Co-design of a Teaching–Learning Sequence to Address COVID-19 as a Socio-scientific Issue in an Infodemic Context

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Abstract

In the post-truth era, one challenge facing science education is the circulation of fake news that distorts the information available for decision-making on issues that have a scientific basis and are controversial for society. In this work, we aimed at designing a learning environment with the objective of equipping students with skills that allow them to deal with socio-scientific issues (SSI) in an infodemic context. To this end, we proposed an educational innovation through design-based research, which was oriented to the treatment of information disseminated in the media and social networks related to COVID-19. We divided this information into four major constructs: virus and disease dynamics; pandemic and environmental crisis; hygiene and protocols; and vaccines, potential solutions, and pharmaceutical industry. On the basis of the activities of the didactic sequence, which included class discussion, interviews with the immediate environment, audiovisual productions, and a final plenary, we identified criteria that students applied to trust or not trust the circulating information and a series of strategies to corroborate the information. In addition, framing COVID-19 as an SSI allowed the discussion of curricular content in science and on sociocultural dimensions that cross the pandemic. Based on the implementation of the teaching–learning sequence, we conclude that the proposed activities favored reflection on critical thinking and awareness of the responsibilities they have as potential disseminators and/or generators of information.

Keywords Fake news · Prosumer · Coronavirus · Scientific literacy · Science learning environment · Information overload

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Introduction

The post-truth era is characterized by a declining social capital and changing values, growing economic inequality, increasing polarization between political ideologies, a transforming media landscape, and increasing distrust of science (Lewandowsky et al., 2017). These social megatrends concur conforming to the complex nature of this era and give rise to a myriad of tensions within society. Consequently, a growing sense of crisis is evident globally regarding the cultural and political status that science holds in the post-truth era (Feinstein & Waddington, 2020). In this perspective, there is an unsettling question in both research fields and educational settings: How is science education being prepared to face the decline in the legitimacy of science?

In March 2020, a bewildering event in recent history burst onto the scene: The World Health Organization (WHO) officially declared a COVID-19 pandemic (WHO, 2020a). This uncertain outlook challenged governments, official bodies, and the scientific community, from whom society demanded explanations, accelerated decision-making, solutions, and responses to the blunders. Dealing with the socio-health crisis inevitably permeated the educational context since they are matters that can be dealt with daily and intensified by the information overload.

The COVID-19 pandemic can be framed as a socio-scientific issue (SSI) because it is a controversial topic with science-based ethical and moral quandaries related to decision making at different scales (from an individual scale to a social scale, from a local scale to a global scale) (Ratcliffe & Grace, 2003; Sadler & Zeidler, 2004). A relevant aspect of this SSI is that the scientific knowledge that is being deployed simultaneously with the spread of the pandemic is at the boundaries of knowledge. As the ups and downs of scientific work are reflected in the media, the lack of linearity in science is exposed and its credibility may be undermined in those who are unaware of its nature.

The increasing distrust of science is fertile ground for the spread of fake news on the pandemic. Based on the assumption that the content people consume can deeply shape their behavior (Cinelli et al., 2020), this unique environment has paved the way for the perpetration of countless untruths, jeopardizing societal responsiveness to a global crisis (Nguyen & Catalán-Matamoros, 2020). In this context, the WHO (2020b) has coined the term infodemic to describe the excess of information—accurate or not—that makes it difficult for people to find reliable sources and guidance when they need it. This phenomenon, combined with the massive access to the Internet and the current significance of social media, raises questions for us as researchers and science educators. Furthermore, apart from the fact of having to deal with the infodemic, in a sudden shift from face-to-face to virtual education, there is the additional challenge of sense-making with others, while we remain isolated or disconnected from social existence as we used to understand it (Bagiutto Botton, 2020).

Thus, since the beginning of the pandemic, a great deal of information began to circulate in the media and social networks, creating a web of scientific arguments, conspiracy theories, and fallacies about COVID-19 (Saribas & Çetinkaya, 2021). Different explanations, often contradictory, about the origin of COVID-19, the way to prevent it, the development of the disease, and potential solutions, promoted a daily dynamic of confusion: What is true and what is not? Why do scientists contradict each other? Why does research take so long? What are the appropriate indicators for decision making? Why are measures taken in my country different from those in other countries?
Based on the question, how can students be equipped with the knowledge and tools to deal with fake news and SSI issues, our main objective was to configure a learning environment to enhance the exercise of critical thinking (CT) when dealing with news related to COVID-19 in an infodemic context. To this end, using a design based approach (DBR) we, researchers and teachers, constructed the following specific objectives for the design of a teaching–learning sequence (TLS):

1) To classify the main topics covered in the news about COVID-19 into constructs that reflect the multidimensionality of this SSI.
2) To select news items that represent the constructs of point 1 and that, due to the diversity of formats, sources, authors, etc., synthesize the way in which information circulates in the media and social networks.

Based on the implementation and evaluation of the TLS, we sought to answer the following questions:

Q1. What are the criteria students use to trust or not trust the news that circulate and what are the strategies they put into play to verify the information?
Q2. In what aspects did the learning environment facilitate the explicitness of the multidimensionality of COVID-19 as SSI?
Q3. Did the learning environment facilitate students’ reflection on their own CT?

The questions are oriented to highlight and exchange ways of individually and jointly approaching news in a context of information bombardment as a progressive exercise, and furthermore, to transcend an exclusively biological perspective of SSI to incorporate other dimensions that enable a complex view of reality.

This study shows the debates and decisions for the co-design of the learning environment. In addition, based on the implementation of the TLS, the categorization of the criteria and strategies for the students’ approach to the news, the students’ reflection on their own CT, and a synthesis of the discussions related to SSI are presented.

2 Theoretical Framework

In this context of information excess, in which knowledge is disordered and decontextualized, it is increasingly difficult to discern relevant information and reliable sources (Morduchowicz, 2018; Quattrociocchi, 2017). What is popularly referred to as fake news is disseminated at great speed, constituting a phenomenon that has intensified in the ongoing pandemic. Although the term “fake news” is widely spread, it is not without drawbacks. Wardle (2020) points out, on the one hand, that “fake news” is a term used by some politicians as a way of discrediting independent media. On the other hand, the author emphasizes that the term itself does not describe the problem, since, for example, it is common for genuine content to circulate decontextualized or in formats and narratives different from the news.

Wardle and Derakhshan (2018) prefer to use the terms misinformation, disinformation, and mal-information. Misinformation is false information distributed by a person who believes it to be true, while disinformation refers to false information disseminated intentionally by a person who is aware of this. A third category is mal-information, which
refers to reality-based content, but it is used to harm or affect a person, organizations, or countries. It is worth noting that, although these conceptualizations are different, they may have similar effects on society and that particular cases may involve different category combinations.

There are several platforms that warn about the characteristics that inaccurate content tends to adopt to capture people’s attention (NLP, 2021; Sardarizadeh, 2020; Télam, 2021). While it used to be journalists and traditional media on whom historically fell the responsibility for the dissemination of inaccurate information (Mayoral et al., 2019), a new actor emerged in the current informational scenario, the prosumer. We no longer speak of a passive receiver of information generated by others, but of a communication subject who plays a new role. The prosumer is the consumer who, in turn, produces content. This generalization in the definition acquires particularities according to the levels of intervention in the communicative act (Lastra, 2016). Thus, the prosumer lives in cyberspace, selects its own media, and develops its own content (Márquez Romero, 2018).

In this sense, it is appropriate to include this perspective in the framework of our project, since this dual role of consumer-generator of contents constitutes a new challenge for the dissemination of relevant information for public and collective health. We recognize two main derivations of this action. On the one hand, this new role admits the development and/or reproduction of contents including opinions, interpretations, and/or personal political positions that may not be based on verifiable data or facts, nor adequately reflect the available information. The absence of expert intermediation may result in the dissemination of information that is not reliable; furthermore, it may be unclear whether the information source is who or what is claimed, and whether the information is original or has been altered at some point (Metzger & Flanagin, 2015). A study by Vosoughi et al. (2018) shows how falsehood—without analyzing the intentionality behind the information—reaches much faster, farther, and is amplified by more people in a social network than “truth” in all categories of information.

On the other hand, it can function as a means of democratization for the expression of content and points of view different from those represented in the hegemonic media. Among some examples we can mention are the installation of debates on climate policies driven by you tubers (Allgaier, 2020); on digital resources, contents, and training spaces on innovative topics by educational influencers on Twitter (Marcelo & Marcelo, 2021); and management and planning in learning by studygrammers (Izquierdo-Iranzo & Gallardo-Echenique, 2020). Both derivations have the potential to reach a mass audience, promoting mis-dis-information or empowerment, respectively.

### 2.1 Self-regulation on Socio-Scientific instruction to face the Mis-dis-information

The denial of science in relation to globally relevant SSI is a social phenomenon that has been deepening for decades. Some examples are the denial of climate change, evolution, origin of life, AIDS and vaccination, and tobacco disease (Fackler, 2021; Nguyen & Catalán-Matamoros, 2020). In the particular case of COVID-19, hyperconnectivity facilitated
the rapid spread of misinformation and disinformation driven by political leaders, celebrities, and influential people (Nguyen & Catalán-Matamoros, 2020).

The combination of the denial of science and the difficulty people have in distinguishing between false and genuine information disseminated massively makes up a problem that is becoming more and more visible. UNESCO (2020) has warned that the population does not have the elements to make decisions in the face of disinformation and points to the work in schools. In this regard, a study by the International Association for the Evaluation of Educational Achievement (ICILS, 2013), which evaluated the skills of 60,000 eighth grade students (average age 13.5 years) in more than 3300 schools in 21 educational systems, showed that only 2% of the young people interviewed applied critical thinking while searching for information online, despite the fact that 89% said they felt skilled in the task. In Argentina, Morduchowicz (2018) points out that seven out of ten adolescents are connected all day on the Internet, with social networks being their main activity. The author mentions that most of them do not take a critical look at the set of digital devices and platforms, nor do they question their origin and funding. In addition, they tend to stick with the first website they find when looking for information and do not verify or contrast it with other sources.

In the post-truth context, it is essential for students to be able to develop critical thinking, since its role is key with respect to the problems and issues that citizens face in everyday life. But how can critical thinking be understood?

There is a lack of consensus on the definition of CT and how to achieve it through educational efforts (Kuhn, 2019; Niu et al., 2013; Thomas & Lok, 2015). General outlines include broad definitions, such as “reasonable reflective thinking focused on deciding what to believe or do” (Ennis, 2015). The Delphi Project, for its part, emphasized the cognitive skills of CT, understanding it as purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (…) (Facione, 2015; APA, 1990). Over time, the importance of CT dispositions was consolidated, since the person who possesses CT tends to be inquisitive, analytical, systematic, truth-seeking, confident in reason, open-minded, and judgmental (Facione et al., 2000). In this sense, what Dewey (1933, p.9) stated as reflective thought is reaffirmed: “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends.”

Throughout the aforementioned definitions, the phenomenon of action is not included in any conceptualization of CT. In line with a transformative vision of scientific literacy aimed to promote citizen commitment (Valladares, 2021), some authors consider that CT education should involve students in CT for action, because of the link between CT and decision-making (Davies & Barnett, 2015; Puig et al., 2021).

