (15.8%), and Masters in Secondary Education (10.9%). These courses are overwhelmingly taken by women (77.3%), with a minority of men (22.7%). The students were aged: 18-19(32.1%), 20-21(35.8%), 22-23(18.5%), 24-25(18.5%) and over 25 (5.4%).

Instrument design and validation

The *ENREDA2* instrument was designed for this study, based on other instruments covering similar ground (Catalina-García, 2019; De Vicente et al., 2021; López-Flamarique & Planillo, 2021; Palau Martín et al., 2023; Pérez-Escoda et al., 2022; Tourón et al., 2023), although in this case examining the strategies university students activate when faced with FN. It is administered online via Google Forms. There is a short introduction indicating the research objective, and instructions for how to complete the instrument. A pilot study was performed using an incidental sample of 12 students. This allowed us to tweak the wording to ensure ease of comprehension for some questions. The questionnaire includes items related to classification variables: age, gender, university, course, daily time spent on SNs, and media or social networks where respondents get their news. It also includes 52 items collecting the young people's

opinions, thoughts, and strategies in relation to FN they receive. The response to each item is given on a four-point Likert-type scale: 1=never/none/not at all, 2=a little/occasionally, 3=somewhat/often, and 4=very much/always (Table 1).

Table 1. Identification of ENREDA2 variables and categories.

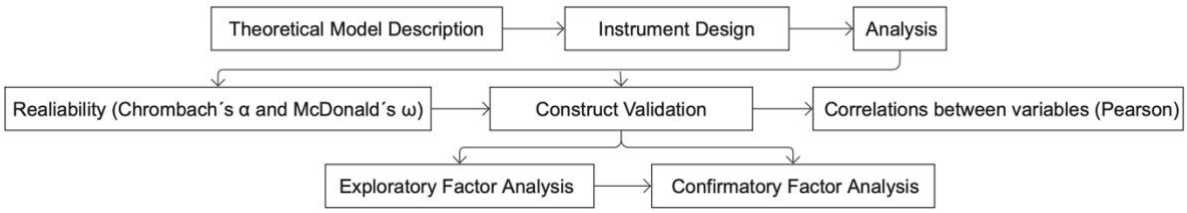
Variables	
V1. *Knowledge.* Are you aware of the fake news you receive?	
V2. *Knowledge***.** What type of fake news (FN) do you encounter on your social networks?	V2.1. Humorous or satirical information V2.2. Information taken out of context V2.3. Misleading headlines, images, or captions V2.4. Information/image with misleading or distorted framing V2.5. Unproven information created to deceive/manipulate
V3. *Understanding.* In which area do you find the most FN?	V3.1. Culture; V3.2. Health; V3.3. Environment; V3.4. Society; V3.5. Economy; V3.6. Politics; V3.7. Sports
V4. *Synthesis and evaluation.* How do you react to alleged FN?	V4.1. I ignore it/do not read it V4.2. I read it entirely V4.3. I check the source/authorship V4.4. I verify the link V4.5. I consult with others V4.6. I seek more information V4.7. I cross-check with other media
V5. *Application and analysis.* How important are certain elements in giving credibility to a news story?	V5.1. Supported by a specialist/recognized entity V5.2. Backed by testimonies V5.3. Includes real images/videos V5.4. Sent by a friend V5.5. It does not generate controversy
V6. *Application and analysis.* To what extent do these indicators make you doubt the truthfulness of a news story?	V6.1. Nonexistent authorship V6.2. Omitted publication date V6.3. Unofficial source V6.4. Forwarded via WhatsApp/Telegram V6.5. Controversial/shocking data V6.6. Clickbait V6.7. Discriminatory/offensive tone V6.8. Poor writing and/or spelling/grammatical errors
V7. *Understanding*. Indicate the reasons you believe generate FN	V7.1. To gain audience/visitors/clicks V7.2. To generate false controversy V7.3. To manipulate V7.4. Economic interests V7.5. Social alarm V7.6. To discredit people/entities V7.7. To cover up other news
V8. *Understanding*. Who do you think is responsible for the spread of FN?	V8.1. Citizens; V8.2. Influencers; V8.3. Pseudo-experts; V8.4. Politicians; V8.5. Journalists
V9. *Synthesis and evaluation*. Indicate the reasons why we contribute to spreading FN without verifying them	V9.1. It may be useful to others V9.2. It relates to my interests V9.3. It worries me V9.4. It impacts me V9.5. It entertains me (humor/irony) V9.6. It aligns with my ideas V9.7. It reinforces my ideology

Data collection and data analysis

Data was collected during academic year 2022-2023. Students were asked to participate, with anonymity assured. They were able to access the questionnaire with their mobile phones via a QR code or through a link.

