Science Communication Objectives and Practices of Science News Websites

Introduction

During the past decades, the relationships between science, media, and the public have been constantly rethought (Bucchi & Trench, 2014; 2021) due to challenges the "Post-normal science age" has placed (Ravetz, 2006). It includes the challenges citizens face with decision-making regarding issues of risk concerning health and the environment that are frequently debated in the public sphere (Scheufele et al., 2021), making the media coverage of such issues a public necessity.

The activity formats of science communication, where publics are exposed to science, are diversified and reflect at least one of the three acceptable science communication model approaches: i.e., *Deficit, Dialogue,* and *Participation*, each of which regards the science-public relation differently (Metcalfe, 2019). *Deficit model* – Science communicators disseminate science to publics perceived to be deficient in understanding it need to be educated with scientific knowledge; *Dialogue model* – Science communicators engage in conversation with the public to provide consultation and listen to the public concerns and needs. *Participation model* – Science communicators and various publics communicate science on the basis that all contribute to creating new knowledge and have a stake in the outcome of the deliberations. Engagement activities that reflect different models place different goals for communicating science (National Academies of Sciences, Engineering, and Medicine, 2017). While some seek to defend science from being misrepresented or educate the public, others are interested in encouraging critical discourse related to science issues or supporting active public participation in the co-creation of science (Entradas et al., 2020; Jensen & Holliman, 2016). Each contributes to the science communication realm with a potentially different effect on public attitudes and opinions (Bauer, 2012; Gilbert, 2008). Therefore, it is paramount to explore the roles, objectives, and practices of science practitioners that provide the public with science engagement activities and enable public discourse about them (Brüggemann et al., 2020).

The primary agent that communicates science to broad publics is the media – broadcast, print, and digital (Dunwoody, 2014). The latter is the context for this study. As the Internet has become the major way of delivering information in general and the leading resource for those searching for scientific information in particular (Brossard & Scheufele, 2013), scholars began investigating different aspects of online spaces of science communication and engagement (Schäfer et al., 2020; Stilgoe et al., 2014). Within the field of digital science communication, the current study focuses on science news websites and their Facebook pages as they have evolved to be an important worldwide media agent (Bubela et al., 2009) and likewise in Israel (Baram-Tsabari et al., 2020). Science news websites are digital journalistic outlets that cover only science-related topics. This research explored their science communication objectives compared against three dominant science communication models, using the framework suggested by Bucchi & Trench (2021), integrated with science communication objectives (Metcalfe, 2019; Scheufele et al., 2021) (Table 2). Investigating the science communication objectives and practices of science news websites, understudied to date, can shed light on the ways science is mediated to the public in such online spaces. Moreover, it may set insight over the informal learning opportunities the websites offer laypeople to engage with science.

As part of a PhD dissertation research[1], I ask:

What are the objectives of science news websites in communicating science to the public, and in what ways are these objectives manifested through the website articles?

Referring to this question, I explored the website objectives by interviewing their operators and investigating the websites' practices via content analysis of their publications.

Method

[1] This research in its entirety encompasses these RQs as well:
RQ2 How are engagement expressions appeared in user comments post-reading the website articles related to the (a) publication platform ,and, (b) accessibility strategies used in the articles?
RQ3 What are the users' motivations for reading website articles and commenting on them, and how do they align with the websites' objectives?
This research is supported by the Ministry of Science Technology and Space under grant agreement 3-15725.

Using the concurrent parallel mixed methods approach (Creswell & Creswell, 2018), quantitative and qualitative data were obtained for the purpose of complementarity and development (Onwuegbuzie & Johnson, 2006). Hence, I conducted a two-part study. Part 1 included interviews with the websites' operators to understand their science communication objectives. Part 2 included content analysis of each website's articles to examine the practices employed by the websites to achieve their objectives.

The websites

Four Israeli science news websites were included in this study. Pseudonyms were used to maintain their anonymity: *A, B, C*, and *D*. These are leading websites in Israel for posting and disseminating articles about diverse science topics. *D* is the eldest – a milestone in Israel's online popular science publishing. The four websites meet two pre-determined inclusion criteria: (1) coverage of various science topics (2) publishing frequency is once a day or at least several times per week. Table 1 details relevant characteristics of the websites and highlights their shared nature as journalistic outlets dedicated exclusively to covering science issues that are not necessarily written by professional journalists (Authors, in review). Table 1 also presents some differences between the websites: *A* and *B* are operated by highly recognized organizations, a research institute, and a scientific association that provide financial support, while the others are by volunteers. *B* focuses on environmental sciences and ecology topics while the other three websites present a more comprehensive range of science topics; *A, B, and C* are operated by much professional staff, while *D* is operated mainly by one person who has previously been a journalist.