In this paper, we adhere to the definition of Jiménez-Aleixandre and Puig (2021) as a set of skills and dispositions that enable students and people to take critical actions based on reasons and values, but also as independent thinking. In addition, we adopt Kuhn’s, (2019) view, which considers CT as a dialogical activity. The dialogic character implies as a practice, the willingness, and commitment to enter into conversation by making one’s beliefs available for scrutiny by others, both real and imagined, as well as to devote similar scrutiny to the beliefs of others.

The critical thinker must be willing to engage in a process of reflection on his or her own thinking and action (Kuhn, 2019). This is critical thinking applied to itself. In this regard, Facione, (2015) highlights the self-regulation, called by some authors “metacognition,” as the most notable CT skill. However, Facione disagrees with the idea that this is a higher level of thinking. The author argues self-regulation is like a recursive function in
mathematical terms, meaning that it can be applied to everything, including itself. Finally, Facione defines self-regulation to mean “self-consciously to monitor one’s cognitive activities, the elements used in those activities, and the results educed, particularly by applying skills in analysis, and evaluation to one’s own inferential judgments with a view toward questioning, confirming, validating, or correcting either one’s reasoning or one’s results.” In this paper, we focus on self-regulation, emphasizing the reflective process of the students on the dialogic practice proposed in the TLS. This dialogic practice involved a first explicitness of criteria and strategies for approaching the news to assess its reliability, followed by the application of these same criteria and strategies. Lastly, the meaningfulness of this exercise was acknowledged by the students as a result of their own reflective process.

Another concept in which this work is framed is that of socio-scientific issues. In view of the fact that modern societies constantly demand from citizens both knowledge and the adoption of positioning for decision-making (Yacoubian, 2017), the SSI approach is highlighted for its potential to develop CT (Torres & Solbes, 2018; Solbes, 2013). By incorporating the SSI approach, learning of science content is enhanced, science and understanding of its nature is contextualized, students are engaged in problem-based situations for the development of higher-order thinking skills (Hodson, 2020), and dialogic argumentation is improved (Zohar & Nemet, 2002). Moreover, the treatment of SSI in the classroom allows students to be encouraged by working with topics relevant to their lives (Puig & Jiménez-Aleixandre, 2011). In this way, a critical view of society and its values is promoted and the possibilities of achieving a socially fair democracy and ways of life that are more respectful of nature are stimulated to think (Hodson, 2020).

In a world immersed in social, political, and environmental crises, deepened by the COVID-19 pandemic, it has become clear how all human relationships are burdened with injustice, economic, and cultural fragility and social inequality (Valladares, 2021). To consider COVID-19 as an SSI is to assume that it is traversed by a diversity of personal, social, economic, scientific, environmental, and ethical-moral aspects that play an important role, interact with each other, and that for the same problem there may be multiple non-exclusive responses (Hodson, 2020).

In relation to the aforementioned, in this work, we address misinformation and disinformation about COVID-19, framing the pandemic as an SSI. Particularly, considering that the promotion of CT in SSIs constitutes a real challenge in view of the excess of information and the new ways in which it circulates (Puig et al., 2020).

Likewise, although education alone does not offer a solution to the problems of post-truth (Feinstein & Waddington, 2020), the aim of this type of design of learning environments is to contribute to the production of strategies, knowledge, and tools that can be used in other contexts, equally challenging, in order to contribute to the development of citizens committed and active in the transformation of the world.

### 3 Methodology

#### 3.1 Context and Participants

Since March 2020, the Argentine government imposed a nationwide mandatory quarantine (DNU N° 297, 2020) that included the exceptional closure of schools with no return
to face-to-face education throughout the year. In the virtual education environment, we planned a teaching–learning sequence (TLS) to address COVID-19 as SSI in an infodemic context. This work was carried out using the theoretical and methodological framework of research of design-based research (DBR), for its potential to bridge the gap between educational practice and research (Cain & Allan, 2017; Perines, 2017; Perines & Murillo, 2017), since it allows the collaborative construction between researchers and teachers of educational interventions (Anderson & Shattuck, 2012) that enhance learning processes in situated contexts (Kelly, 2006). Co-design is understood as the first phase of the process of co-production of knowledge, which from the joint development of a research project seeks to satisfy collective interests and needs of the participants (Moser, 2016.) Therefore, the TLS was co-designed from the initial identification of the problem for the design of the intervention to the evaluation of the results (Getenet, 2019). We had the participation of two secondary school teachers and three researchers, and two different groups of 20 and 35 students from two private schools in Córdoba, Argentina. Both courses were 4th grade Biology (ages 15–16), in a system of six-grades secondary school, and the general attendance belongs to a mid-to-high socio-economic background, with availability of personal and mobile devices, as well as unrestricted Internet access. Meetings were held with the management teams to introduce the team and the research project and to make the agreements that formalize the work link with each institution. As such, the TLS was enriched with the contributions of the teachers regarding not only the subject knowledge, but also from their awareness of the institutional, social, and personal circumstances of the students. The same teachers were also responsible for the implementation of the TLS in a virtual classroom.

3.2 How Did We Design the TLS? Debates and Decisions

The co-design stage consisted of an active participation of teachers throughout the entire process, from planning to the implementation of the TLS, through the creation of spaces for joint training, dialogic feedback, and consensus construction (Anderson & Shattuck, 2012; Ayuste González et al., 2016). Both the development of the TLS objectives and their results were worked on during this stage, in order to design the learning environment that would answer the research questions.

To address the first objective, we generated constructs of analysis that, in a general way, (1) grouped the main topics of disinformation and misinformation that were exposed in the media and social networks and (2) traversed sociocultural dimensions that were the object of reflection in publications during the pandemic. Regarding the first point, it was remarkable how the context of uncertainty generated by the COVID-19 pandemic gave space to the proliferation of countless false and potentially dangerous information in different digital media. A brief enumeration of examples is the relationship between 5G antennas and the spread of the coronavirus, the artificial origin of the virus for geopolitical purposes, an infinity of potential home remedies or drugs to treat the disease, diversity of forms of prevention, among many others (Mian & Khan, 2020; Nguyen & Catalán-Matamoros, 2020; Pennycook et al., 2020a; Saribas & Çetinkaya, 2021).

In relation to the second point, as the pandemic uncovered the multidimensional crisis that had previously seemed fragmented into different kinds of problems (Grimson, 2020), numerous reflections arose which evidenced the complex nature of this SSI (Amadeo,
Firstly, the media agenda has been characterized by the generation of news about the material and logistic capacities of the countries (how many beds and ventilators exist? what are the possibilities of increasing these quantities? how many screening tests can be performed?) in order to ensure the health of the population. Following Breilh’s (2003) ideas, this first reading of the situation leaves aside the possibility of exploring in depth what is understood by health in a society, what other dimensions besides health make it up, what the measures and protocols respond to, and who are responsible for carrying them out.

Secondly, isolation and/or social distancing emerged as the main ways of preventing a potentially fatal disease with a high rate of infection. These measures demand commitments ranging from the individual to the collective, requiring equal actions and responsibilities in the presence of unequal material conditions. In addition to this, expectations are placed on solutions that put an end to extraordinary measures of isolation/distancing. Hand in hand with this yearning, other elements of analysis underlie: the pharmaceutical business, medical scientific development and its processes, magical prescriptions, and the anti-vaccine movement.

Thirdly, there is a demand for knowledge about the virus, its ecology, and behavior, both from scientists on the specifics of SARS-CoV2, and from society as a whole to understand the pandemic.

Finally, another element that stands out is related to thinking critically about the pandemic in relation to socio-environmental aspects, focusing on the way we currently relate to nature (Revel Chion & Adúriz Bravo, 2021).

Therefore, in order to organize the reflective approaches on the main issues involved in the pandemic, we developed four constructs to be incorporated into the TLS:

1. The Virus and the Dynamics of the Disease.
2. Pandemic and Environmental Crisis.
3. Hygiene and Protocols.
4. Vaccines, Potential Solutions, and the Pharmaceutical Industry.

The constructs can be seen as dimensions of the SSI in themselves and, in turn, contain others, as evidenced by the reflections described above.

A debate that arose within the working group was how correct it was to talk about true or fake news. This question generated an exchange of notions within the team around the idea of “truth” or “true” and, thus, false. These concepts are linked to a long history of philosophical debates and we thought that they exceeded the intentions of this paper. Mayoral et al. (2019) state that the term post-truth alludes to a state of confusion and uncertainty in which the concepts “true” or “lie” have already been neutralized, and in which the feeling that nothing is verifiable predominates, imposing a general skepticism that impedes speaking of true or false facts. Furthermore, they propose to consider post-truth as the final result of a previous communicative context conditioned by disinformation, in which the model of informative and rigorous journalism is almost a historical anomaly. In particular, within the research team, when discussing the criteria and strategies to deal with news, we noticed that information aimed at the production of meaning is mediated by technologies,
access modes, and social practices. In this way, it is difficult to categorize it as “true” or “false”, especially when we do not have more elements for the analysis of events in which we do not have direct participation. In this sense, we considered that it was better to speak of “reliable” or “unreliable,” as we understood that it would allow a better interpretation and approach by the students and could give rise to a greater diversity of criteria and strategies and enrich the reflection.

When asked through what media we received the disinformation/misinformation, we exposed that the entire team had received unreliable news on social media, apart from the news disseminated by the media. Therefore, we decided to expand the search to incorporate into the TLS, not only news elaborated by the media but also news circulating on social media created by prosumers, given the massive scope they have.

On the other hand, we discussed whether the indicators for the identification of news that mis/disinform (Gragnani, 2018; Nusdeo, 2020; Télam, 2021) are exclusive to them. Thus, we noted the existence of news that, despite being checkable a posteriori, reproduces the structure of the news that mis/disinform, i.e., they lack accurate sources, decontextualize the information, and have biased titles. Consequently, we concluded that these are journalistic and/or editorial styles that would seek to attract the public’s attention or to reflect an identity that characterizes the media or the person who produces it. This could generate some mistrust about their intentions and be counterproductive for the verification of the information.

Taking these aspects into account in order to address the second objective, we selected for the TLS one news item for each COVID-19 construct and the criteria used for the selection were as follows:

- That each news item is represented in a different format (image, video, text in a digital newspaper, audio).
- That different structures are reflected in the news item, allowing for the discussion of different criteria for approaching them.
- That both reliable and unreliable news are included according to the possibility of a posteriori verification.
- The inclusion of a news item elaborated by a prosumer and circulated through social networks.

In this way, the news used during the first synchronous class presented the following characteristics:

News No. 1: Image showing the lifespan of the virus on various surfaces, which was used on a television station during an interview but was decontextualized on social media.
News No. 2: A 54-s-long viral video, which exposed the return of charismatic animals to their environment due to the decrease in pollution caused by the interruption or reduction of human activities during the quarantine.
News No 3: A piece of news in text format, from a well-known media in Argentina. Its structure had difficulties related to its verification, but it presented genuine information on sanitary protocols.
News No. 4: Audio widely disseminated on social media, in which an unidentified person exposed the extraordinary properties of a veterinary drug as a cure against coronavirus.
3.3 Teaching Learning Sequence Co-designed

In the first synchronous class, we started with a playful instance to promote the students’ participation. This game presented the selected news, and the dimensions of SSI were addressed while setting out the evaluation criteria to rely on the information or not.