Data analysis was performed using a variety of statistics. Reliability was calculated using Cronbach Alpha and McDonald's Omega coefficient. Construct validity was determined via exploratory factor analysis (EFA), using principle axis factoring and oblique rotation, following the Oblimin method (delta=0), as suggested by Lloret-Segura et al. (2014). In addition, we performed a confirmatory factor analysis (CFA), following the guidelines from Cabrera-Nguyen (2010), using weighted least squares, as it did not meet the criteria for normality. The EFA, reliability, and correlations were performed using SPSS v26, the CFA was done using SPSS Amos v21 (Figure 2).

Figure 2. Flow diagram of validation and consolidation.



Results

Reliability analysis

The instrument was validated through applying the Cronbach Alpha statistic (α=0.884), confirming its high level of internal consistency, without redundancy or duplication of items. This was complemented by McDonald's Omega (ω=0.861), which is suitable for Likert-type scales. There was very little difference comparing the two models, which indicates that the instrument has a high level of reliability.

Table 2 shows the values of Cronbach's Alpha for the 52 items along with the value if items were eliminated. Only three items would improve the reliability of the instrument if they were removed, although the impact on its reliability would be minimal: 1:*Are you aware of the fake news you receive?; How do you usually react when you think you are seeing fake news?* 4.1: I ignore it /I don't read it; and *How important to you are the following elements to give a news story credibility?* 5.4: It was sent by a friend. According to the corrected homogeneity index, the item: *How do you usually react when you believe you are looking at fake news?* 4.2 I read it fully, did not reach the minimum value of 0.200. Removing it did not affect reliability, and we chose to retain it. In general, the other items presented indices of homogeneity that were good (0.300<r<0.400; in 29/52 items) or very good (r>0.400; 15/52 items).

Table 2. Cronbach alpha (α) for each element.

Variables	α if the item is deleted	Corrected item-total correlation
1.	.885	.098
2.1.	.884	.205
2.2.	.882	.343
2.3.	.882	.313
2.4.	.882	.336
2.5.	.881	.385
3.1.	.882	.330
3.2.	.881	.390
3.3.	.883	.301
3.4.	.881	.403
3.5.	.882	.353
3.6.	.881	.402
3.7.	.884	.210
4.1.	.885	.118
4.2.	.884	.161
4.3.	.883	.306
4.4.	.884	.223
4.5.	.883	.304
4.6.	.881	.375
4.7.	.882	.337
5.1.	.882	.373
5.2.	.882	.332
5.3.	.883	.310
5.4.	.885	.059
5.5.	.884	.201
6.1.	.881	.424
6.2.	.882	.342
6.3.	.881	.425
6.4.	.882	.337
6.5.	.883	.308
6.6.	.881	.390
6.7.	.880	.481
6.8.	.881	.438
7.1.	.880	.480
7.2.	.880	.460
7.3.	.880	.495
7.4.	.881	.448
7.5.	.881	.431
7.6.	.880	.463
7.7.	.880	.459
8.1.	.882	.367
8.2.	.883	.306
8.3.	.882	.333
8.4.	.882	.333
8.5.	.882	.346
9.1.	.882	.346
9.2.	.881	.381
9.3.	.881	.401
9.4.	.881	.400
9.5.	.882	.334
9.6.	.881	.374
9.7.	.881	.373

Table 3 shows the indices of reliability for each of the eight variables used according to Cronbach alpha (α) and McDonald's omega (ω). It also includes the composite reliability (CR) coefficients, the average variance extracted (AVE), and the maximum shared variance (MSV).

Table 3. Analysis of reliability for each variable.