Data Collection and Analysis

Part 1

Interviews. Eight semi-structured interviews were conducted with the websites' operators to understand the websites' objectives and ways of communicating scientific knowledge to the public from the insiders' point of view. While using an initial protocol for each interview, I encouraged the interviewees to elaborate to deepen an understanding regarding their science communication objectives. I did so in two moves: firstly, I asked the interviewees to broadly discuss the website's objectives. Secondly, to address science communication objectives presented to them and rank them by importance from the website perspective. This analytical framework of science communication objectives was developed based on science communication literature (Metcalfe, 2019; Scheufele et al., 2021) and was organized according to an

Table 1. Websites' characteristics

		A	*B*	*C*	*D*
Owner/Operator		A prestigious organization that provides solid financial support	A prestigious organization that provides solid financial support	Scientists' association	Private ownership of the founder and leading writer
Subject areas		Various science topics	Primarily environmental sciences and ecology	Various science topics	Various science topics
Staff		The staff all have advanced degrees in science. Among them are writers and scientific & language editors. Most of the writers are graduate students.			Runs by the owner who has experience in journalism; other writing contributors have an advanced degree in science
Employment status		Paid staff		Volunteers	
Published articles in 2018 :written by	Website staff	507	233	203	421
	University PR	14	-	-	300
Published articles in 2019 :written by	Website staff	532	208	232	345
	University PR	48	-	-	258
of followers # as of December 2019 (data (collection	Facebook	49,203	10,436	138,711	16,522
	Instagram	1,798	657	9,102	-
	Twitter	1,813	296	3,799	-
of followers # as of October 2021	Facebook	65,292	11,136	154,058	17,978
	Instagram	4,308	873	11,600	-
	Twitter	4,050	379	7,105	-

analytical framework of science communication models (Bucchi & Trench, 2021; Trench, 2008). It includes twelve objectives classified according to the three models of science communication: *Deficit*, *Dialogue*, and *Participation* (Table 2). All interviews were audio-recorded and transcribed.

Table 2. Analytical framework for analyzing the websites' science communication objectives

PCST models (Bucchi & Trench, 2021; Trench, 2008)	***Sci-comm applications***	***Science orientation to public***	***Science communication objectives*** (Metcalfe, 2019; Scheufele et al., 2021)
Deficit	Education	They are ignorant	Enhance public's scientific literacy to be able to make informed decisions
	Defense	They are hostile	Contradict science misinformation, disinformation and fake news
	Popularization	They need to be informed	Inform the public about science and distribute scientific content
			Make scientific content accessible
	Promotion	They can be persuaded	Excite the public about science and increase appreciation for science
			Gain public's support and government funding for science
	Contextualization	They have diverse needs	Tailor messages to specific audiences and build trust
Dialogue	Engagement	They talk back and we found out their views	Gain lay knowledge
	Consultation	They take on the issue	Stimulate the public to be involved in public science discourse, express concerns and raise questions that stem from science and its applications
Participation	Deliberation	They and we shape the issue and set the agenda of science	Foster the public to help set the agenda for science by actively deliberate in public debates on the "why" and "why not" of science, as part of democratic policymaking
	Critique	They and we negotiate meanings	Enable responsible innovations – Acknowledge the public critique on the science research enterprise priority list, and strive to maximize possible societal returns from investments in science for the larger social good
	Collaboration	They and we co-create	Citizen science – Encourage the public to participate in research endeavors with scientists

Website homepage. Additional information was retrieved from the "about" section of each website. It was analyzed to better understand the websites' aims and how they describe themselves (e.g., their staff's academic and professional experience).

Part 2

Article content analysis. Content analysis (Krippendorff, 2013) of the articles enabled to examine how the websites' objectives are manifested through their articles, including identifying and quantifying accessibility strategies used by the websites.
All articles published by the websites' staff during the last quarter of 2019 were collected for this analysis (n=298): 118 published by *A,* 51 by *B,* 62 by *C, and* 67 by *D*. The data collection period was chosen since it is the closest to present time preceding the COVID-19 crisis, that changed science coverage. The number of published articles of each website during this period is within the standard deviation range regarding all quarters of 2018 and 2019. These articles were content analyzed using a codebook. The codebook was developed based on the accessibility strategies mentioned by the websites' operators and supported by information from the research literature of making texts accessible in general and science content in particular (Appendix). The starting point, for that matter, was the analytical framework presented by Baram-Tsabari & Lewenstein (2013; 2017), who suggested a comprehensive framework of learning goals for guiding scientists to communicate their science to the public. I modified and elaborated on some of these framework components with adjustments to suit this research goal. For example, one of their guidelines is to select appropriate content (i.e., engaging, interesting, and relevant to a particular audience). This general guideline was modified to specific accessibility strategies (e.g., local events, current affairs). Thirteen accessibility strategies were included in the codebook and classified into four clusters; each focuses on a specific aspect of accessibility: Clarity, Visualization, Relevance, and Style (Table 3).
The articles were analyzed by their topics and coded either to one or two science field categories: Medicine & Health, Life sciences, Environmental sciences, Technology & Space, and, Exact sciences (i.e., Physics, Chemistry, and Math).