For the asynchronous instance, students were asked to create productions in relation to an SSI construct (videos, audio files, a Twitter thread, etc.) using the means that are best suited to them based on the resources they had at home. The instructions that guided the students’ productions were designed to be elaborated as a group, considering this instance as an opportunity for the negotiation of meanings and agreed upon reflection on the SSI constructs and the criteria and strategies that had been discussed in the first class. Furthermore, this activity was designed as an exercise, in terms of the new role of prosumer, which contributes to a way of democratization in the expression of points of view different from those represented in the hegemonic media, through the generation of a rigorous and responsible production. Such productions were presented in the last synchronous class, in order to retake the criteria and strategies presented by each group, clear up doubts or uncertainties, and reflect on the dimensions that characterize COVID-19.

As a second activity, the students conducted an “interview at home” to find out how a member of their environment evaluated the reliability of the news. This activity was designed to involve other perspectives outside the classroom and enrich reflection.

Synchronous classes were recorded with the informed consent of families, each educational institution, and the students. A virtual collaboration notice board (padlet.com) was used to keep track of group productions for the asynchronous class.

A diagram of the complete TLS can be seen in Fig. 1.

3.4 Data Analysis

For the analysis of this work, we adopted a qualitative methodological approach in which we considered (a) the contextual aspects of the learning community (course, institution, authorities, families, teacher in charge) and (b) the expressions of the different actors during the implementation of the TLS.

The data were collected from the co-design team discussions recorded in the field diary, the transcription of the synchronous virtual classes, and the interview records. In addition, we incorporated a semi-structured digital questionnaire aimed at collecting each student’s appraisal of the self-regulation skill after completing the TLS. All these elements constituted our corpus of analysis.

In order to address the research questions, we used discourse analysis methods (Meruane & Castro, 2008). First, to answer Q1, we conducted an open coding based on the iterative review of the students’ expressions recorded in classes and of the responses in the interviews conducted with the family environment. In this step, the data were divided into parts, examined and compared in search of similarities and differences. Then, those data that were considered conceptually similar were grouped into categories, which were defined on the basis of their specific properties and dimensions. Based on the interpretation of the coding, categories were identified as the criteria that participants considered to trust or not trust a news item (Table 1), and the strategies they reported to implement to corroborate the information (Table 2). In order to achieve reliability of the coding, all data sources were analyzed separately by the authors of this work.
on multiple occasions, and then the emerging categories were discussed until a consensus was reached. The relative frequency of mention of the criteria is incorporated with respect to a total of 70 mentions to highlight the importance of each one. The criteria and strategies are presented sequentially from the most mentioned to the least mentioned. In Section 4.3, we show two examples of the application of criteria and strategies in the students’ presentations.

Second, in relation to Q2, the students’ expressions throughout the TLS were addressed in order to synthesize the discussions derived from the analysis of the news for each construct on COVID-19 (virus and disease dynamics; pandemic and environmental crisis; hygiene, protocols and vaccines, potential solutions and pharmaceutical industry). To illustrate the negotiation of meanings during the debate, we incorporated excerpts from the class exchanges.

Finally, to answer Q3, based on the students’ expressions during the TLS in the approach to the news to assess their trustworthiness and on the anonymous answers from the semi-structured questionnaire, we analyze the reflections they make on their own CT as a result of the proposed activities.
| Criterion          | Criterion sub-categories                              | Characteristics                                                                 | Ways of evaluation                                                                 | Examples of students’ oral expressions developed in class and expressions from the interviews. |
|--------------------|-------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| The Media          | Media: newspapers, the radio, and television          | - Popularity and aesthetics                                                     | The media are evaluated according to these factors and how they can impact on the news they broadcast/generate | - “The media want you to see what is convenient for them”. (C)                                 |
|                    |                                                       | - Social prestige                                                               |                                                                                  | - “I believe that the news is relative and all newscasts have a stance or interests of their own”. (I) |
|                    |                                                       | - Ideology                                                                       |                                                                                  | - “I always pay attention to the source where the information comes from. If the source is unknown, I don’t believe it; on the other hand, if the information comes from a means of communication that has professional and technical support, it is more reliable”. (I) |
|                    |                                                       | - Political and economic interests                                               |                                                                                  | - “The only news I watch is on television, not to be informed or to change my mind, but to listen and see what the media want us to understand or know. [...] as you watch daily news programs or newscasts you become aware of the opportunism and the dissemination of fake information that they present for “x” benefits [...]”. (I) |
|                    |                                                       | - Independence                                                                   |                                                                                  | - “I increasingly doubt about hegemonic or big media”. (I)                                   |
|                    |                                                       | - Funding and available resources                                               |                                                                                  | - “I trust a piece of news mainly because of the track record of the media outlet that broadcasts it”. (I) |
|                    |                                                       |                                                                                 |                                                                                  | - “I pay attention to the media that publish it, what references I have about it. Then I compare what is circulating on social networks with other media I trust”. (I) |
|                    |                                                       |                                                                                 |                                                                                  | - “First of all, I look at the source, and the origin of the information; a factor that also influences is the dissemination of the news, because it may be a lie, although not necessarily, or things may be said in a distorted way” (I) |
| Social Media       |                                                       | - Popularity                                                                     | In social networks it is more difficult to determine the source of the information. Mass dissemination facilitates distortion. | - “In the Twitter thread they answered that they check if the media is of the same political tendency and if the page is recognized”. (C) |
|                    |                                                       | - Aesthetics                                                                     |                                                                                  | - “I pay attention to the source of the news, for example, if I see the news on an Instagram account, I will have to corroborate it somewhere else because on the networks any information can be uploaded regardless of whether it is reliable or not”. (I) |
|                    |                                                       | - Ideology                                                                       |                                                                                  |                                                                                  |
|                    |                                                       | - Political and economic interests                                               |                                                                                  |                                                                                  |
|                    |                                                       | - Context                                                                        |                                                                                  |                                                                                  |
|                    |                                                       | - Type: Facebook, Twitter, WhatsApp, TikTok, YouTube, etc.                        |                                                                                  |                                                                                  |
| Web page           | - Domain                                            |                                                                                 |                                                                                  |                                                                                  |
|                    | - Type and quantity of advertisements                 |                                                                                 |                                                                                  |                                                                                  |
|                    | - Aesthetics (font, color)                            |                                                                                 |                                                                                  |                                                                                  |
|                    | - Interests pursued                                  |                                                                                 |                                                                                  |                                                                                  |
|                    | - Genre of the site                                  |                                                                                 |                                                                                  |                                                                                  |
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| Demand of knowledge | Criterion sub-categories | Characteristics | Ways of evaluation | Examples of students’ oral expressions developed in class and expressions from the interviews. |
|---------------------|--------------------------|-----------------|-------------------|------------------------------------------------------------------------------------------------|
| - Scientific knowledge | - Information comparison | - Evidence or scientific data available | The arguments presented in the news are compared with previous knowledge of the subject matter. | “It doesn’t matter whether or not it has a cell because it meets all the other requirements to be a living thing. And that this is a scientific debate in which there are conflicting positions”. (C) (news item N° 1) |
| - School knowledge | - Suitability | - Social and geographical context | | “If a person with coronavirus is next to you and coughs and does not cover with his/her elbow, you become infected”. (C) |
| - Everyday knowledge | - Official and governmental information | | | “It’s not supposed to be transmitted via direct contact with objects. It’s like 0% probability”. (C) (news item N° 1) |
| - Official and governmental information | | | | “It is logical because it is true that I had seen news that in Italy more fish were circulating because the waters were clearer because the traffic of boats and people decreased. I believe it because even though it has no valid support, it does have logic; therefore, that makes me trust. It may happen that with less circulation there will be less pollution and more space for fish and other animals to swim”. (C) (news item N° 2) |
| | | | | “I don’t trust because I didn’t see any swans in the video. I don’t know if there are or were dolphins in Venice. I understand that there never were, at least that’s what I had read. So, whether they come back or enter, it seems false to me”. (C) (news item N° 2) |
| | | | | “I am going to try to speak with a bit of biological argument, but maybe I am wrong and you can correct me. According to what is known, in order to “evolve”, the covid needs to be in contact with the cell. Once it enters the body it will be constantly feeding on the cell that sustains it. Once the person dies, the cells die slowly, they do not die all at once. There are cells that will die over time even if the person is already dead. I believe this is true because it has a biological basis, because cells do not die all at once, it is a process. And if the virus that feeds on the cell will continue to be there until all the cells die”. (C) (news item N° 3) |
| | | | | “Of course, besides, he is spreading it as a solution and you don’t know if what he took has serious side effects. It is dangerous to send audios like that”. (C) (news item N° 4) |
| | | | | “In any case, if it is fake news, the worst thing that can happen is that you don't go near a corpse. It is not like the Whatsapp audio news that will affect your health. In any case, if you follow the WHO recommendations, even if it is not true in the end, it does not affect you”. (C) (news item N° 3) |
| Criterion        | Criterion sub-categories | Characteristics                                                                 | Ways of evaluation                                                                                                                                                                                                 | Examples of students’ oral expressions developed in class and expressions from the interviews.                                                                 |
|------------------|--------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
| Source           | - Presence or absence of source Type: - Private sector - Official bodies: international institutions, governments, ministries, departments - Universities, Research Institutions - Professionals or specialists - Prosumers | - Suitability - Political and economic interests - Context - Evidence or scientific data available                                                                                                                 | When available, the participants analyzed whether the information is supported by the private sector, the public sector, professionals/scientists or unknown people.                                                                                                      | - " Basically, the image does not present any external source to support the claim, that is, it is simply text, it does not say: Source: Nature". (C) (news item N° 1)                                                                                   |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "I check if it comes from a public body, whether it is national or international. Eg.: WHO (World Health Organization), OAS (Organization of American States), INDEC (National Institute of Statistics and Census)". (I)                                           |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "Depending on the sources it comes from, that is, if it is a recognized source, I can trust what it says. Also, if you’re talking about health and it’s not said by a recognized doctor, university, or someone really engaged in research, it’s hard to believe". (I)         |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "I trust when the media collects information about scientific research or enables an easier entry to one". (I)                                                                                                                                           |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "It seems reliable because it is conducted in a safe and honest place like Oxford University,". (C)                                                                                                                                                    |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "The source from which the information arises comes first. How independent is that source from external factors that could distort it. The official authorities always try to impose the truth to suit themselves". (I)                                                |
|                  |                          |                                                                                  |                                                                                                                                                                                                                        | - "He should prove to me that it is really like he says, it is not enough just to tell me. There must be experiments, research". (C) (news item N° 4)                                                                                      |
| Criterion     | Criterion sub-categories | Characteristics                     | Ways of evaluation                                                                 | Examples of students’ oral expressions developed in class and expressions from the interviews. |
|---------------|--------------------------|--------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Authorship    | - Journalists - Announcers - News anchors - Communicator - Professionals - Government official - Scientist - Prosumers | - Suitability - Professional background and experience - Ideology - Political and economic interests - Writing and speaking style - Rigour, evidence-based support | Trust in who generates the news is based on their professional background and political stance. | “The standard of Argentine journalism is very low because in all areas, there are people in the media who are not trained in what they talk about and it does not give you much confidence that they come out to deny what they have said after a few hours, that is very common”. (C) |
|               |                          |                                      | - “I wouldn’t take as a reliable source an audio of this random man (prosumer), I don’t even know where the audio came from”. (C) (news item N° 4) | |
|               |                          |                                      | - “If a doctor said it, I would not necessarily believe him because it could be for money or political reasons”. (C) (news item N° 4). | |
|               |                          |                                      | - “Another factor would be the person who wrote it, since, if you know him or her or have been following him or her for some time, you may learn about the sources of the information he or she publishes, and, thus, you can find out if those pages are reliable”. (I) | |
|               |                          |                                      | - “At the beginning of the pandemic, when the U.S. population heard that Trump claimed that injecting disinfectants could cure us of the coronavirus, many people believed it because it was said by someone with a lot of authority. Even though the doctors denied the claim, people decided to believe their president.” (C) (oral presentation) |
Table 1 (continued)