Variables	α	ω	CR	AVE	MSV
What type of fake news (FN) do you find on your social networks?	0,665	0,686	0,702	0,440	0,233
In which area do fake news (FN) abound the most?	0,680	0,682	0,703	0,454	0,477
How do you react to alleged fake news (FN)?	0,668	0,710	0,685	0,477	0,330
How important are certain elements in giving credibility to a news story?	0,692	0,694	0,675	0,449	0,240
To what extent do these indicators make you doubt the truthfulness of a news story?	0,786	0,788	0,779	0,534	0,373
Indicate the reasons you believe generate fake news (FN).	0,845	0,846	0,837	0,674	0,477
Indicate who you think is responsible for the spread of fake news (FN).	0,672	0,687	0,693	0,450	0,418
State the reasons why we contribute to spreading fake news (FN) without verifying it.	0,853	0,858	0,844	0,590	0,217

The instrument was confirmed to demonstrate good internal consistency, despite some variables presenting a somewhat lower level of reliability—particularly according to Cronbach alpha—because in all cases, the values for α and ω were close to 0.700. These two taken together indicate high overall reliability.

In addition, the model was shown to have suitable reliability (CR), although three variables had values <0.700. It also demonstrated limited convergent validity (AVE), as only three variables were >0.500, although those that did not reach this level were close to it. Suitable discriminant validity (MSV) was also confirmed, as all of the variables had values of AVE > MSV.

Exploratory factor analysis

We determined whether exploratory factor analysis was possible. The Kaiser-Meyer-Olkin (KMO) test confirmed the adequacy of the sampling with a value of 0.835. Bartlett's sphericity test also gave a significant result $p<0.001$.

Table 4 shows the amount of the total variance explained by each of the variables making up the dimension being examined, establishing their relation and interdependence.

Table 4. Total explained variance

Variables	Initial eigenvalues			Extraction communalities
	Total	% of variance	% cumulative	
1.	8.315	15.989	15.989	.193
2.	3.209	6.171	22.160	.211
3.	2.832	5.447	27.607	.400
4.	2.039	3.922	31.529	.472
5.	1.924	3.700	35.229	.482
6.	1.797	3.456	38.685	.400
7.	1.712	3.293	41.978	.221
8.	1.547	2.975	44.953	.327
9.	1.414	2.719	47.672	.316
10.	1.330	2.558	50.230	.332
11.	1.249	2.402	52.632	.515
12.	1.170	2.250	54.882	.422
13.	1.047	2.013	56.894	.199
14.	1.037	1.995	58.889	.251
15.	.974	1.873	60.762	.284
16.	.936	1.800	62.562	.636
17.	.926	1.781	64.343	.436
18.	.899	1.729	66.072	.391

19.	.851	1.637	67.710	.556
20.	.836	1.608	69.317	.486
21.	.792	1.523	70.840	.390
22.	.787	1.513	72.353	.526
23.	.766	1.474	73.827	.404
24.	.738	1.420	75.246	.259
25.	.703	1.352	76.598	.428
26.	.696	1.339	77.937	.663
27.	.691	1.329	79.266	.527
28.	.653	1.256	80.522	.394
29.	.619	1.191	81.713	.332
30.	.611	1.176	82.889	.330
31.	.584	1.123	84.011	.439
32.	.563	1.082	85.094	.520
33.	.540	1.038	86.132	.439
34.	.532	1.024	87.155	.513
35.	.514	.989	88.144	.476
36.	.495	.952	89.096	.496
37.	.487	.936	90.032	.452
38.	.460	.884	90.917	.534
39.	.445	.855	91.772	.559
40.	.418	.803	92.575	.481
41.	.404	.777	93.351	.265
42.	.393	.756	94.107	.328
43.	.376	.724	94.831	.327
44.	.351	.675	95.506	.683
45.	.343	.660	96.166	.379
46.	.336	.646	96.812	.511
47.	.324	.623	97.435	.551
48.	.320	.616	98.051	.642
49.	.302	.581	98.632	.732
50.	.296	.569	99.201	.391
51.	.233	.448	99.649	.812
52.	.183	.351	100.000	.674

Looking at the communalities of extraction, most of the variables indicated excellent condition, with values >0.70 and present in two items; or moderate, with values between 0.35 and 0.70, present in 35 items. Few items had a low value.

Grouping the values around 15 components was shown to explain more than 60% of the variance of the results. The scree plot indicates the contribution and importance of the variables used to analyze the young people's opinions of FN, the strategies they activate, and their perceptions of that (Figure 3).

Figure 3. Scree plot.

