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ARTICLE

The impact of comics on knowledge, attitude and behavioural intentions related to wind energy

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ABSTRACT
This study compares two modes of visually presenting information about wind energy – one using photographs and the other using cartoons – on audience's knowledge, attitudes and behavioural intentions. In an online experiment, participants were randomly assigned to the two treatments. Results indicate no significant difference between the two groups in terms of knowledge and attitudes, but those shown in the comics version showed stronger intentions to support wind energy than those shown as photos. Those exposed to the comics-aided brochure found it more informative, interesting and cognitively engaging. Those who saw the photo version found the brochure more credible.

KEYWORDS
Communicating wind energy; comics as science communication tools; public knowledge; attitude and behavioural intentions toward wind energy; visual communication of wind energy

Introduction

Among energy experts, there is broad consensus that the future American energy portfolio must contain a large wind energy component. As of 2012, the U.S. has installed an electric generating capacity of 1200 GW of which only 36 GW is from wind (United States Department of Energy, 2008). The Department of Energy recommends increasing the wind energy contribution to 300 GW by 2030. To address climate change impacts, many have suggested the electrification of transportation, which may result in a projected wind capacity growth to as much as 600 GW (McEowen, 2009). This wind capacity can only be reached with significant investments in technology development, wind energy workforce and electricity market structures while managing the interrelationships among agriculture, economic structures and rural life (Ibáñez et al., 2008).

The advantages of wind energy are obvious. It is powered by a renewable source and entails only construction costs. Wind is a clean, non-polluting source of electricity compared to oil and coal. With better-engineered turbines, electricity-producing efficiency is expected to be 25–30% by 2030 (The Iowa Policy Project, 2010). Situated in one of the richest wind regions in the nation, the Midwest U.S. is poised to harness this resource. The state of Iowa has done so and is now second in the country in terms of its installed wind capacity of 3670 MW. With future Iowa wind capacity predictions

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between 30 and 60 GW, at 2 MW/turbine, the upper bound would require 30,000 turbines to meet state projections (Dai, Aliprantis, McCalley, & Ajjarapu, 2010). This would result in a significant landmass supporting, on average, four to five turbines per square mile – a visible change in landscape with potentially dramatic social repercussions (McCalley et al., 2010).

Despite obvious benefits and government incentives, many keep sceptical attitudes toward wind energy, mainly due to several concerns: (1) they do not like the way big turbines 'scar the landscape' and create 'visual pollution', (2) the turning blades and whirring generators produce noise many say they cannot tolerate, (3) people worry that the blades are hurting birds and bats, and (4) some question their efficiency. Power systems engineers counter by saying that poor visual reception can be minimized by thoughtful wind farm designs and by adjusting the scale and arrangement to satisfy aesthetic concerns. Wildlife impact can be avoided by careful site selection. Data also show that wind turbines can be very efficient electricity producers.

Still, public opinion polls (e.g. Klick & Smith, 2009) report that the general public is ambiguous about wind energy. This comes as no surprise considering that a litany of studies have consistently found that people are generally not well informed about most scientific and technical issues, even those that are prominent and long-standing (e.g. National Science Foundation, 2004; Yale Project on Climate Change Communication, 2010). Because wind energy is a relatively new topic in the media and the public agenda, the findings of those who attempt to determine public perception of this renewable source show the same trajectory. For example, Grady (2002) found that 'most western North Carolinians do not foresee or cannot articulate a problem with developing a wind industry in the state' (p. 12). Klick and Smith (2009) detected a pattern of responses that appear to 'reflect wishful guessing' (p. 9) as only 18% of their respondents were aware that wind-fuelled electricity was more expensive than that from conventional sources.

These concerns must be addressed because the level of people's support for scientific and technological undertakings determine, to a large extent, the nature and amount of public spending for research and development. Thus, for scientists and engineers, increasing the public's literacy about wind energy can result in a range of outcomes, including motivating greater interests and concern, influencing political or personal behaviour, and defining policy choices or options.