| Criterion   | Criterion sub-categories | Characteristics                                                                 | Ways of evaluation                                                                 | Examples of students’ oral expressions developed in class and expressions from the interviews |
|-------------|---------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Structure   | - Writing format          | - Verisimilitude                                                                | The structure of the news item is observed: title, subtitle, narrative,             | - “[…] It is important to look not only at the source but also at other factors such as:  |
|             |                           | - Coherence and clarity                                                         | use of images/audio files, and graphic resources                                   | author of the article or news item, sources cited in the news item, date of publication,  |
|             |                           | - Political and economic interests                                              |                                                                                   | among others; at the same time, it is ideal to look for information in other media and    |
|             |                           | - Ideology                                                                       |                                                                                   | not to be satisfied with what the source tells us”. (I)                                   |
|             |                           | - Sensationalism                                                                 |                                                                                   | - “I think that some news can be very credible and still be false, since even the best   |
|             |                           | - Writing and spelling                                                           |                                                                                   | known newspapers can be providing us with false information and we can believe it simply  |
|             |                           | - Aesthetics (font, color)                                                      |                                                                                   | because it is a famous newspaper and it is well written. I also believe that a news item  |
|             |                           | - Technical language                                                            |                                                                                   | is more plausible when the aesthetics of the page is neater and nicer (so to speak), the  |
|             |                           |                                                                                   |                                                                                   | more seductive it is in the eyes of the public, the more people will see the news item and |
|             |                           |                                                                                   |                                                                                   | probably believe it. Aesthetics is something that important newspapers usually have”. (I) |
|             |                           |                                                                                   |                                                                                   | - “In general, the verb tense tells me a lot about the news. If it is written using      |
|             |                           |                                                                                   |                                                                                   | modal verbs or in the conditional, I doubt… that is, if it says: “They would have” or   |
|             |                           |                                                                                   |                                                                                   | “It could be about…”. (I)                                                                |
|             |                           |                                                                                   |                                                                                   | “I check if they quote any study, the graphs that they show. On many occasions the       |
|             |                           |                                                                                   |                                                                                   | graphs that are shown have no relationship whatsoever with the content of the news; they |
|             |                           |                                                                                   |                                                                                   | show you statistics with missing axes, or they don’t have names, so, for example, if    |
|             |                           |                                                                                   |                                                                                   | they tell you that one thing is better than the other, you don’t know specifically what  |
|             |                           |                                                                                   |                                                                                   | comparison they are making ”. (I)                                                        |
|             |                           |                                                                                   |                                                                                   | - “I pay attention to the way it is written. Generally, a news item is fake when the    |
|             |                           |                                                                                   |                                                                                   | author tends to take the information along a specific way, and if you are attentive you  |
|             |                           |                                                                                   |                                                                                   | can see that”. (I)                                                                       |
|             | - Explicit quotes and     |                                                                                   |                                                                                   | - “If you take a photo, you can photoshop it and you can put Telefé (television channel) |
|             |   sources                |                                                                                   |                                                                                   | on it. You have to do some research, there can be a lot of editing”. (C) (news item N° 1) |
|             | - Author’s data and date  |                                                                                   |                                                                                   | - “Apart from that, I don’t know if it adds up, but I heard that they speak Italian… I  |
|             | - Verb tense             |                                                                                   |                                                                                   | don’t know if there are many places in Italy where there are large water channels, like   |
|             | - Journalistic style      |                                                                                   |                                                                                   | in Venice. And those two things make me believe it’s true. It’s not that I’m hearing      |
|             |                           |                                                                                   |                                                                                   | Turkish, for example. That also helps; the audio, even if there is very little what they |
|             |                           |                                                                                   |                                                                                   | say”. (C) (news item N° 2)                                                               |
|             |                           |                                                                                   |                                                                                   | - “I don’t trust because there is no proof that it really is Venice. I mean, there are    |
|             |                           |                                                                                   |                                                                                   | dolphins, fish, whatever you want, but I don’t know if it is Venice” (C) (news item N° 2)  |
| Criterion                  | Criterion sub-categories                                                                 | Characteristics                  | Ways of evaluation                                                                                           | Examples of students’ oral expressions developed in class and expressions from the interviews. |
|----------------------------|------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Socio-Cultural Factors     | - Ideology and/or personal political position  
- Socio-cultural environment  
- Beliefs  
- Values structure  
- Management of information and communication technologies (ICT) | - Comparison with your ideas  
- Socio-cultural context  
- Impact on public policies  
- Party orientation  
- Ethics | Several personal and contextual factors influence when it comes to trusting the information they receive. | “My family’s responses depended a lot on the experience and knowledge they have with ICT, and in turn, that depends on age.” (I)  
“I would have asked the interviewee her theory about the origin of Coronavirus since hypotheses affect from many aspects, such as beliefs, environment and political preferences”. (I)  
“It is unreliable because no research was done on whether these traditional drinks are effective. Also, it is not reliable because it is based on a belief of a religion.” (C) (oral presentation) |
| Strategies                        | Description                                                                 | Examples of students’ expressions                                                                 |
|----------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Media comparison                 | Comparison of information presented in a particular media outlet with other news and media addressing the subject. It also includes information disseminated through social networks (Facebook, Twitter, Instagram, etc.) Consultation on platforms created for the verification of news. | “It is important to consult different media and not just take the first thing we hear or read, but to check where this information comes from and evaluate it based on the different elements that allow us to establish this criterion of being reliable or fake.” (I)  
“If I get news via WhatsApp or others, I look at the links and search, I google the news in a media or government page or some official page; in such a way to verify myself, if the news is true or not.” (I) |
| Checking the information in the cited sources | To look for the source to confirm that the information presented in the news item was not distorted. For example, institutional web pages, scientific journals | “One way is to verify information, something that should be done all the time. Search in different pages, files, etc…. and, even better, if they are from official sources (governmental, provincial, etc….).” (I)  
“At first, I try to find out about the source of the information, then I consult other pages and/or websites to expand on the news and, in this way, I get more information about the topic to be dealt with.” (I) |
| Contrasting with reality          | Comparison of the content and ideas that the news exposes with our own experience from common sense. | “If it were true that in cardboard or plastic the virus lives for 72 h, we would not be able to buy in the supermarket, because if someone who has coronavirus, touches something, we would get infected immediately and that does not happen.” (C) (news item Nº 1)  
“A personal experience is not a good argument.” (C) (news item Nº 4)  
“The indicators that I could pay attention to in order to know if something is true or not I believe are in the street, where things happen. For example: the economy…to see too many stores closed, people begging and selling in the street and to go to the supermarket and see how prices go up are indicators that the economy of a country is in trouble.” (I) |
## Table 2 (continued)

| Strategies                              | Description                                                                 | Examples of students’ expressions                                                                 |
|-----------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Review of the context of the news item  | To observe the entire context of the news content: images, audio files, titles, date, subtitles, comments, author, etc | - “Both Google and most of the comments on Youtube say it’s a lie, so I believe what most people say.” (C) (news item N° 2) |
|                                         | To review consistency between its parts and whether resources show unambiguously what is being said |                                                                                                   |
| Asking suitable people                  | To ask about topics that we do not handle to other people who, because of their experience or knowledge, can better guide us in interpreting the information | - “I ask someone who is knowledgeable on the subject.” (I)                                           |
| Contrasting arguments with formal knowledge | The arguments expressed in the news item are analyzed with the formal knowledge of the subject in order to evaluate the logic and accuracy of the information | - “First I check the source of the news and then I contrast its arguments with what I already know about it”. (I) |
4 Results

4.1 Criteria for Assessing the Reliability of News and Strategies for their Corroboration

In order to synthesize the criteria that emerged from the classes and from the student’s interviews with their close environment, we created Table 1. This table contains seven criteria with subcategories, characteristics, description, and examples of oral or written expressions. Although there are expressions that refer to only one criterion, most of them refer to more than one and may even incorporate corroboration strategies. For practical reasons, such expressions are placed in a single category.

The first criterion involves the media, which includes traditional mass media (radio, TV, newspapers), social networks (Twitter, WhatsApp, YouTube, etc.), and web pages. This criterion was mentioned with a relative frequency of 0.26. If we focus on traditional media, students and their environment refer mainly to the prestige, ideology, political and economic interests they represent or seem to represent. In addition, by contrast, they also make reference to the degree of independence of the media in relation to groups that could exercise power over the generation of the information transmitted. Therefore, there is both trust and distrust in the information generated by large, hegemonic, and recognized media because, on the one hand, they enjoy prestige and popularity, and on the other, there is an underlying idea that they pursue their own benefits. In relation to social networks, there is an a priori distrust of their content, since information is more easily distorted due to the massiveness of its dissemination and the difficult traceability of sources and authors. Regarding web pages, the domain of the page, the type and quantity of advertisements, the genre of the site, and the website features are indicators of reliability. Institutional domains guarantee a certain rigorousness in the information, which is linked to what was mentioned above about the credibility of public institutions. Advertisements give an idea of the financing of the page, and when they appear in excess, the site is considered unsafe and unreliable.

The second criterion, called demand for knowledge, refers to the comparison of the arguments presented in the news item with the different types of knowledge that are held on the subject. This criterion was mentioned with a relative frequency of 0.19. A particular example of this category is the comparison of the information with the knowledge obtained from the dissemination of health protocols, which varies according to the social and geographical context. On the other hand, when faced with the lack of scientific rigor in the news or the absence of pertinent research, students choose the precautionary principle for decision making.

The third criterion is the source of the information, which is defined by the presence or absence of the source as the first indicator of reliability. Then, if the source is cited, the participants analyze whether the information is supported by the private sector, the public sector, professionals/scientists, or unknown people. In this sense, most participants consider official public institutions as reliable sources of information. The same effect is produced by the word of professionals with expertise in the subject or the allusion to relevant research on the topic. However, there are also ideas that the sources may respond to interests that distort the credibility of what is said. The relative frequency of mention was 0.16.

The fourth criterion is authorship, i.e., who generates the information. It may seem similar to the previous criterion, but here it refers to a more individual level, related to who produces or issues the news. The style and background of the author and the use of sources...
and data are pointed out. Some students express that certain journalists, due to a lack of rigorousness, tend to retract their statements shortly after giving a news item, which affects credibility. They also mention untruthful news generated by prosumers who may pursue different interests. In the expressions, it is common to appeal to the authority of professionals or scientists as a support of rigorousness. On the other hand, students showing disagreement point out that some people may believe the word of government officials just because they are authorities. In general, personal interests that may influence the generation of news are mistrusted for all identified authors. Like the previous criterion, this one has the same frequency of mention of 0.16.

The fifth criterion identified is related to the structure of the news item and includes a series of elements such as title, narration, use of different formats or graphic resources, journalistic style, authorship data, and date. All these elements are evaluated for verisimilitude, clarity, and coherence. In addition, the spelling and verb tenses used are taken into account; for example, the use of the conditional generates doubts. In the same way, sensationalist or biased news generates distrust. Another important element is the correct use of data graphics. This criterion was mentioned with a relative frequency of 0.14.