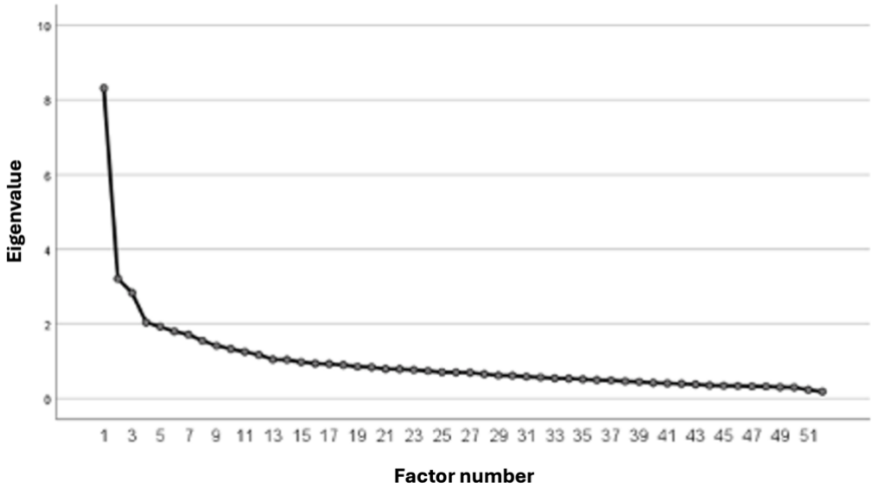


Table 5. Component matrix.

Variables	Components										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.	.39										
2.1.			.38								
2.2.			.59								
2.3.			.64								
2.4.			.66								
2.5.			.60								
3.1.				-.35							
3.2.				-.50							
3.3.				-.51							
3.4.				-.41							
3.5.				-.69							
3.6.				-.57							
3.7.											
4.1.		.41									
4.2.		-.40									
4.3.	.77										
4.4.	.60										
4.5.		-.46									
4.6.	.41	-.49									
4.7.	.52	-.37									
5.1.					.53						
5.2.					.69						
5.3.					.57						
5.4.					.45						
5.5.					.58						
6.1.						-.80					
6.2.						-.68					
6.3.						-.47	.47				
6.4.							.52				
6.5.							.51				
6.6.						-.33	.62				
6.7.						-.46	.52				
6.8.						-.48	.42				
7.1.								.59			
7.2.								.62			
7.3.								.65			
7.4.								.59			
7.5.								.69			
7.6.								.72			
7.7.								.66			
8.1.											
8.2.									.46		
8.3.									.50		
8.4.									.80		
8.5.									.57		
9.1.										-.65	.36
9.2.										-.65	.43
9.3.										.35	-.32
9.4.										.40	-.33

9.5.	.52	-.40
9.6.	.85	-.73
9.7.	.79	-.77

Components: 1: Awareness and Reaction (1); 2: Reaction (2); 3: Type; 4: Environment; 5: Elements of credibility; 6: Indicators of doubt (1); 7: Indicators of doubt (2); 8: Motives for creating FN; 9: Those responsible for spreading FN; 10: Justifications for spread (1); and 11: Justifications for spread (2).

With the matrix of components rotated, the grouping of the variables was around 11 factors (Table 5).

The items >0.320 were grouped into eight factors, given that the variables *awareness* and *reaction* to FN were combined into a single factor despite the latter being split over two factors—one focused on the reaction to the source of the FN (reaction 1) and the other to the reaction to the content (reaction 2). The variables related to the *types of FN*, the *environments* where they predominate, the elements that give them *credibility*, *motives for creating FN*, and *those responsible for spread* each produced factors from the initially identified items. The items related to *indicators of doubt* were spread over two factors. The items linked to *justifications for spread* of FN were grouped in two other components (justifications 1 and 2), although the first of those had greater representivity, meaning the second was rejected.

Each of the resulting factors was made up of at least four items that were accurate and stable in the factorial solution. Furthermore, almost all of the items had values >0.320, and only two were suggested for elimination: "*What environments do you think have more FN?* 3.7: Sports" and "*Indicate who is responsible for spreading FN to a greater or lesser extent:* 8.1 The general public".

Analysis of bivariate correlations for each of the eleven factors generally produced significant relationships (Table 6).