Trustworthiness

The codebook was face-validated by five science education researchers and was tested and revised several times until a detailed, accurate, and satisfying version was achieved. The website articles were jointly coded by the first author and a trained research assistant. They independently coded 20% (n=61) of the articles to achieve inter-coder reliability. Cohen's kappa coefficient was calculated for each criterion to ensure acceptable inter-coder reliability; values ranged from 0.62 to 1. All coding discrepancies were discussed until a consensus was reached before their inclusion in the analysis. By repeatedly conducting Fisher's exact tests, I tested the null hypothesis of no difference in any pair of proportions for more than two groups, with adjustment of type I error for multiple comparisons of Bonferroni.

Table 3. Accessibility strategies by cluster

Clusters	*Accessibility strategy*	*Operationalization*	*Cohen's kappa coefficient*
Clarity	Number of words	The number of words per article, excluding title and captions.	-
	Number of Jargon terms	The number of jargon terms (e.g., zygote, endothelium, hydrolysis). Each term was marked once, regardless of how often it occurred in the text.	0.74
	Explanations	Whenever a clarification followed an unfamiliar scientific term.	0.80
	Examples	Whenever a concrete case demonstrated a generalization of the scientific idea.	0.75
	Analogies	Whenever a familiar, simple concept supported a less familiar and more complex one.	0.81
Visualization	Pictures	Whenever a picture, a photo, or an illustration accompanied the text.	-
	Diagrams	Whenever a graph, a flow chart, or a formula appeared in the text.	0.92
	Videos	Whenever a video clip accompanied the text.	-
Relevance	Current affairs	When the article reported on or followed a recent event (e.g., an award for a scientist or a recent climate conference) or presented an issue highly covered by the general media.	0.74
	Local aspects	When the article presented an event or an issue relevant to Israel or Israelis. For example, the launch of "Beresheet," the robotic lunar lander and lunar probe developed by Israeli aerospace industries.	0.92
	Socio-scientific issues	When the article presented a public-debated scientific issue that carries societal implications (e.g., genetically modified organisms, biofuels).	0.62
	Applications	Whenever a technological innovation that improves individuals or society was presented, for instance, innovative sensor prostheses improve gait speed and reduce phantom pain.	0.65

Style	Narrative	When the article was written in a storytelling style, involving one or several characters, or presents a sequence of events.	0.80

Findings

Science news websites' objectives in communicating science to the public

To understand the website objectives in communicating science to the public, I interviewed their leading staff members. Table 4 displays the website operators' ranking of the science communication objectives presented to them during the interviews and illustrative quotes. It shows that the objectives related to the deficit model were the most dominant, and the interviewees spontaneously mentioned many. Two objectives were found to be in complete agreement as to the most preeminent ones: (1) Inform the public about science and distribute scientific content (2) Make scientific content accessible. Table 4 also indicates that the interviewees perceived the objectives related to the dialogue model as relevant yet, less central. In contrast, some participation model objectives were not reported as the websites' objectives.

Manifestation of science news websites' objectives in the website articles

To examine the ways and the extent to which the websites' objectives are manifested in their articles, I content analyzed a sample of 298 articles according to pre-determined criteria. Here addressed the most prominent two objectives.

(1) Inform the public about science and distribute scientific content. Table 1 shows the number of articles published on each website in 2018 and 2019. All websites' staff write articles themselves; however, *A* and *D* post press releases from research institutions and university PR, as well (8% and 43%, respectively). The websites distribute science information in various ways. All four websites are active on social networks, which serve as distribution platforms for the websites' articles *"It is a path for spreading and reverberating our messages…delivering science to more people" (A); "It is the marketplace where you can stand on a crate and present publicly and out loud your manifest" (B).* The follower numbers of their social media platforms are consistently growing, though Facebook is the most dominant (Table 1). However,

only 66% of all articles were posted on their Facebook pages. According to the interviewees, Facebook algorithm constraints, priority order, and time limits are the reasons for that. *A* and *B* provide articles at no cost to general online news outlets; within this research sample, 47 out of 51 of *B's* articles (92%) were published in general online news outlets (e.g., YNet, Walla, Mako), and 31 out of 118 of *A's* (26%). *B's* strategy is straightforward, as they intend their articles to be published in

Table 4. Interviewee ranking of the science communication objectives and illustrative quotes