The sixth criterion refers to the format of the news, that is, whether it is written, an image, a video, or an audio. When exposed to news in different formats, students notice the possibility of manipulation by means of software. Related to this, they observe that an image or video can be altered by digital advances or be presented out of context. A text, on the other hand, would provide greater elements of analysis to evaluate the reliability of the information.

Finally, the seventh criterion is transversal to all the others, and is related to the socio-cultural factors that influence both the generation of information and its reception. On the one hand, it is mentioned in the previous criteria how personal or institutional interests can lead to the manipulation of information. For example, there are news items that mis/disinform in order to favor political positions or to stress political party discussions. On the other hand, personal stances, beliefs, values, the environment with which we interact, etc., affect us and determine the way we interpret information. In addition, students mentioned the mastery of Communication and Information Technologies (ICT), whose knowledge and handling would depend on age, as an important factor in the reception and verification of information. These two last criteria were mentioned with a relative frequency of 0.06 each one.

The six strategies described for addressing the news that were found during the implementation of the TLS are summarized in Table 2. Some strategies were observed during the I trust/don’t trust exercise, others emerged from the interviews, and finally, students expanded and deepened them in the presentations of their productions. In general, these forms of verification were not employed in isolation, but appeared simultaneously as part of the same information corroboration exercise.

The first strategy, called media comparison is based on checking the information presented in a news item in different media and/or verification platforms. This also includes information circulating in different social networks. It is assumed that some media are useful to corroborate others, giving greater status to traditional media over social networks.

Secondly, the strategy of checking the information in the cited sources is to look for the source of origin and check that the information presented in the news item is not distorted. This strategy requires a more precise knowledge of where to look for the source, especially if it is not correctly detailed in the news item. This strategy and the previous one were the most frequently mentioned throughout the TLS.

The next strategy, called contrasting with reality, is associated with the comparison of the content of the news with one’s own experience. It is a useful strategy to place the
information in the personal context and interpret it in the light of everyday reality. On the other hand, if the disseminator of a news item tries to extrapolate a personal experience to the rest of society (e.g., news item No. 4), it quickly generates distrust, since students understand that a single experience is not enough to generalize.

The fourth strategy, review of the context of the news item, is related to the comprehensive observation of the news item, from the title to the users’ comments. If it is a video, the language in which it is spoken is also listened to, and the images are carefully observed, that is to say, the whole context. Here, coherence is sought between the content, images, and other resources used when informing.

A fifth strategy is asking suitable people and refers to seeking advice from a person whose knowledge and/or experience facilitates the interpretation of a particular subject.

Finally, contrasting the arguments with formal knowledge refers to the fact that the arguments presented in the news item are analyzed with the formal knowledge one has about the particular topic, in order to evaluate the logic and accuracy of the information.

### 4.2 Overview of the Debates in Relation to the Multidimensionality of COVID-19

In this section, we synthesized the discussions around each construct on COVID-19 from the treatment of the news. In addition, we incorporated some excerpts from the debate to account for the exchange among students, and between students and teachers. In each of these constructs, the teachers took the opportunity to clarify and highlight concepts from biology or related disciplines that emerged from the analysis of the news. Furthermore, the treatment in these constructs promoted discussion around the multidimensionality of this SSI.

In relation to the construct “The Virus and Disease dynamics,” students expressed their understanding of viruses’ life cycle. Most of the course content related to the topic covered in previous years was applied in the discussion, during which concepts were also reviewed by the teachers. Likewise, students demonstrated their knowledge arising from the dissemination of prevention protocols and some of them appealed to their personal experiences to discuss the forms of transmission of the disease. An excerpt from the discussion in one of the schools is presented below.

Student 1: “The coronavirus is spread when you sneeze or cough, that is, the virus would not survive in the air. If that were the case, we would be more worried and it would be more dangerous because you would catch it much easier.”

Student 2: “It lives in the air, that’s why we catch it so easily.”

Student 1: “No, because actually if a person with coronavirus is next to you and coughs and does not cover with his/her elbow, you become infected.”

Student 3: “It doesn’t live in the air, it moves through the air because of pressure or gravity, that’s why it falls and can stay on a surface like copper.”

Student 4: “It is said that on cardboard or plastic it lives 72 h, if it were true we would not be able to buy in the supermarket, because if someone has coronavirus and touches something, we would get infected quickly and that does not happen.”

Teacher: “Is the virus alive or not?”

Student 2: “If it affects a cell yes, if not, it doesn’t meet the requirements of a living being.”

Student 4: “It doesn’t matter whether or not it has a cell because it meets all the other requirements to be a living thing. And that this is a scientific debate in which there are conflicting positions.”
Teacher: “It can become a philosophical debate. The image does not question that, it says ‘the virus lives,’ and from there, you started to debate. Part of the confusion is related to the fact that the virus does not live in the air, it moves in saliva. So, if the plaque said ‘how long does it take for saliva to evaporate on a cardboard’, would you believe it?” (the debate continues).

Regarding the construct “Pandemic and Environmental Crisis,” students had conflicting positions when analyzing their trust in news item No. 2. This contrast allowed them to recognize themselves within a generation that lives in a world immersed in an environmental crisis and to consider that there are issues more emotional than others and that the news appeals to these emotions. Since at the beginning of the pandemic expectations for a global social change, which would result in a better society, were generated, they discussed how these expectations could be a tool to make a news story more credible, given that people who read it desire it to be true.

Student 1: “I trust and I don’t trust. It is logical because it is true that I had seen news that in Italy more fish were circulating because the waters were clearer because the traffic of boats and people decreased. I believe it because even though it has no valid support, it does have logic; therefore, that makes me trust. It may happen that with less circulation there will be less pollution and more space for fish and other animals to swim. So, for me, yes it is, I trust.”

Student 2: “Venice is a part of Italy that is on the sea. So, all the traffic is because of the boats, there is a lot of pollution. Because that’s not there, the water is clean.”

Student 3: “Other than that, I don’t know if it adds up, but I heard that they speak Italian… I don’t know if there are many places in Italy where there are water canals, big ones, like there are in Venice. And those two things make me believe it’s true. It’s not like I’m hearing Turkish spoken, for example. That also helps, the audio, however little they say.”

Student 4: “That doesn’t prove anything in my opinion, but okay.”

Student 5: “Since there is not so much human activity, there is more biodiversity.”

Student 6: “It looks very real, but I don’t trust it that much, but I don’t think it is photoshopped. At the same time it has logic and looks real, I have doubts.”

Student 7: “I don’t trust it. And the comments say it’s a lie and I googled it and it also says it’s a lie. Both google and most of the comments on YouTube say it’s a lie, so I’m going for the majority.”

Student 3: “I’m very much in doubt, it can be both true and a lie. A priori you don’t know, unless you look for more information. It’s all guesswork until you investigate well.”

Teacher 1: “The first thing X (student 7) did was to google what was going on with the news. We don’t even know who spreads the news. A person X, with a video in his possession, gives it a title and description and uploads it to YouTube and becomes a disseminator of information. First, we have to check what we receive. Fake news appeals to emotions. Venice and love, dolphins as charismatic animals, what we want to see. In a month of less human intervention we cannot recover a body of water, even if we start by stopping polluting. Every natural process takes time.”

Student 7: “It would be really easy to solve all the disasters caused by human beings. I found four pages that say it is Cagliari in Cerdeña. Don’t just take the first opinion, you have to search” (the debate continues).
This construct brought its difficulties in both schools because of its logic: less activity, less pollution, more nature. The teachers used these pieces of news to address concepts of ecological succession and conservation biology to reflect on the effects of human activities. During the presentations in the second class, one of the teachers also intervened, expanding on the reasons why fauna can be seen near urban centers in the face of similar news.

Teacher 2: “Do you think that animals can come to the city just because of the quarantine? I don’t know if you remember that recently there was an aguará guazú (a native canid species) near a shopping mall, and it was caught… It also happens that many animals have no habitat left, so the advance on the forests, on the pastures to carry out different types of human activities is increasingly fragmenting their habitat or reducing it. Then, in a way, they move closer to the city because they have less space to live in. There could be many reasons behind why a… Because of the fire, says X (a student) here in the chat. Another reason could be because of illegal petting, fauna trafficking, there could be many reasons behind this event.”

In relation to the construct “Hygiene and Protocols,” positions around the news were expressed. This piece of news in particular presented genuine information, even though it lacked accuracy on the sources. The verification strategies applied at that time confirmed the information presented in the news. In addition, it was observed that the students showed a good general knowledge of the current health protocols. Below is a part of the classroom exchange at one of the schools.

Student 1: “I trust. Because it says it is a measure that seeks more than anything else to prevent more cases, as it is not confirmed, precautionary measures are taken.”
Student 2: “Of course, besides, if you don’t trust, it is better to take measures just in case.”
Student 3: “And it is quoting WHO.”
Student 4: “Of course, because they put reliable sources, they justify credibly why these measures should be taken, that is, because sometimes they justify things that are clearly lies.”
Student 5: “I don’t know why, but they say that there are many people who died because of Covid and in fact they died because of another cause. I feel that it is not very well defined.”
Student 6: “My understanding is that it’s not Covid that kills you, it just lowers your defense and another disease kills you. That’s why I thought it was odd that they say no autopsies are done.”
Student 7: “It is strange that they don’t want to do autopsies and know why a person died.”
Student 8: “I think so because the news itself says that they are looking at it and they are checking it and recommending it as a preventive measure so that there are no more contagions.”
Student 9: “In any case, if it is fake news, the worst thing that can happen is not to go near a corpse. It is not like the news of the WhatsApp audio that is going to affect your health. In any case, if you follow the WHO recommendations, even if it is not true in the end, it does not affect you.”

Some students expressed a mistrust about the local number of deaths caused by COVID-19, considering that these figures were overestimated, although they could not explain the source of this mistrust. This made it possible to deal with statistical concepts and some criteria for the development of health protocols. Besides, given the lack of scientific knowledge on the subject, due to omission in the news or because studies
are being carried out at the same time as the pandemic occurs, the students consider that it is better to take preventive measures. Based on these appreciations, the nature of science was discussed.

Multiple positions were expressed in the construct “Vaccines, Potential Solutions, and the Pharmaceutical Industry” about what solutions might be available for the disease. We discussed news about a veterinary drug because at that time vaccines for COVID-19 were in their initial stages of development. A part of the exchange is shown below:

Student 1: “It does not cause the same effect to all people. Besides, it can be harmful to health because there is not even one doctor who tells you ‘yes, take this’.”
Student 2: “Besides, it is not known where this information came from. Whether it is a reliable source or not that says that this medicine is useful to get better.”
Teacher: “But he took the medicine and it worked well” (the teacher intervenes to generate controversy).
Student 2: “Yes, but maybe I take it and it doesn’t have the same effect.”
Student 3: “He is actually telling what happened to him, we don’t have to check if it works for everyone or not. I mean, trust what he is saying if it really happened to him or not. Bah, I see it that way.”
Student 4: “A personal experience is not an argument. Besides, he bought it at a veterinary…”
Student 5: “Of course, besides, he is spreading it as a solution and you don’t know if what he took has serious side effects. It is dangerous to send audios like that.”
Student 6: “Maybe someone listens to it and says ‘since it worked for him, I’ll try it, because if it worked for him it might work for me’ and, in fact, it ends up giving you side effects as X (student 5) said. I don’t see it as reliable, he should clarify that it worked for him, but it might not work for someone else, it won’t work for everyone.”
Student 7: “I wouldn’t take as reliable an audio of this random man, I don’t even know where the audio came from.”
Student 5: “Maybe it is for the neighbors to go and buy that medicine from him.”