Table 6. Distribution of bivariate correlations for the obtained factors.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	1.000										
2	-.292**	1.000									
3	.096	-.025	1.000								
4	-.076	.023	-.285**	1.000							
5	.102*	-.168*	.055	-.063	.000						
6	-.234**	.223**	-.076	.098	-.262**	1.000					
7	-.132*	.272**	-.014	.078	-.380**	.363**	1.000				
8	.049	.028	.018	-.182*	-.234**	.214**	.261**	1.000			
9	-.083	-.052	.189*	-.228**	.103*	0.071	.060	.318**	1.000		
10	.004	-.038	-.109*	.065	-.128*	.189*	.230**	.014	-.091	1.000	
11	.019	.014	-.197**	.131*	-.222**	.136*	.148*	-.213**	-.086	.273**	1.000

*The correlation is significant at 0,05 (bilateral); The correlation is significant at 0.01 (bilateral); Components: 1: Awareness and reaction (1); 2: Reaction (2); 3: Type; 4: Environment; 5: Elements of credibility; 6: Indicators of doubt (1); 7: Indicators of doubt (2); 8: Motives for creating FN; 9: Those responsible for spreading FN; 10: Justifications for spread (1); and 11: Justifications for spread (2).

The variable *reaction to FN* is linked to the variable *elements of credibility* and to *indicators of doubt*. The *type* of FN and the *environment* they are produced in are related to each other and to the *justifications for spreading FN* and to those *responsible* for that. The elements that provide a news story's *credibility* are negatively correlated to the *indicators of doubt*. These indicators are also linked to the *motives for creating FN*, *justifications for spread*, and *those responsible for spreading FN*. The *indicators of doubt* are related to the *motives for creating FN* and the *justifications for spreading FN*. In addition the

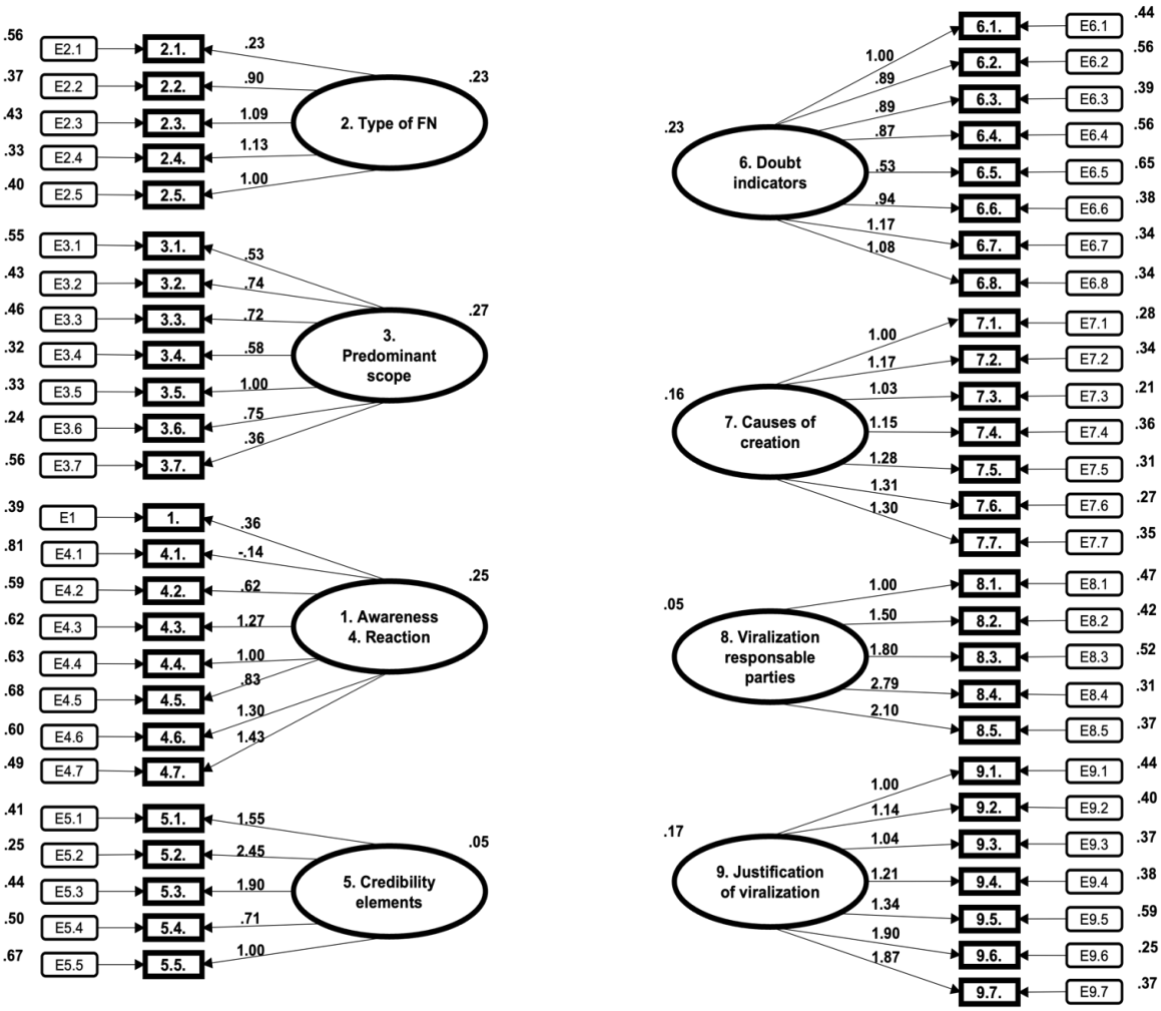
motives for creating FN are strongly linked to the *justifications for spread* and *those responsible for spreading FN*.