Science communication objectives by PCST models		*A*	*B*	*C*	*D*	*Illustrative quotes*
Deficit	Enhance public's scientific literacy to be able to make informed decisions	*	*			*"In the short run, we simply want people to consume the content we publish, while, in the long run, we aimed at educating the public to be able to make informed decisions based on scientific information, and raising its acknowledgment to look for it" (A)*
	Contradict science misinformation, disinformation, and fake news	*		*	*	"*Our struggles against unsupported arguments regarding issues such as evolution or climate crisis is an integral part of our science communication" (D)*
	Inform the public about science and distribute scientific content	*	*	*	*	*"Our primary goal is to enhance the scientific content consumption in Israel…that people will routinely consume science content…to engage science to every house and pocket in Israel…we do so by exporting our articles to other platforms" (A)*
	Make scientific content accessible	*	*	*	*	*"We have two language editors in our team who are not from within the science field [which gives them an advantage]… they simply edit the texts to be more readable for laypeople" (C)*
	Excite the public about science and increase appreciation for science	*		*	*	*"To introduce science as valuable to daily life and important source of information, in an interesting manner that excites the public and makes him want to read more science content…we focus on the wow factor and why it is worthwhile reading" (C)*
	Gain public's support and government funding for science					*"It is very far from our goals…however, it is a consequence of our practice" (D)*
	Tailor messages to specific audiences and build trust	*	*			*"In many cases, science involves other aspects of life…economic, transportation, agriculture…so we ask ourselves what is the angle that this story meets the people and what is the most interesting manner of telling this story" (B)*

Table 4. (Continued)

Dialogue	Gain lay knowledge					*"We have sensors…meaning a bunch of people on social networks that provide us with inputs on what interests the public…and according to these issues we write science articles" (A)*
	Stimulate the public to be involved in public science discourse, express concerns and raise questions that stem from science and its applications			*		*"Once the article is published, it triggers people to comment and discuss…sometimes I answer…sometimes users, two sides of a coin debate" (D)*
Participation	Foster the public to help set the agenda for science by actively deliberate in public debates on the "why" and "why not" of science as part of democratic policymaking		*			*"To connect between members of the scientific community within the ecology and environmental fields, and the public…and through it, to reach decision-makers" (B)*
	Enable responsible innovations – Acknowledge the public critique on the science research enterprise priority list, and strive to maximize possible societal returns from investments in science for the larger social good					*"It is not one of our goals" (A)*
	Citizen science – Encourage the public to participate in research endeavors with scientists					*"Sometimes we cover citizen science projects…but nothing further" (D)*

Legend:

	Ranked first by the interviewees as the website objective
	Ranked second by the interviewees as the website objective
	Ranked third by the interviewees as the website objective
	Ranked forth by the interviewees as the website objective
	A potential outcome of the website's operational objectives

	Is not one of the website objectives, according to the interviewees
*	Spontaneously mentioned by the interviewees

non-science sections: *"Our philosophy is to tell the story where people are, rather than bring them to us"*. *A* and *B* are also reaching out to non-Hebrew readers through a website in English. *A* has a website in Arabic as well to serve the Arab-speaking population of the country. All websites reported keeping their articles constantly on the site platform and acting as archives of a firm source of scientific information *"The website offers its readers a comprehensive stockpile of scientific content" (D)*; *"We maintain a content-rich site that is always accessible to everyone, anywhere and at any time" (A)*. The articles are either stored in different sections according to their main subject *(B, C,* and *D)* or organized in chronological order *(A)*; either way, they can easily be reached by keywords via search engines. The websites undertake to inform the public about a variety of science topics. The topic distribution was found to extend various science fields: 30% Medicine & Health, 20% Life sciences, 25% Environmental sciences, 29% Technology & Space, and 19% Exact sciences.

(2) Make scientific content accessible. This shared fundamental goal is expressed loud and clear in the "about" section on the websites' homepage: *"to bridge the apparent gap between the scientific community and the general public" (C).* Content analysis of the articles enabled to scrutinize the accessibility strategies. Table 5 presents the thirteen accessibility strategies used by each website according to the four clusters: clarity, visualization, relevance, and style.

Table 5. Accessibility strategies and their use by the websites (%)*

Clusters	Accessibility strategies		*A* (n=118)	*B* (n=51)	*C* (n=62)	*D* (n=67)
Clarity	Number of words	Small: < 450	$5^{a,b}$	0^{b}	18^{c}	$15^{a,c}$
		Medium: 451-850	72^{a}	29^{b}	81^{a}	66^{a}
		High: > 851	23^{a}	71^{b}	2^{c}	19^{a}
	Number of Jargon terms	Light: < 3	47^{a}	67^{a}	58^{a}	27^{b}
		Moderate: 4-6	41^{a}	26^{a}	31^{a}	31^{a}
		Heavy: > 7	13^{a}	8^{a}	11^{a}	42^{b}
	Explanations		$^{a}80$	65^{a}	71^{a}	37^{b}
	Examples		48^{a}	39^{a}	47^{a}	28^{a}
	Analogies		6^{a}	6^{a}	13^{a}	6^{a}
Visualization	Pictures		87^{a}	$96^{a,b}$	$98^{a,b}$	100^{b}
	Diagrams		9^{a}	2^{a}	11^{a}	10^{a}
	Videos		22^{a}	77^{b}	10^{a}	9^{a}
Relevance	Current affairs		13^{a}	35^{b}	39^{b}	43^{b}
	Local aspects		2^{a}	55^{b}	11^{c}	25^{c}
	Socio-scientific issues		2^{a}	35^{b}	2^{a}	3^{a}
	Applications		10^{a}	$18^{a,b}$	10^{a}	30^{b}