Students were very distrustful about alternative drugs and/or treatments that are promoted by prosumers, mainly due to the lack of scientific evidence in these broadcasts. In this sense, the idea that the reported success of treatment in a single person cannot be applied to the entire population arose among the students. Based on these statements, some simple concepts of statistics were resumed. As the information analyzed claimed to be generated by a professional vet, there was a discussion about the social legitimacy that professionals and scholars have in society. In turn, this content led to a discussion about the economic interests that allow the dissemination of certain drugs, overriding the processes of scientific validation. This discussion made it possible to address the political and economic implications that exist in patent regulation. Other topics discussed both in the evaluation of the news and in the presentations of the last class revolved around how the possibility of access to health care and the socio-cultural and economic contexts promotes or conditions the distribution of so-called medications or homemade remedies.

4.3 Examples of Students’ Group Presentations Using the Criteria and Strategies and Their Reflections on Their Own Critical Thinking

In this section, we present some examples of the presentations made by the students for the last class, in which the use of the criteria and strategies is evidenced. In addition, we focus
on self-regulation as a critical thinking ability to look at oneself and reflect on the changes identified by the students in their approach to news from the TLS.

During the first synchronous class, in the activity “I trust/don’t trust,” the students, using their knowledge, experiences, and beliefs, evaluated the credibility of the claims, sources and authors, and the acceptability of the arguments presented. In this way, each one made his or her own judgment about the reliability of the news, explaining to the rest of the class the personal criteria to which they appealed in this first approach. At the same time as the exchange of arguments took place, different information verification strategies were also explained to support or not their own point of view or that of a classmate. Finally, from the debate of the news approaches used, some students reasserted their position, while others, convinced by the arguments of their classmates, changed their point of view or recognized that their analysis lacked depth, reflecting the capacity for self-regulation:

“I said I don’t know what to believe, but then based on my classmates’ thoughts, I don’t trust the news item anymore because it has no sources, none of them credible.”

In this way, faced with the problem of assessing the reliability of a news item, a set of options were deployed to address them. These options were progressively completed as the news items were presented in different formats. The development of the activity promoted the ability to infer the accuracy of the information from the different elements present in each news item and the criteria and strategies built together.

In the last synchronous class, the students presented the group production activity, which reflected a broad search for news related to the SSI constructs. In the productions, students explained how they used the criteria and strategies discussed during the TLS to assess reliability. In addition, they made use of online surveys to gather opinions from other social network users, verified the chosen news items, and made explicit their conclusions from the activity. The productions included the use of different resources: Twitter threads, videos, written reports, and audios. Below are some examples of this exercise.

Example 1

Resource: podcast

Group presentation: “We found some news stories that had false or non-specific information. For example, we found some recommendations for taking care of coronavirus in BBC News that said that to reduce the risk of infection you had to avoid contact with people who have colds or symptoms. This indicates that you could have contact with many people who do not have symptoms. This is false, since the person with whom you have contact could be asymptomatic, you would not realize that he/she has the virus. We also found news that disproved speeches. For example, that of Donald Trump who said that the coronavirus could be fought by ingesting or injecting a disinfectant or undergoing a powerful beam of light. Because of this, many people were intoxicated and even died. In addition, we found a lot of false information coming from WhatsApp audios, for example, if you sunbathed or lived in warm areas, this prevented the coronavirus. This was refuted by the occurrence of cases and deaths in warm areas. They also claimed that bathing with hot water prevents or kills the virus, as it was believed that the virus would not survive at high temperatures. By bathing with hot water, it was expected to raise the body temperature, which does not happen, the only thing we would cause would be burns or skin irritations.
To corroborate the information what we did was to look for what we had read in other sources that transmitted the same information and that had scientific support.”

In this presentation different criteria used can be observed. One of them is demand for knowledge, particularly the one associated with the dissemination of protocols and therefore, the form of contagion. The scope that a governmental authority has in the dissemination of information dangerous to public health (authorship criteria) is also exposed. They recognize as strategies used the media comparison and checking the information in the cited sources, but they also used contrasting the arguments with formal knowledge and contrasting with reality.

Example 2

Resource: Video from France 24 on traditional drinks used to combat common fevers and that would combat COVID-19 in different parts of the world

Group presentation: “About the video we think that it is not reliable since none of these methods was supported by any authority to combat COVID-19. On the other hand, we think that the information provided by the Ministry of Health is much more reliable and safe, since one of the countries that had less contagions was Argentina, because they followed the prevention measures provided by the Ministry of Health, which are: social distancing, washing hands frequently, coughing into the crook of the elbow, using a mask, not putting your hands to your face, ventilating the rooms well, disinfecting the objects you use frequently, not self-medicating, not sharing mate, avoiding social gatherings. To close, this video does not seem reliable either, since it bases the solution to the problem on religious beliefs, for example, drinking cow piss, an animal considered sacred in India, as a solution to the coronavirus.”

Teacher 1: “I think that the information you brought is very good and that it is associated with the issue of ‘magic solutions’ and well, you took the government page as a reliable source to refute those ideas. We are not going to dismiss people’s religious beliefs, but as the other teacher said, medicines or vaccines have to be tested with specific processes.”

Teacher 2: “There is a large part of the world’s population that does not have access to hospitals or Western medicine and therefore relies on their traditional medicine, their cultural knowledge and that has been the way they have been able to take care of themselves and their health. Much of Western medicine is based on this knowledge and then, taking a plant, they turn to generate a medicine or product for sale. In this particular case, the coronavirus is a serious disease, very complex, so, before taking a particular medicine or solution as a cure, without having submitted it to scientific tests, it is dangerous, you have to be very careful. Basically, what they said there, is that they used these things in a preventive way, it is seen that they use them for colds, to increase defenses, as here in the West of Córdoba they use chañar syrup when you have respiratory problems. But not as a cure for the coronavirus.”

In this example, students use the criteria of demand for knowledge and source, pointing to the scientific validity of the content and the information provided by public entities in relation to the topic. Accordingly, they used the strategy of checking the information in the cited sources, in this case, in the official site of the Ministry of Health of Argentina. It also allowed reflection on the Socio-Cultural Factors that influence people when making
decisions. In this way, it is possible to observe how different dimensions of the SSI can be addressed on the basis of the constructs designed for the TLS.

**Example 3**

Resource: Student-made video in which they show the news and analyze them  
Group presentation, excerpt: “The news item tells us about a study published in the Journal of Medical Virology (the article in the source journal is shown) that says that mouthwash can inactivate coronavirus in humans by interacting with it in the oral and nasal cavities. However, the same news item clarifies that more studies are relevant and that there is no total scientific evidence. Searching for the source of the news, we also found a note from the New York Times denying this study, stating that mouthwash has no effect against the virus. We can say that the first news is false, or at least unreliable. The original news item has been disproved with in-depth studies that have clarified the situation.”

In this example, the strategies *Checking the information in the cited sources* and *Media comparison* were used, and scientific support was used as a determining factor for reliability (*demand for knowledge* criteria).

Elements of analysis that allowed us to illustrate the skill of *self-regulation* were the students’ expressions during the TLS and the semi-structured questionnaire that the students completed at the end of the implementation of the TLS. These allowed them to evaluate the TLS and, at the same time, to record their reflections on the process carried out. In this way, their comments were oriented towards awareness and reflection on the critical capacity and the practices they performed when encountering the information before and after the TLS. Below are some examples of these expressions:

“It is good to think about things that happen around us, to realize if what is said is true or not. To have doubts about whether to trust or not to trust. It is important to be informed and see where each piece of news comes from and where we get it from.”

“Before, I didn’t realize that some of the news I consumed and shared were fake, and from now on I will pay more attention.”

“[…] it is interesting to see how the other classmates did the same activities as me but from another point of view.”

“I found it interesting to put into practice the way in which we evaluate the veracity of the news that circulate through the networks.”

“It helped me, since I had never before thought about these criteria to see if a news item is real or not.”

“It has happened to me that I received a news item about coronavirus and I read the title and nothing else and immediately sent it to my friends’ or family’s group, and I could go in and say anything, because the title alerted me. (...) The news that do not quote anyone and do not put any source, I would not have thought before ‘maybe it is false and that’. And after these classes, I realized that yes, it is very misleading… I already knew it, but I didn’t think about the news if it was false or not, and now I say ‘wow, yes’.”

Other expressions are related to the interview activity in their homes, in the asynchronous phase.

“This is good, because you understand the point of view of someone who did not do the workshop we did.”
“I found it one of the most interesting activities. I liked the idea of seeing what my family thought and being able to reflect on it.”
“I thought it was very good, because usually in my family we don’t talk about the news, and this is a way to see what they think.”
“The proposal was interesting, since, on a personal level, you know a little more about the opinion of a person close to you that maybe you never got to know at all.”

These expressions emphasize the contribution that the activity made to them to know other points of view, even to know more about the people close to them from their points of view and to broaden their reflection.

Finally, we will highlight other expressions related to a question that teachers asked at the closing of the TLS: Based on everything we have discussed and the elements we have to verify the news, why do you think that mis-dis-information is spread so easily?

Some of the responses were related to the use of ICT:

“It is easy to spread news on social networks and with devices that we have.”
“We are a society that consumes a lot, especially technology and, for example, if someone sends you by Whatsapp or we see a publication that says any news ‘x’, we do not take the time to verify it. I read it and if it is passed on to me it is for a reason, I share it and then a chain of fake information is generated and people start to believe it. And there are always one or two who say: this is a lie because of such and such a thing, and that also spreads. And in itself, it’s like a process.”

Other responses referred to people’s attitudes towards information:

“It’s that we make a superficial reading of the news.”
“I read that people are so upset about the pandemic that they believe everything they see. There are two types of people, those who believe and those who doubt. That is, it depends. Those who spread the word are the ones who believe it without doubting.”

“Because sometimes if it is a media that we believe to be reliable, we do not verify.”

In relation to the above, as an exercise oriented to meta-reflection, the teachers asked: Then, why do you think prosumers’ news are spread? Students stated that people trust more if what is exposed is in line with what they think or feel:

“Maybe because it creates an expectation, it shows something they want to see, something in line with what we feel or think… you would think you see dolphins in Venice.”
“I feel there can be two types of people. People who think that there may be things that are not true and people who think that everything they see or hear is real. Anyway, it depends on what is convenient for the family, if, for example, a medicine is cheaper, it might be convenient for a poorer family to believe in it because it is the possibility they have. They do not have the possibility of buying an expensive vaccine.”

Students also distrust those who generate content according to personal interests:

“I also believe that it is because of the benefits it brings to those people who make the news. Yesterday I read about fake news and it’s like there are many motives, more than anything it’s always for money or ideology, but it’s like a whole world… I don’t know, some people live off of that.”
5 Discussion

In a context of growing distrust in science, the COVID-19 pandemic broke out, further revealing the obstacle that the dissemination of mis-dis-information implies for individual and collective decision making. Faced with this challenge, science education should be oriented to involve people in evidence-based reasoning and CT, as well as in the exercise of responsible and active citizenship (Erduran, 2020). To this end, it is essential to design learning environments that address SSI so that students understand the relevance of science in their lives and foster critical analysis of the quality of information circulating in the news (Belova & Eilks, 2016; Chang Rundgren & Rundgren, 2014; Hodson, 2003). In the face of this, we designed a TLS to equip with knowledge and promote the reflection on CT through deliberation and construction of reliability criteria and news verification strategies around COVID-19 as an SSI.