Lastly, the validity of the construct of the starting theoretical model was confirmed, and consequently, that of the instrument.

Confirmatory factor analysis

The factor loadings for the elements making up each variable were high (Figure 4), mostly >0.7. They were only <0.5 for four items: "*What type of fake news do you often encounter in your feeds?* 2.1: Satirical or humorous information", ""*What environments do you think have more FN?* 3.7: Sports", "*Are you aware of the fake news you receive?*", and "*How do you usually react when you think you are seeing fake news?* 4.1: I ignore it /I don't read it".

Figure 4. Structural diagram of the scale.



The fit of the results to the proposed theoretical model was tested using the parameters established by Hu and Bentler (1999). Table 7 shows the values and the reference values for the fit of the model in terms of the following statistics: Chi-squared (CMIN), the Goodness of Fit Index (GFI), the Parsimonious Goodness of Fit Index (PGFI), the Normalized Fit Index (NFI), the Parsimonious Normalized Fit Index (PNFI), the Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Incremental Tucker Lewis Index of Fit (TLI) (Table 7).

Table 7. Indices of fit to the model.

Índex	Result	Fit Criterion
CMIN	.000	p>.050
GFI	.861	p>.700
PGFI	.793	p>.700
NFI	.725	p>.700
PNFI	.685	p>.700
RMSEA	.049	p<.050
CFI	.880	p>.900
TLI	.865	p>.900

All of the data met the criteria of fit or were very close to it (Table 7). Only the CMIN index did not, although that might be due to the sample size. In any case, the results generally confirm the consistency of the initially proposed theoretical model.

Discussion and conclusions

The ENREDA2 instrument allows us to understand the cognitive strategies that university students deploy when dealing with FN, although its application may be extrapolated to different contexts. The analysis confirmed the reliability of the model used, which demonstrated good internal consistency, met confirmatory requirements, and demonstrated a suitable fit to the theoretical model based on Bloom's taxonomy. It is constructed around nine components: awareness and perceptions (are they aware they are receiving FN); reaction to FN; types of FN they can identify; the environments where they think FN proliferates; elements of a news story that give them credibility; indicators that raise doubts; the motives or causes behind the creation of FN; who is responsible for spreading FN; and justifications for spreading FN. In line with previous research on related topics (Catalina-García, 2019; De Vicente et al., 2021; López-Flamarique & Planillo, 2021; and Pérez-Escoda et al., 2022), supported by similar theoretical postulates (Herrero-Diz et al., 2022), suitable construct and discriminant validity was confirmed.

The psychometric value of ENREDA2 opens up new study approaches focused on the educational dimension. It allows us to identify the type of cognitive strategies young people prioritize, from the most basic related to superficial understanding of the phenomenon, awareness that it exists, and identifying who creates it, to other, higher-order strategies such as the ability to verify or discern whether it is true, and finally, the ability to react to FN critically and responsibly. In this regard De keersmaecker and Roets (2017) noted that people using higher cognitive strategies were more likely to detect FN, while those who used more basic strategies were more likely to accept it as true.

In our study, following a preliminary analysis of the results, it is concerning that almost half of the students were not aware of receiving FN stories, which is a risk if they believe them to be true, do not check them, and share them without questioning them. Most of the students did not have strategies for detecting FN, and were often victims of clickbait. They recognized that political and society news stories were more likely to be manipulated, although the bubble effect that algorithms produce reinforces their beliefs and limits their critical faculties. Nor did they establish criteria for detecting FN, although they did find experts or recognized bodies more credible. They gave priority to obvious indicators such as spelling or grammatical errors, although they tended not to check the date of publication or the source. They supposed that the creators of FN are seeking to make money, provoke social alarm, or deceive people, although not all of the students discerned the underlying reasons behind FM.