How can wind energy literacy be enhanced? One of the ways by which this fairly complicated and multi-faceted topic can be made more accessible to the general public is through comics and cartoons (Tatalovic, 2009). Scholars say these popular art forms can be potent vehicles for science education and communication because they can overcome the 'dull' or 'boring' evaluations of scientific and engineering content. Can they assist people in understanding wind energy? Do audiences develop more positive attitudes and behavioural intentions from exposure to them? This study examines the impact of communicating a science and engineering subject matter in cartoon form in terms of people's knowledge of, attitudes toward and behavioural intentions related to wind energy. It matches the performance of cartoons and photos as visual aids to counter the public's negative perceptions of an alternative energy source. The goal is to provide guidelines and insights regarding the application of comics and cartoons as a way of communicating science and engineering outside classroom settings, and to enhance their value as tools with which to improve wind energy literacy among non-technical audiences.

Literature review and theoretical rationale

Comics have been used to disseminate ideas of public utility, but there is no general agreement about what comics is. When speaking of comics, people may refer to comic strips, comic books, graphic novels, single-panel cartoons and animated cartoons, among other forms. Tatalovic (2009) found that some consider comics 'as a narrative form consisting of pictures arranged in sequence' while others see the 'juxtaposition of words and pictures, not sequence' as essential to the comics form (p. 2). Tatalovic (2009) equates comics to film in that a single cartoon frame is just like a single photograph that helps build an entire movie. To Rota and Izquierdo (2003), comics are 'pictorial images and graphics juxtaposed in a deliberate sequence destined to transmit information and/or to produce an answer in the reader' (p. 85).

Comics as science communication vehicles

Weitkamp and Burnet (2007) find comics an excellent vehicle for conveying scientific knowledge because of their ability to fuse the visual appeal of graphic representations and intriguing narrative. Supplemented by comics, science stories can be presented in ways that are more compatible with how the left brain functions (Williams, 2005). Educators have experimented on using comics to teach students or the general public about science and scientific breakthroughs. Carter (1988), for example, notes that 'comic books throughout their history have contained a surprising number of references to chemical facts, many of which can be referred to in the teaching of chemistry' (p. 1029). Comic illustrations have also served as a basis for initiating discussions on topics such as biotechnology (Rota & Izquierdo, 2003). By using comics, the understanding of scientific content is contextualized, identified, and strengthened with a playful vision:

> As the fiction makes part of the world of the children, they assimilated easily, and even almost 'playing' the concepts of agri-biotechnology presented in the comics, showing great curiosity on the topic, asking many questions and being motivated to look for more information in magazines, newspapers, the Internet and other means. (p. 88)

Exploratory studies have been conducted to understand the role of comics in science education. Di Raddo (2006) used comics as a teaching aid to enhance the learning of laboratory safety practices and ethics. Nagata (1999) showed that the use of *manga* (Japanese printed comics in graphic-novel format) prevented biochemistry classes from being monotonous, and made them more 'light-hearted'. In this case, *manga* was helpful in providing 'cognitive-psychological and pedagogical-technical effects', which gave 'students clues to remember what they have learnt and make biochemistry lectures exciting' (p. 203).

Animated cartoons used by Dalacosta, Kamariotaki-Paparrigopoulou, Palyvos, and Spyrellis (2009) also improved students' understanding of scientific concepts such as mass, volume, and density. The animated cartoons were observed to have 'facilitated the differentiation of scientific concepts, [so that students were able to] recall prior knowledge and, therefore, promoted the process of conceptual development' (p. 741).

In Olson's (2008) study, the use of comic strips in warm-up activities for science classes engaged students in 'thinking, conversing and writing about science and science issues' as well as 'practicing and engaging in science literacy activities' (p. 84). Students found 'comic strips preferable to working out of the textbook' and 'made learning science fun' (p. 89). Using comics in science classes, Keoghy, Naylory, and Wilson (1998) note that 'pupils who are generally reluctant to be involved in discussion or to put their views forward find it easier to join in debates with cartoon characters' (p. 222).

Because the above studies were conducted in classroom settings, there is no guarantee that the results can be generalized to the way people learn about science outside the classroom. Most of these studies also had children as respondents, a sample that limits the applicability of results to adult audiences. Furthermore, they emphasized comics' role in attracting attention and enhancing memory, while the influence of comics on other dimensions of scientific literacy, such as the ability to apply scientific principles in daily life, have yet to be explored. Moreover, the majority of these studies use knowledge or the process of learning science as dependent variables. The extent to which comics can change the general public's attitude and behaviour towards certain science issues – and how they do so – cries for research attention.