The activity performed at the beginning of the implementation (I trust/don’t trust) allowed students to be alert regarding the news to be evaluated, as inattention plays an important role in the exchange of erroneous information online (Pennycook et al., 2020b), so simple reminders about the concept of accuracy may be enough to improve people’s sharing decisions regarding information on COVID-19 (Pennycook et al., 2020a). In this sense, the reliability assessment instruction was an advantage in the context of short, virtual classes. Thus, during the course of the TLS, there was a gradual enrichment of the debate based on the outline of reliability criteria and verification strategies, also giving rise to reflection on the position adopted by the students before and after having gone through these activities and discussion of knowledge associated with the multidimensionality of COVID-19.

In relation to the approach to news during the TLS, elements were identified that made difficult its evaluation, such as headlines or images that do not represent the content of the news; genuine content framed in a false context; content deliberately designed to harm or mislead; content in video format or real images that are manipulated; and content maliciously attributed to prestigious sources. These descriptions coincide with much of the typology of content assigned to “fake news” in academic articles (Tandoc et al., 2018). Thus, both the news items chosen for classroom discussion and the activities allowed for discussion of a range of misleading information that tests the verification of the information. From this, a set of seven reliability criteria emerged from the students. Next, we discuss their scopes one by one.

Regarding the media, based on general appreciations and without taking into account particular examples, there was no clear consensus on the perception of credibility in the traditional media. On the one hand, those who trust are students who think that the prestige of certain media is a guarantee of good information. In this sense, Alcalá-Santaella et al. (2021) in their study observe that the high reputation of the media makes the news more credible and vice versa, establishing a bidirectional relationship between the construction of reputation and the veracity of the news published. At the same time, many of these media are part of what is perceived as hegemonic, and for other students, there is an underlying idea that they respond to interests of various kinds that bias information. On the other hand, there are also those students who show a skeptical attitude towards all media. Mayoral et al. (2019) through their historical analysis on the credibility of journalism and the media outline reasons that may explain these perceptions. The authors point out that the lack of credibility is a historically rooted problem linked to the shaping of journalistic professionalism and that the rise of news-based journalism lasted a short period of time. At
the same time, credibility and independence were also affected by crises of different kinds: economic, technological, business model, labor, communication model, and the identity of journalism itself.

The change in the way information is consumed and the crisis of traditional media (Shenk, 2003) have led to the fact that mainstream media are no longer the main source of information (López-García, 2004). The information age has significantly increased the amount of options available, particularly the rise of information technologies and the use of Internet services worked as two promoters of this phenomenon (Roetzel, 2019). Precisely, digital platforms and social networks imply a series of characteristics such as immediacy, omnipresence and ubiquity, interaction, and gratuity (Civila et al., 2021). In this regard, students expressed a greater distrust in the content disseminated in social networks. This is in line with the role played by social networks in making misinformation and disinformation massive (Cinelli et al., 2020; Nguyen & Catalán-Matamoros, 2020; Pennycook et al., 2020a). However, Oeldorf-Hirsch (2018) points out that the use of social networks may have a positive relationship with the ability to generate news engagement and prompt elaboration of current events, given that by incidental encounter or active search, they are in contact with a greater amount and variety of news. It should be noted that the arguments put forward by students for distrust point to two fundamental issues regarding the circulation of news through social networks, one is the easy distortion resulting from mass dissemination and the other is the difficulty in tracing sources and authors. In connection with the first issue, Alcalá-Santaella et al., (2021) note that news or headlines are less credible but more interesting when their impact is greater, although they do not focus on the reasons behind them. And with respect to the second question, it has been studied that unverified accounts significantly boost the dissemination of misinformation (Xu et al., 2021). Although distrust of social networks was expressed, some students stated that they disseminated messages through this means without any type of verification of the information and that the TLS had helped them to reflect on this practice.

Also, within this criterion, we find web pages. Students highlighted the type and quantity of advertisements as indicators of the site’s financing and possible editorial interests. They also pointed out the domain of the web page as an indicator, giving more rigorous information to those pages that had a recognized institutional domain. On the other hand, they focused on the characteristics of the web page (design, graphics, font, color) and whether or not it is tagged as a secure site in search engines. These elements coincide with the users’ credibility components investigated by Flanagan and Metzger, (2007) and Adams et al., (2006). In addition, students also look at the site’s genre, according to these authors who show that familiarity with the genre of the site, as a source of a particular type of information, is an important component of credibility perceptions, with news sites being rated higher. The authors also found that users pay attention to site and sponsor cues such as genre and site attributes.

When focusing on the source of information, students took the presence of the source as the main indicator. Then, they paid attention to the sector that supports it, being official and/or public institutions and universities the ones that generated the highest reliability. Similar results were found in a previous study in relation to science communication, in which citizens ranked sources from most to least credible, with scientific institutions and universities coming first, then the government, and finally the business sector (Sanz-Menéndez & Cruz-Castro, 2019). Likewise, and as other studies show, people’s qualifications and credentials grant greater reliability when they refer to a subject related to their area of expertise (Hargittai et al., 2010; Saribas & Çetinkaya, 2021; Sbaffi & Rowley, 2017). Specifically in Argentina, when it comes to conflictive situations derived from
scientific-technological development, science and technology agents have a higher social credibility. At the same time, those scientists belonging to the public sphere are distinguished as more reliable than those belonging to the private sector as differences in the motivations, values, practices, and interests of each are recognized (MinCyT, 2014). As for prosumers, they can function as a source of information without going through the intermediation of experts or other arbiters of information. In these situations, news receivers know little about the expertise, qualifications, and possible biases they possess (Metzger & Flanagin, 2015). This results in students’ lack of credibility and trust in content generated by any random person.

In relation to authorship, students identified that the style, rigour, and prestige of the communicator are indicators of the credibility of the information, as indicated by Arias Robles, (2014). In addition, professionals and scientists are a guarantee of reliability. In this sense, it has been pointed out that when there is a choice, people prefer information presented by scientists rather than journalists, as they consider it more accurate and objective (EU, 2017). Likewise, teachers and journalists are more reliable issuers than politicians, celebrities, or companies (Arias Robles, 2014).

In relation to the demand for knowledge criterion, knowledge is highlighted as an important factor in assessing credibility (Metzger & Flanagin, 2015), particularly in relation to SSI news and its implications (Puig et al, 2021). In this regard, we would like to highlight that at the beginning of the proposal, students from both schools encountered a particular difficulty when evaluating the news. It is mainly to put the focus on contrasting the content of the news with the formal knowledge they have of the topic. That is, when the content of the news is consistent with their scientific and school knowledge, some students are more likely to trust the news and forget about how the news is presented (structure, authorship, sources, etc.). For example, the video that spreads the “return” of nature due to the cessation of human activities during the quarantine presents a correspondence with the effects that anthropic activities have on biodiversity. This resulted in those who trusted the information not asking further questions, since the news item contained minimal (misleading) elements that illustrated what it was intended to inform. In this sense, Puig et al., (2021) assign a low epistemic value to this type of evaluations where the content is examined based on one’s own knowledge but there is no critical questioning of the credibility of the source. On the other hand, those who, in addition to knowledge, emphasized how the information is presented made a comprehensive evaluation of the news item, focusing on its title, description, language, context, comments, etc.

Within this category, a singular source of knowledge about COVID-19 came from the health protocols disseminated. This means that there is knowledge of “how to behave” based on what these guidelines establish. Hence, we reflected on how technical, scientific, and/or epidemiological information varied from the beginning of the pandemic up to the time of the debate. For example, the sanitary protocols for the prevention of contagion were different or even opposed at the beginning. A notable case is the use of masks, which was advised only for patients at risk (Bruemmer, 2020). At the same time, we consider the importance of discussing the advances and setbacks of science, since several studies show that, in general, students and teachers do not usually have adequate conceptions of the nature of science, attributing to it ahistoricity, neutrality, infallibility, invariability over time, among others (Fernández et al., 2002; Lederman, 1992, 2006). Particularly, highlighting that, although scientific knowledge has a provisional character, we have great principles in force within the Natural Sciences (González Galli, 2019). Consequently, and from various examples, we reflected on how scientific knowledge was generated and measures for epidemiological control were planned, while the pandemic was already installed and
expanding. In the face of uncertainty, students appealed to the precautionary principle in order to prevent unnecessary risks. This notion was interesting to us, as it is also reflected in the design of health protocols to preserve health, avoid risks, and mitigate the negative impacts of the disease (Moya Padilla, 2020). It should also be noted that for the different constructs, students made an effort to look for evidence or scientific data available to support the reliability or not of the news item.

Within the criterion of news structure, elements such as clarity, use of sources, and wording were identified as influencing interest and trust in the information (Alcalá-Santaella et al., 2021; Arias Robles, 2014; Gómez-García & Carrillo-Vera, 2020). It was raised that what is commonly referred to as “fake news,” usually do not present sources, nor quotes, nor official links; or they may refer to another news item generating a sort of circular verification (Gragnani, 2018; Télam, 2021). In addition, it was discussed that some media have a style of presenting information that makes the reader used to not looking for the sources of what is exposed. Thus, we found news verifiable a posteriori, although their structure lacked precision or even presented a sensationalist discursive tone. On the other side of the coin, there are articles that have no factual basis, but are published in the style of news articles to generate legitimacy (Tandoc et al., 2018). Another element pointed out that generates greater distrust is the use of verb tenses such as the conditional, which is used to express probabilities, proposals, doubts, or desires, since they understand that these forms can deliberately manipulate the public’s opinion. Also, students made reference to appealing to emotions, as identified by Saribas and Çetinkaya, (2021).

As for the format criterion, a new difficulty was observed in the evaluation of the news. Some students assume that there can be a greater manipulation of a photograph than of a video. This idea is particularly delicate, due to the fact that there are new software, for example, facial recognition that oriented to entertainment, admit an image manipulation as it did not exist before (Nusdeo, 2020; Rössler et al., 2019). In this regard, we consider that it would be interesting to include other content dissemination formats, for example, deepfakes. Also, memes that appeal to humor and include satires or parodies can be included and are increasingly taking more prominence in the networks. Although this kind of content implies the complicity of a public informed about reality and the entertainment intentions of those responsible are made explicit, the lack of knowledge of their origin or the subtleties of style can present drawbacks (Tandoc et al., 2018). Moreover, their ambiguity makes them vehicles for the dissemination of health mis-dis-information (Buts, 2020).

Finally, both students and their environment recognized that there are a series of sociocultural factors that affect people when it comes to trusting or not trusting the information that reaches them, i.e., the emphasis is placed on the characteristics of the receiver (Pornpitakpan, 2004). These factors include the sociocultural environment and the beliefs, values, ideologies or political and/or party leanings that people have (Gunther, 1992; Nygren & Guath, 2019; Salmon, 1986; Sherif & Hovland, 1961). In this regard, Milani et al., (2020), Bessi et al., (2015) and Del Vicario et al., (2016) show that people tend to polarize into homogeneous groups, called echo chambers (Del Vicario et al., 2016), orienting their interaction with communities that share information that conforms to their own thinking. It is also important to highlight that by attributing to others the possibility of generating news according to their own political, ideological, religious, etc. interests, sociocultural factors also have an impact on those who produce the news. This idea was present in all the criteria.