They habitually shared information without checking it, immediately and without thinking, driven by emotion, although some were more cautious and moderated their response.

This instrument means that we can infer different groups of students' educational gaps in terms of filtering the news they receive, identifying aspects that need to be stressed, as Herrero-Diz et al. (2021) concluded—in their case with adolescents—and improving their education to strengthen their media competencies, as noted by Mateus et al. (2019). The instrument is useful because it can facilitate the design of educational interventions that are tailored to the needs detected in each context and that address subjects' different cognitive levels so that they know how to critically respond to FN and the challenges raised by AI. They should be given guidelines for identifying reliable sources of information, detecting the strategies used in SNs to attract and persuade different sectors of the population, identifying the role of the media and its social impact, understanding consumers' rights and responsibilities and ways to avoid deception and/or fraud, and for thinking about their responsibility to not contribute to FN stories going viral. All of this will develop critical thinking and alert students to the emergence of generative AI, so that they are ready to used tools designed to detect it.

One of the main limitations of this study is the sample characteristics. All of the participants were university students aged between 18 and 22 who were studying degrees related to education. A larger sample, which includes different ethnic groups, levels of study, and cultural contexts, will produce results that are more representative of the young population that is faced with fake news.

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Authors / Autores

Castañeda-Fernández, Jonathan (castanedajonathan@uniovi.es) 0000-0003-4934-2979

Lecturer at the University of Oviedo, affiliated with the area of Research Methods and Diagnostic in Education (MIDE). He holds a degree in Pedagogy (awarded the National Prize for University Studies Completion) and a PhD with an international mention from the University of Oviedo, achieved thanks to a University Teaching Staff Training Scholarship (FPU) and a pre-doctoral research stay at the Universidade Lusiada de Lisbon. In teaching, he has primarily delivered courses linked to research and educational assessment. In research, he has participated in various projects (lines: evaluation of training activities, learning approaches, ecosystems for building global citizenship, etc.) and is currently a member of the research group "TECN@: Technology and Learning" at the University of Oviedo.

Author contribution (JCF): Conceptualization • Study Design • Hypothesis Development • Methodology • Data Collection • Data Analysis • Interpretation of Results • Manuscript Writing • Project Supervision • Presentation of Results

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del Moral-Pérez, M. Esther (emoral@uniovi.es) 0000-0002-9143-5960

Professor at the University. Teaches ICT applied to Education. Faculty of Teacher Training and Education. University of Oviedo (Spain). She has been recognised with four six-year research periods. She coordinates the TECN@ Research Group: Technology and Learning. Lead researcher of competitive projects, author of impactful articles in prestigious journals. Research areas include: media, digital literacy, TV and childhood, video games, social networks, augmented reality, digital applications, gamification, education in rural areas, etc. She has undertaken research stays in Calgary (Canada), Poitiers (France), Freiburg (Germany), and ITD Genoa (Italy). She has delivered courses at Ibero-American universities (Chile, Mexico, and Peru).

Author contribution (MEMP): Conceptualization • Literature Review • Study Design • Hypothesis Development • Methodology • Data Collection • Interpretation of Results • Manuscript Writing • Project Supervision

Competing of interests: MEMP expresses that there is no conflict of interest in writing the article.

López-Bouzas, Nerea (lopeznerea@uniovi.es) 0000-0003-0753-0672

PhD in Education and Psychology, awarded a University Teaching Staff Training Scholarship (FPU). Holds a degree in Early Childhood Education and a Master's degree in Research and Innovation in Early Childhood and Primary Education. Collaborates with the Department of Education Sciences and is a member of the TECN@ research group: Technology and Learning at the University of Oviedo. Her research focuses on the integration of technological resources into the teaching-learning process, inclusive education, digital applications, augmented reality, gamification, analysis of audiovisual narratives, etc. She has completed a research stay at L'Istituto Tecnologie Didattiche (CNR-ITD) (Genoa, Italy) and the Centro de Investigação e Intervenção Educativas (CIIE) of the University of Porto (Porto, Portugal).

Author contribution (NLB): Conceptualization • Literature Review • Study Design • Hypothesis Development • Data Collection • Interpretation of Results • Manuscript Writing • Manuscript Editing • Presentation of Results

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