Style	Narrative	4[a]	10[a,b]	18[b]	5[a,b]

** A value's superscript letter indicates whether that value is significantly different (p<0.05) than another value in the same row*

Generally speaking, this analysis supports the interview data and demonstrates that all four websites apply to some degree the thirteen accessibility strategies; yet, some are more frequent than others (e.g., explanations compared to examples or analogies). However, several discrepancies between the interviewees' statements and the article analysis were also found. *A*, *B,* and *C* reported that their articles are routinely language edited as part of the production process to reduce jargon and enhance clarity, and *D* claimed it aims at *"…wording that sixteen-years old could understand"*. About 90% of the first three websites' articles are written with light or moderate levels of jargon, and once they use scientific terms, explanations are provided (80%, 65%, 71%, respectively); whereas 38% of *D's* articles use the highest level of jargon and provide fewer explanations (37%) and fewer examples (28%) compared to the other three websites (39% - 48%). Regarding the use of science-related current affair stories, at least one-third of *D's*, *C's*, and *B's articles* dealt with current events, which aligns with their claims *"We make efforts to connect our items to current affairs, rather than be stripped from the reality we live in"(C)*. *A,* on the other hand, addresses them to a much lesser extent (13%), though arguing: *"We address current affairs in our articles to connect the science information to daily life events"*. Similarly happened regarding local events. Aligns with the claim: *"Whenever a worldwide issue comes up, we ask ourselves: does it happen in Israel too? or, does it somehow affect Israel?"(B),* at least a third of *B's* and *D's* articles address local contexts, while apparently, this is not prioritized by *A* (2%) and *C* (11%), though they declared favoring reporting on Israeli research. Socio-scientific issues are outstanding in *B's* articles (35%) compared to the other websites that hardly address such issues in their articles (2% - 3%). Only limited evidence for using a narrative style was found with higher use by *B* and *C* (10% and 18%, respectively).

Discussion

This research aims to understand the objectives and practices of science news websites and shed light on these online spaces of engagement with science as informal learning environments.

The findings (Table 4) indicate that the websites hold similar objectives and perceive their significance in roughly the same order. Most of the objectives reflect the deficit and dialogue models, though the former was found to be more fundamental. This is congruent with previous studies pinpointing that many engagement activities hold objectives that reflect a mix of deficit and dialogue models and employ the deficit model principles as a backbone by emphasizing information transfer and education (Brossard & Lewenstein, 2010; Metcalfe, 2019). For instance, science museums communicate scientific information through their exhibits but also allow visitor discussion via a Q & A forum during the visit. Following the retrospective discussion of the deficit model concerning its science-public relation, and despite claims over the last two decades that have widely rejected it, the deficit model appears to be alive and well and has a legitimate place; so, as such can-not be discarded (Irwin, 2014; Trench, 2008). The websites allow users to comment. Doing so has the potential to accomplish the dialogue model objectives. i.e., gain lay knowledge and inputs regarding the publics' concerns and needs. However, these objectives were found to be secondary on the websites' behalf. This aligns with the low willingness of other practitioners to engage in online dialogue with the public demonstrated previously, e.g., scientists (Besley, 2015; Rose et al., 2020), science bloggers (Yuan & Besley, 2021), and PR of science organizations (VanDyke & Lee, 2020); this is despite the acknowledgement among science communicators of the dialogue model as the most effective way to make the public interested in science and understand it (Reincke et al., 2020). Most of the objectives that reflect the participation model are hardly held by the websites. In light of the growth of citizen-science projects due to the integration of the Internet in everyday life which has significantly increased visibility, functionality, and accessibility (Bonney et al., 2014), it seems a missed opportunity. Meaning, in the same way the websites serve as intermediaries between science and the public in disseminating scientific knowledge, they can also use their online platforms to facilitate scientists' collaborations with the public.