Enhancing visual and scientific literacy

Scholars (e.g. Burmark, 2002; Frey & Fisher, 2008) have argued that comics and cartoons, illustrated books, graphic novels, anime films and other visual sources of information are vehicles for imparting knowledge, abilities and even values in education. These materials have gained ground in the classroom probably due to their thematic diversity, and the seeming permeability between visual and theoretical content that, by most teacher accounts, enhances comprehension. Visual sources have been known to capture students' attention and foster their critical thinking skills following learning models based primarily on human physiology in relation to colour and perception of forms (Paivio, 1990). However, the manner in which visual materials should be administered, their appropriate age range targets and the actual content they can successfully deliver are questions that are just being posed.

This study examines comics' role in imparting scientific and technical information to a popular audience. Visuals as potent carriers of scientific content finds support in Williams, (2005) theory of omniphasism, which poses 'intuitive and rational cognitive abilities as equally significant and complementary components of an integrated model of cognition in which visual cognition and learning are the basis of a primary intuitive intelligence' (p. 195). According to Williams, there is a *rational cognitive system,* which is the cognitive basis for mathematical and linguistic intelligences, and an *intuitive cognitive system,* which is the cognitive basis for visual and musical intelligences. Although these two operate independently, they have the ability to work together because information gained from intuitive, visual cognition can subsequently be considered using rational processes to develop a reasonable response.

The theory further suggests that 'most, if not all, intelligences and cognitive processes have strong visual components' (p. 208). Thus, literacy is enhanced, according to this perspective, by the integration of these two systems, which activate complex and multifaceted cognitive processes that draw on perception, memory, imagination, and logic supplied primarily by visual data. The integration of these two systems fosters greater creativity and more powerful problem-solving abilities.

Such an integration is critical because 'reading comics' require the essential literacy skills needed to comprehend any text material. These include understanding the unique vocabulary and language of comics – words, pictures, icons and how these elements interact (Pustz, 1999), the ability to understand graphic conventions and sequence of events, to interpret characters' nonverbal gestures, to discern the story's plot, and to make inferences (Lyga, 2006). Science educators, therefore, can take advantage of readers who are already actively engaged by their sheer exposure to this visual form. To test levels of literacy, students can be asked to describe the action taking place, explain the message and how words clarify symbols, and posit on what special interest groups might agree/disagree with the message.

Comics characteristics

The combination of images, narratives and humour in cartoons can be harnessed to enhance content, credibility, interest, and cognitive and emotional engagement among lay audiences.

Content and credibility

The iconic nature of images (e.g. its vividness, spontaneity, and non-verbal cues) is a boon to the use of comics and cartoons as science communication tools. There is evidence that images enhance learning and recall of information (e.g. Rogers and Thorson, 2000). Hughes (1998) showed that comics can help children understand concepts by, for example, depicting what happens to a scene over time. Narratives that accompany visuals help students make connections between scientific principles and the real world, thus reinforcing their understanding of scientific concepts (Weitkamp & Burnet, 2007).

Interest

Cartoons and comics drum up interest by injecting humour, the main reason why people find them entertaining. Roesky and Kennepohl (2008) argue that humour can create a healthier atmosphere for the introduction of new ideas and concepts. This is so because humour has been shown to 'increase the rate of learning, improve problem-solving skills, heighten retention, reduce nervousness, and increase perceptions of teacher credibility' (p. 1358). It is also suggested that humour lightens up 'dread' courses, such as science classes (Kher, Molstad, & Donahue, 1999).

Emotional engagement

Visuals, according to Messaris (1997), have a greater ability to evoke rich emotions because they are able to reproduce the real world, a strategy advertisers have used in promoting products and services. Comics and cartoons rely on the iconicity of visuals to elicit an emotional response. Emotions, in turn, can mediate people's perception of scientific topics discussed in comics form.

Iconicity introduces emotional disposition toward the person and objects portrayed in comics (Abraham, 2009). Iconicity makes it 'possible for images to draw upon the rich variety of visual stimuli and associated emotions to which we are already attuned through our interaction with our social and natural environments: facial expressions, gestures, postures, personal appearance, physical surroundings, and so on' (Messaris, 1997, p. 34). On the other hand, written and spoken language devoid of iconicity delays such associations (Abraham, 2009).