Students also highlighted the importance of digital literacy when assessing news credibility (Metzger & Flanagan, 2015). Consistent with this, there is evidence that poor literacy
may increase vulnerability to information (Stvilia et al., 2019; Cline & Haynes, 2001; Diviani et al., 2015). In addition, students relate lower digital literacy to older generations, and although not entirely true (Lorenzo et al., 2006), the need to improve digital competence in older people is recommended (Prado & Ruiz, 2020).

In relation to the verification strategies described by the students, similar results were found to previous works and in the recommendations made by news agencies and other institutions. The strategies of contrasting arguments with formal knowledge and contrasting with reality are part of the first response when evaluating a news item. Then, the most common actions had to do with the search and comparison with other pages or media (Adams et al., 2006; NLP, 2021) and the use of verification platforms (López Pan & Rodríguez, 2020; Kiely & Roberston, 2016). These strategies could be related to information presented in multiple sources being perceived as reflecting different perspectives and with informational independence (Harkins & Petty, 1987). In addition, students highlighted source verification (Saribas & Çetinkaya, 2021; NLP, 2021; Télam, 2021; Sardarizadeh, 2020; Kiely and Roberston, 2016; Adams et al., 2006) and reviewing the context of the news (NLP, 2021; Saribas & Çetinkaya, 2021; Kiely & Roberston, 2016). Finally, asking people we consider suitable to help us in the interpretation is a strategy that was rarely mentioned but that we think it may be more important in offline verification.

6 A Toolbox for Addressing SSI News

The treatment of the news items grouped in the COVID-19 constructs encouraged the approach of different dimensions of SSI. During the TLS, the students’ previous ideas and notions associated with the subject matter were reviewed, clarified, and/or deepened, mainly some concepts of biology and statistics. Some examples of this are mentioned in Section 4.3.

Despite the short time available for the development of synchronous classes, the results show that a wide range of criteria and strategies arose from the activities and that specific difficulties that hindered the evaluation of credibility could also be identified. In this regard, we highlight the importance of addressing a more detailed investigation of each criterion to delve into the elements that compose them. Additionally, the interaction between criteria and their hierarchy, if any, and whether criteria apply equally to different topics and news formats should be studied. Another future consideration is the incorporation of new news formats in accordance with both the evolution of software and the communication dynamics proposed by the networks. Lastly, we emphasize the design of activities that address news that, from partial perspectives but consistent with scientific knowledge, provide a reductionist interpretation of the problem that disorients students (See news item Nº 2).

The design of the TLS around an SSI facilitated the students’ expressions and participation in relation to a topic relevant to their lives. The constructs designed for the TLS made it possible to broadly group the news circulating on COVID-19 and can be seen as dimensions of the SSI in themselves. At the same time, within each construct, a series of topics emerged that reflected the diversity of personal, social, economic, scientific, and moral-ethical aspects that play important roles in the approach to information. To cite examples, in the Pandemic and Environmental Crisis construct, the consequences of anthropic activities on nature were debated on the basis of thinking about what and how much time is needed to recover ecosystems. Another example is Vaccines, Potential Solutions, and the Pharmaceutical Industry, in which the aforementioned aspects crossed the discussion on the role of science to support treatments or cures, access to health according to people’s possibilities, and the business around health.
Of course, as we pointed out in the Section 7, all these topics were not treated in sufficient depth. Therefore, we stress that they can be triggers for future classes and research, with questions such as “How do the reliability criteria relate to each construct? Are there topics in which some criteria are more important than others?”.

The initial approach of framing news as reliable and unreliable had mixed results. Although the students understood the instructions (data collected by the final questionnaire), there were cases in which they spoke in terms of “false and true” and others in which they discussed in terms of “reliable, not very reliable, unreliable.” In this regard, we think that there is an inertia in categorizing news as true or false. Those terms are the ones widely used in all kinds of media that warn about mis-dis-mis-information or deal with the issue in some way. Also, academically, the treatment is usually the same (Tandoc et al., 2018). Therefore, we consider that ingraining students to these terms and ways of dealing with information is a process that takes more time, just like learning to perform any other form of analysis. However, we also noted that a portion of the students were very receptive to the idea of more or less reliable news, and indications of this are shown in their final presentations, examples of which we include in Section 4.3.

In relation to the reliability of the news, there are also two points worth highlighting. First, the collective construction of criteria and strategies through the negotiation of meanings, which in sum, combined different epistemic levels (Puig et al., 2021) and enriched the individual perspectives of the students. The criteria to evaluate a news item and the corroboration strategies worked as a toolbox to face mis-dis-information, but do not work in isolation; rather, depending on the individual, they can adopt different combinations, which depend on his or her skills and motivations (Metzger, 2007). The criteria give an idea of what is observed, what is seen in the news as indicators of reliability. The strategies then take these criteria into account and denote actions to be able to track, compare, and/or verify, as appropriate. A good part of the criteria and strategies found in this work coincide with the analytical strategies or heuristic strategies described and analyzed by Metzger and Flanagin (2015).

Secondly, the students progressively took a skeptical and open-minded attitude from the first individual contact with the news to the group elaborations, and in the latter, the incorporation of the different perspectives of the participants in each group was reflected. These appreciations are based on what the students expressed about their own process (see Section 4.3), where they talk about the awareness of how they used their critical capacity before and after the TLS. It is also evident in the final presentations, where each news item chosen by them was subjected to different criteria and strategies through the search for data for the elaboration of a reflective judgment on the information circulating through different media. Therefore, there was a “stop to think and check” before making a judgment, which was the result of the activities, being the opposite, one of the causes that part of the students attributed to the dissemination of mis-dis-information. These dispositions are in line with the recommendations made by news agencies, which call to pay attention to many of the criteria that students identified during this TLS, but fundamentally, they encourage to take time, to be skeptical, and to check before disseminating the information (NLP, 2021; Télam, 2021). The students’ awareness of their responsibility as prosumers was reflected in practice through the use of the “toolbox” built to rigorously evaluate news information, especially in the last class.

During the final class plenary and in the light of all that was discussed, the students rehearsed a series of responses to the diffusion of mis-dis-information which are in line with studies on the topic. Some expressions refer to the consumption of technology and its associated practices (Vosoughi et al., 2018); to trust in the sender (Media Insight Project,
to external conditions such as time constraints (Metzger & Flanagin, 2015); to CT skills and dispositions (Facione, 2015; Metzger & Flanagin, 2015); and to the need to believe in something that generates hope or is in consonance with what one feels or thinks (Quattrociocchi, 2017). In addition, some students understand that people’s material conditions can affect decision-making and, also, that there are people who benefit from the dissemination of mis-dis-information. In this way, we observe a multifactorial web of reasons that are expressed from the reflection on one’s own practice achieved in the TLS, each of which can be further elaborated in more detail.

Finally, teachers noticed a substantial difference in students’ participation in the proposal, as opposed to previous classes. Additionally, they observed that the group work assignment had not fallen on a single person, but that the tasks reflected the perspectives of the different members of each group. They also highlighted the diversity of resources used in the presentations and a variety of criteria and strategies that provided the rest of the classmates with other examples of how to approach the news.

In summary, the adoption of an SSI and the dialogic dynamics of the TLS, in accordance with the literature supporting its inclusion, encouraged students, allowed discussion about the nature of science, enhanced the learning of scientific content, and involved them in activities that promoted reflection on their own CT (Evagorou, 2020; Hodson, 2020; Kuhn, 2019; Rodríguez-Losada et al., 2021; Zeidler et al., 2005).

We consider that becoming aware of CT itself, the knowledge needed to be able to evaluate news and the tools we have is a step forward towards a rigorous practice of information evaluation. Therefore, hasty and careless conclusions are not consistent with the intention to understand reality.

The results of this work support the idea that scientific literacy and news literacy play a fundamental role in combating mis-dis-information (Archila et al., 2019; Vraga et al., 2020). Furthermore, they can collaborate with the understanding of the processes involved in evaluation and guide educators and science education researchers in designing TLS that help students deal with the large amount of circulating information.

7 Conclusions

A vast literature explores the evaluation of credibility in the news from multiple approaches and with different variables, taking into account the challenge that it represents for citizens to adopt a critical judgment for decision-making. In this study, motivated to make a contribution to science education, we co-designed a TLS between teachers and researchers to address this issue.

The implementation of the TLS presented gave rise to a wide emergence of criteria and strategies that made it possible to show in class, the multiplicity of factors that affect the approach to the news. Likewise, some particular difficulties presented to the students were identified, from which we propose to incorporate their treatment in the classroom by means of some recommendations.

On the whole, the TLS contributed to the reflection on CT. Moreover, some social and ecological dimensions related to COVID-19 such as SSI and also concepts from biology and statistics could be addressed.

Given the spread of mis-dis-information, it is increasingly common to find lists of tips on different platforms to verify the content of a news item. In our case, there is an underlying idea among students that people, and therefore institutions, can change their commitment.
to the truth, driven by different interests. This casts a mantle of mistrust beyond the general criteria and strategies for approaching news, considering also that these could manifest interactions or hierarchies that we are unaware of and may be the object of future research. Another point is illustrated in the difficulty of assigning specific characteristics to define a news item as “fake,” since we have seen that certain journalistic or editorial styles replicate these patterns of news presentation with genuine information. In relation to the above, and based on the diversity of factors that traverse the interpretation and evaluation of news for each person, in this work, we advocate transcending the “recipes” of information verification through the creation of spaces for collective discussion, highlighting several points in favor: (1) the possibility of dealing with different dimensions of SSI, collaborating with a complex analysis of reality, (2) the opportunity to discuss scientific content and about the nature of science, (3) the contribution that this type of dialogic proposals make to the negotiation of meanings and the collective construction of meaning through the participation and engagement of the participants, and (4) individual and collective awareness of the responsibility that exists in the generation and/or dissemination of the information that circulates, and of the tools that can be put into practice to reach a reflective judgment.

Lastly, regarding the DBR approach, we would like to emphasize that we share the idea that promoting collaborative and horizontal practices between teachers and researchers in which questions—socially alive—are addressed, places teachers as producers of discourses relevant to science teaching (Martins, 2016). More specifically in this work, both teachers and researchers participated in the design as well as in the implementation of the TLS and in the elaboration of this article.

8 Limitations

The research was carried out during the adaptation of the face-to-face classes to virtuality. Due to this, the total time allotted by each institution of 60 min maximum for synchronous classes was a limitation that required readjustments that took into account technical and connectivity problems. We also consider that exchanges in virtual spaces tend to be less frequent and not as fluid, as opposed to face-to-face meetings. It was not possible to deepen the approach to the SSI constructs given the time we finally had for the application of the TLS. We are aware that each of the constructs, by itself, has the potential to address several SSI. We also did not work on the evaluation methodologies of the teaching–learning process because the educational institutions determined this task as exclusive to teachers. The implementation of the project was favored by the socioeconomic conditions that allowed students to access the necessary resources to participate. An adaptation of the TLS to the conditions of other schools and students would be interesting to extend the results. This project is an approach through DBR in the construction of promising learning contexts. We suggest strengthening this type of educational proposals with spaces for the construction of argumentation around SSI through interdisciplinary and/or intercurricular approaches.

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