The websites make an effort to inform the public about science by providing hundreds of articles per year (Table 1) and operating as free-to-use science information archives. The Israeli public is interested in hearing about science through the media and perceives scientific knowledge as necessary for everyday life (Smith & Pniel, 2014); the two reported most attractive topics are Medicine & Health and Environmental sciences. The websites addressed these topics in 30% and 25% of their articles, respectively; however, they tend to cover a broader range of science topics to interest various publics. Their articles can easily be reached by keywords via search engines, supporting laypeople seeking specific scientific knowledge. To expand the distribution of scientific information, the websites publish articles written by their staff as well as by university PR. They employ multiple ways to expose their articles to a broader public. Their common way is by being active on social media. In a wired world, online media platforms intensify science exposure since new media and Web 2.0 affordances increase the availability of science information and create a digital public sphere of engagement and debate (Buchi, 2017; Davies & Hara, 2017). As such, online media platforms are an effective way of information distribution. However, while the websites are active on Facebook, their other social networks have much lesser followers. Furthermore, they posted only 66% (on average) of their articles on their Facebook page, partially because of priority order and time limits, which can be explained by the nature of the website staff, i.e., volunteers (*C* and *D)* and a small team (*D)* (Table 1). Other ways to enhance their article distribution to reach out to large heterogeneous publics are the attendance of non-Hebrew websites (i.e., English and Arabic) and article provision to general online news outlets. It is worthwhile to consider these websites as science intermediaries; since, when trustworthy and comprehensible scientific information is available to publics that do not consume science information regularly, it might assist in decision-making once they face daily science-related dilemmas (Howell & Brossard, 2021).

Mediating scientific content to diverse audiences, specifically to laypeople is essential, however, not a trivial task (Brownell et al., 2013; Hunter, 2016). All four websites applied the investigated accessibility strategies, though to a different extent (Table 5). They aim at making scientific texts more accessible, i.e., to enhance clarity and improve relevance and interest. They consider the article length (White, 2012), minimize jargon use (Rakedzon & Baram-Tsabari, 2017), provide explanations and examples (Sevian & Gonsalves, 2008); accompany the articles with visual elements (Pipps et al., 2009); address contextual factors (McTigue & Slough, 2010); and, use a storytelling writing style (Hillier et al., 2016).

In general, the analysis of the articles was found to be in accordance with the websites' statements regarding their practices; however, several discrepancies were found, which imply that, from time to time, the websites should audit their practices to ensure they comply with their communication objectives.

To conclude, this exploratory study offers a glance at science news websites' objectives and practices in communicating science to the public to inform science communication model theory. It demonstrates that science news websites provide the public with mediated scientific articles, and, first and foremost, reflect the deficit model objectives, notwithstanding following the dialogue model objectives. Science news websites adhere to present science accurately, relying on reliable scientific sources while using accessibility strategies that may contribute to the text comprehensibility in terms of clarity, visualization, relevance, and style. Doing so, they play an important societal role as informal science learning environments for advancing the broad public's scientific literacy.

Appendix A: Accessibility strategies of texts

The comprehensive guidelines of learning goals for scientists to communicate their science to the public suggested by Baram-Tsabari & Lewenstein (2013; 2017) served us as a framework. Here we list the strategies against which we analyzed the articles, supported by information outlined in the research literature.

(1) *Number of words*. Can affect reader comprehension of the presented information; the longer the text is, the higher is the difficulty it to understand (White, 2012).

(2) *Jargon*. Many scientific terms (jargon) are not used in everyday life, and most of them are abstract or require substantial scientific knowledge to understand. This might hinder readers' understanding (Mikk & Kukemelk, 2010; Rakedzon & Baram-Tsabari, 2017).

(3) *Explanations*. An explanation of an unfamiliar term can help its understanding (Sevian & Gonsalves, 2008).

(4) *Examples*. Examples are given to demonstrate an abstract idea can enhance comprehension (McTigue & Slough, 2010).

(5) *Analogies*. An analogy is a comparison between a familiar, simple concept and a less familiar and more complex one. It illustrates an abstract idea and provides clarification (Kapon et al., 2010).

(6) Pictures. Recall and understanding are improved when the text is accompanied by pictures (Gardiner, Sullivan, & Grand, 2018; Pipps et al., 2009).

(7) Diagrams. Diagrams are graphical representations of data, processes, or systems, which help clarify the information, dynamic processes, and change over time (McTigue & Slough, 2010).

(8) Videos. Videos are informative communication products that can enhance recall and understanding (Pipps et al., 2009).

(9) *Local aspects.* Local aspects and local events have the potential to facilitate interest in science as many engage with scientific information when it addresses their needs and concerns (Bubela et al., 2009).

(10) *Current affairs.* Current affairs refer to science or general news events that need scientific explanation and trigger public attention and interest (Badenschier & Wormer, 2012).

(11) *Socio-scientific issues.* Reflect scientific and societal dilemmas increase the relevance of scientific information and people’s interest (Ratcliffe & Grace, 2003) and encourage action (Kolstø, 2001).

(12) Application. Applications of basic scientific knowledge attract public attention (Dimopoulos & Koulaidis, 2003).

(13) *Narrative*. Narrative involves creating stories and converting expository scientific information that portrays science as a de-contextualized set of facts into stories with a social context that the reader can relate to and make sense (Hillier

et al., 2016). Using narratives/stories is a powerful communication tool and promotes understanding (Hillier et al., 2016).