Cognitive engagement

According to Messaris (1997), a greater degree of mental participation is needed for viewers to interpret images. On this aspect, comics and cartoons have an inherent advantage. Visuals invite viewers to be more mentally engaged, helping them to reach their own conclusion about an issue under discussion. Visuals make for potent tools for persuasion because compared to text, the visual form has a more subtle and indirect way of suggesting certain meanings. That is, explicit messages can be shown in words, whereas implicit messages can be communicated in pictures to avoid the consequences of saying it explicitly. Thus, comics, with its combination of visual and verbal claims, can deliver the message with greater impact.

Considering the foregoing literature, this study hypothesizes that:

H1: Wind energy information presented in cartoons + text form will be more positively evaluated by audiences as an informational aid in terms of (a) content, (b) credibility, (c) interest, (d) emotional engagement, and (e) cognitive engagement.
H2: The cartoons + text version will outperform the photographs + text presentation in improving people's knowledge of wind energy.
H3: The cartoons + text version will perform better in enhancing people's attitudes about wind energy.
H4: The cartoons + text version will produce more positive behavioural intentions toward the use of wind energy as an alternative source of power.

Method

This study compares people's responses to two ways of presenting information about wind energy. One mode involves the use of cartoons with text (cartoons + text); the other involves the use of photographs with text (photos + text). In order to gather data under natural information consumption conditions, an online field experiment was employed. In this conventional post-test only design, respondents were randomly assigned to one of the two experimental treatments after which the two groups were compared in terms of knowledge gained about wind energy as well as their attitudes and behavioural intentions toward it. The study also aims to determine which mode of presentation readers found more credible, informative, interesting, emotionally and cognitively engaging.

The sample

A sample of 2000 adult residents of the state of Iowa, which has been experimenting with wind energy use, was procured from the National Data Group, an email list provider that compiles email addresses from U.S. resident listing services, unique compilers, credit bureaus and privately-owned databases. The participants were randomly assigned to view one of the two informational brochures about wind energy after which they were asked to complete a questionnaire that was administered online.

Iowa was selected as the study locale because it is a state that has provided incentives to wind power since 1983, when it enacted a law that required investor-owned utilities to buy a total of 105 MW of wind-generated electricity (Wiser, 2011). By 2008, Iowa overtook the historical leader in wind power, California, in terms of installed wind power capacity. The American Wind Energy Association (AWEA, 2015) reports that Iowa generated more than 28% of its electricity from wind power. It has the third most installed wind capacity of any state and, as the base of three major turbine and blade manufacturers, is now known as a leader in wind manufacturing (AWEA, 2015).

Experimental treatments

As the use of wind power expands, more people are being introduced to wind turbines in their communities. Wind power is still a relatively new technology, and a number of myths – some based on old technologies, some based on misunderstandings – are constantly repeated. The brochure titled *Wind Power – Myths vs. Facts*, produced by the Minneapolis-based National Wind, a company that develops community wind projects, aims to dispel some of the most common myths, which include perceptions that wind turbines (1) are ugly, (2) noisy, (3) harm property values, (4) hurt wildlife, (5) are unreliable energy sources, (6) operate only a small fraction of the time, and thus (7) provide only a small amount of electricity.

The participants were randomly assigned into two groups. Group 1 was presented with the text + photos informational brochure. Group 2 was exposed to the text + cartoons version (Appendix A). The participants were not allowed to re-examine the experimental stimulus once they had begun answering the online questionnaire.

Variables and their measure

Three questions were posed to measure respondents' *exposure* to wind energy prior to viewing the brochure: (1) How familiar were you about wind energy before responding to this study? (Very familiar, Somewhat familiar, Unfamiliar, Never heard of it before). (2) Have you ever seen an actual wind turbine in operation? (Yes, I am living next to/working with wind turbines; Yes, I have visited a wind farm; Yes, I have seen wind turbines from a distance; No, I have never seen one at all). (3) To what extent have you read, watched or heard about articles or stories about wind energy in the media, including the Web? (Very often, Often, Seldom, Rarely, Not at all).

To measure *knowledge* about wind energy, respondents were asked six true or false items. Their correct answers were added as a measure of knowledge, the values ranged from −6 to 6.