References

Authors. (in review)

Baram-Tsabari, A., & Lewenstein, B. V. (2013). An instrument for assessing scientists' written skills in public communication of science. *Science Communication*, *35*(1), 56–85. https://doi.org/10.1177/1075547012440634

Baram-Tsabari, A., Orr, D., Baer, A., Garty, E., Golumbic, Y., Halevi, M., Krein, E., Levi, A., Leviatan, N., Lipman, N., Mir, R., & Nevo, E. (2020). The history and evolution of science communication in Israel. In T. Gascoigne, B. V. Lewenstein, L. Massarani, B. Schiele, P. Broks, M. Riedlinger, & J. Leach (Eds.), *The Emergence of Modern Science Communication*. ANU Press.

Bauer, M. W. (2012). Public attention to science 1820–2010 – A 'longue durée' picture. In S. Rodder, M. Franzen, & P. Weingart (Eds.), *The Sciences' Media Connection - Public Communication and its Repercussions* (pp. 35–57). Springer. https://doi.org/10.1007/978-94-007-2085-5_3

Besley, J. C. (2015). What do scientists think about the public and does it matter to their online engagement? *Science and Public Policy*, *42*(2), 201–214. https://doi.org/10.1093/scipol/scu042

Bonney, R., Shirk, J. L., Phillips, T. B., Wiggins, A., Ballard, H. L., Miller-Rushing, A. J., & Parrish, J. K. (2014). Next steps for citizen science. *Science*, *343*(6178), 1436–1437. https://doi.org/10.1126/science.1251554

Brossard, D., & Lewenstein, B. V. (2010). A critical appraisal of models of public understanding of science: Using practice to inform theory. In L. Kahlor & P. Stout (Eds.), *Communicating Science: New Agendas in Communication* (pp. 11–39). https://doi.org/10.4324/9780203867631

Brossard, D., & Scheufele, D. A. (2013). Science, new media, and the public. *Science*, *339*(6115), 40–41. https://doi.org/10.1126/science.1232329

Brownell, S. E., Price, J. V, & Steinman, L. (2013). Science communication to the general public: Why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. *The Journal of Undergraduate Neuroscience Education*, *12*(1), 6–10. http://communicatingscience.aaas.org

Brüggemann, M., Lörcher, I., & Walter, S. (2020). Post-normal science communication: Exploring the blurring boundaries of science and journalism. *Journal of Science Communication*, *19*(3), 1–22. https://doi.org/10.22323/2.19030202

Bubela, T., Nisbet, M. C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., Geller, G., Gupta, A., Hampel, J., Hyde-lay, R., Jandciu, E. W., & Jones, S. A. (2009). Science communication reconsidered Nature. *Nature Biotechnology*, *27*(6), 514–518.

Bucchi, M., & Trench, B. (2014). Science communication research: Themes and challenges. In M. Bucchi & B. Trench (Eds.), *Routledge Handbook of Public Communication of Science and Technology* (Second Edi, pp. 1–14). Routledge. https://doi.org/10.4324/9780203483794

Bucchi, M., & Trench, B. (2021). Rethinking Science Communication as the Social Conversation Around Science. *Journal of Science Communication*, *20*(3), 1–11. https://doi.org/10.22323/2.20030401

Buchi, M. (2017). Microblogging as an extension of science reporting. *Public Understanding of Science*, *26*(8), 953–968. http://pus.sagepub.com/cgi/doi/10.1177/0963662516657794

Creswell, J. W., & Creswell, D. J. (2018). *Research design. Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Davies, S. R., & Hara, N. (2017). Public science in a wired world: How online media are shaping Science communication. *Science Communication*, *39*(5), 563–568. https://doi.org/10.1177/1075547017736892

Dunwoody, S. (2014). Science journalism: Prospects in the digital age. In M. Bucchi & B. Trench (Eds.), *Handbook of Public Communication of Science and Technology* (2nd ed., pp. 27–39). Routledge. https://doi.org/10.4324/9780203483794

Entradas, M., Bauer, M. W., O'Muircheartaigh, C., Marcinkowski, F., Okamura, A., Pellegrini, G., Besley, J., Massarani, L., Russo, P., Dudo, A., Saracino, B., Silva, C., Kano, K., Amorim, L., Bucchi, M., Suerdem, A., Oyama, T., & Li, Y. Y. (2020). Public communication by research institutes compared across countries and sciences: Building capacity for engagement or competing for visibility? *PLoS ONE*, *15*(7), 1–17. https://doi.org/10.1371/journal.pone.0235191

Gilbert, J. (2008). Science communication: Towards a proper emphasis on the social aspects of science and technology. *ALEXANDRIA Revista de Educação Em Ciência e Tecnologia*, *1*(1), 3–25. http://alexandria.ppgect.ufsc.br/files/2012/03/GILBERT.pdf

Hillier, A., Kelly, R. P., & Klinger, T. (2016). Narrative style influences citation frequency in climate change science. *PLoS ONE*, *11*(12), 1–12. https://doi.org/10.1371/journal.pone.0167983

Howell, E. L., & Brossard, D. (2021). (Mis)informed about what? What it means to be a science-literate citizen in a digital world. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(15), 1–8. https://doi.org/10.1073/pnas.1912436117

Hunter, P. (2016). The communications gap between scientists and public. *EMBO Reports*, *17*(11), 1513–1515. https://doi.org/10.15252/embr.201643379

Irwin, A. (2014). From deficit to democracy (re-visited). *Public Understanding of Science*, *23*(1), 71–76. https://doi.org/10.1177/0963662513510646

Jensen, E., & Holliman, R. (2016). Norms and values in UK science engagement practice. *International Journal of Science Education*, *6*(1), 68–88. https://doi.org/10.1080/21548455.2014.995743

Krippendorff, K. (2013). *Content analysis. An introduction to its methodology* (3rd ed.). Sage Publications.

McTigue, E. M., & Slough, S. W. (2010). Student-accessible science texts: Elements of design. *Reading Psychology*, *31*(3), 213–227. https://doi.org/10.1080/02702710903256312

Metcalfe, J. (2019). Comparing science communication theory with practice: An assessment and critique using Australian data. *Public Understanding of Science*, *28*(4), 382–400. https://doi.org/10.1177/0963662518821022

National Academies of Sciences, Engineering, and Medicine (2017). *Communicating science effectively: A research agenda*. Washington, DC: The National Academies Press. https://doi.org/10.17226/23674

Onwuegbuzie, A., & Johnson, R. (2006). The validity issue in mixed research. *Research in the Schools*, *13*(1), 48–63.

Pipps, V., Walter, H., Endred, K., & Tabatcher, P. (2009). Information recall of internet news: does design make a difference? A pilot study. *Journal of Magazine & New Media Research*, *11*(1), 1–20. https://doi.org/Article

Rakedzon, T., & Baram-Tsabari, A. (2017). To make a long story short: A rubric for assessing graduate students' academic and popular science writing skills. *Assessing Writing*, *32*, 28–42. https://doi.org/10.1016/j.asw.2016.12.004

Ravetz, J. R. (2006). Post-Normal Science and the complexity of transitions towards sustainability. *Ecological Complexity*, *3*(4), 275–284. https://doi.org/10.1016/j.ecocom.2007.02.001

Reincke, C. M., Bredenoord, A. L., & van Mil, M. H. (2020). From deficit to dialogue in science communication. *EMBO Reports*, *21*(9), 1–4. https://doi.org/10.15252/embr.202051278

Rose, K. M., Markowitz, E. M., & Brossard, D. (2020). Scientists' incentives and attitudes toward public communication. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(3), 1274–1276. https://doi.org/10.1073/pnas.1916740117

Schäfer, M. S., Kessler, S. H., & Fähnrich, B. (2020). Analyzing science communication through the lens of communication science: Reviewing the empirical evidence. In A. Leßmöllmann, M. Dascal, & T. Gloning (Eds.), *Handbook of Science Communication* (pp. 77–104). De Gruyter Mouton. https://doi.org/10.1515/9783110255522-004

Scheufele, D. A., Krause, N. M., Freiling, I., & Brossard, D. (2021). What we know about effective public engagement on CRISPR and beyond. *PNAS*, *118*. https://doi.org/10.1073/pnas.2004835117

Sevian, H., & Gonsalves, L. (2008). Analysing how scientists explain their research: A rubric for measuring the effectiveness of scientific explanations. *International Journal of Science Education*, *30*(11), 1441–1467. https://doi.org/10.1080/09500690802267579

Smith, R., & Pniel, O. (2014). *Surveys' findings: publics' standpoints with regard to science and technology.*

Stilgoe, J., Lock, S. J., & Wilsdon, J. (2014). Why should we promote public engagement with science? *Public Understanding of Science*, *23*(1), 4–15. https://doi.org/10.1177/0963662513518154

Trench, B. (2008). Towards an analytical framework of science communication models. In D. Cheng, M. Gascoigne, T. Claessens, J. Metcalfe, B. Schiele, & S. Shi (Eds.), *Communicating Science in Social Contexts: New Models, New Practices* (pp. 119–135). Springer. https://doi.org/10.1007/978-1-4020-8598-7_7

VanDyke, M. S., & Lee, N. M. (2020). Science public relations: The parallel, interwoven, and contrasting trajectories of public relations and science communication theory and practice. *Public Relations Review*, *46*(4), 101953. https://doi.org/10.1016/j.pubrev.2020.101953

White, S. (2012). Mining the text: 34 text features that can ease or obstruct text comprehension and use. *Literacy Research and Instruction*, *51*(2), 143–164. https://doi.org/10.1080/19388071.2011.553023

Yuan, S., & Besley, J. C. (2021). Understanding science bloggers' view and approach to strategic communication. *International Journal of Science Education, Part B*, *0*(0), 1–15. https://doi.org/10.1080/21548455.2021.1938741