To measure *attitudes* toward wind energy, participants were asked the extent to which they agree to 10 statements using Likert scales with response options ranging from 1 (strongly disagree) to 5 (strongly agree): (1) Wind turbines are as quiet as a refrigerator in one's kitchen; (2) Wind turbines spoil the scenery; (3) Wind turbines close to my community will lower local property values; (4) Wind turbines are more efficient in generating electricity than coal plants; (5) Wind turbines operate only for short periods of time and are therefore unreliable; (6) Wind turbines kill a lot of bats and birds; (7) Wind turbines produce small amounts of electricity compared to coal plants; (8) Wind energy is clean energy; (9) Overall, the benefits of wind energy overshadow its drawbacks; and (10) Wind farms will boost the local economy. The responses were averaged to serve as a measure of attitudes (Cronbach's $\alpha = .795$).

Seven Likert scale items were used to gauge behavioural intentions toward wind energy: (1) I will support government initiatives to make wind energy a significant part of national efforts to meet America's future energy needs; (2) I will support more investments in wind energy projects in the U.S.; (3) I will support a wind project in my community; (4) I will vote for candidates for public office who are in favour of wind energy; (5) I will join groups and organizations that will advocate for the development of wind energy; (6) I intend to learn more about wind energy by seeking more information about it; and (7) I am willing to pay a little more to support wind energy initiatives in my community. The answers (1 = strongly disagree to 5 = strongly agree) were averaged as a measure of behavioural intentions (Cronbach's $\alpha = .845$).

The respondents were asked to evaluate the brochure as a communication tool based on five criteria: (1) content, (2) credibility (3) interest, (4) emotional engagement, and (5) cognitive engagement. Two items tapped each criterion. Respondents were asked where they position themselves on each of these statements using Likert scales with responses ranging from 1 (strongly disagree) to 5 (strongly agree): *Informativeness* – (1) The brochure helped me a great deal in understanding wind energy and (2) The brochure clarified the drawbacks of wind energy I keep hearing about. *Interest* – (1) The brochure held my interest and (2) I find the overall appearance of this brochure very interesting. *Credibility* – (1) I find the information contained in the brochure very credible and (2) There is no reason for me to doubt the information contained in the brochure. *Emotional engagement* – (1) I feel more positively about wind energy after reading the brochure and (2) I find the visuals in the brochure emotionally engaging. *Cognitive engagement* – (1) The visuals in the brochure helped me follow the logic of the arguments and (2) I intend to learn more about wind energy after reading this brochure. The items comprising each criterion were averaged (Cronbach's $\alpha = .842$).

Results and discussion

A total of 226 participants (111 who saw the photo version and 115 who were exposed to the comics or cartoon counterpart) returned their completed questionnaire. Of these, 61.5% were female. Their ages ranged from 18 to more than 55, with about 60% belonging to the 18–21 age group. About 80% had some college or higher educational status. About 68% were students, 20% were employed for wages and the rest were out of work, retired or homemakers. A large majority (70%) were Caucasians, about 21% were Asian/Pacific Islanders, African American or Hispanic, and the rest were multi-racial. The median household income was \$10,255.50 in 2012 (range = \$25,000–\$125,000).

More than half of the participants (51%) said they were unfamiliar with wind energy; about 41% were somewhat familiar with this renewable energy resource before participating in the study. An overwhelming majority (93%) claimed they had seen a wind turbine or visited a wind farm; less than 14% said they had done so only through media exposure.

Knowledge about wind energy

Six 'true or false' questions were asked to determine the participants' knowledge of wind energy after exposure to one of the two types of brochure. Reponses were scored from −1 to 1 where −1 = incorrect, 0 = not sure, and 1 = correct. Their answers were added as a measure of knowledge (range = −6 to 6).

Despite the reported relatively low level of familiarity with wind energy, the sample provided an average of three correct responses to the six knowledge items ($M = 2.96$, $SD = 2.22$). More than 82% answered correctly that engineers and developers are now able to create a virtual view of a wind farm to give people a sense of how these farms may look like. Seventy-three percent were correct in disagreeing that wind farms are less efficient than nuclear plants in generating electricity because nuclear plants never suffer from unexpected outages. Another 69% correctly said that the statement, 'Wind turbines kill more birds than any other human activity,' was false.

A series of independent-samples *t*-test was conducted to determine whether there was a significant difference between the photo group and the cartoon group based on their performance on each of the six knowledge items and on the combined knowledge measure (Table 1). The results show that those exposed to the brochure with cartoons as visual aids ($M = 3.04$, $SD = 2.20$) outperformed those who saw the version with photos in terms of knowledge scores ($M = 2.88$, $SD = 2.24$), but this difference was not statistically significant [$t(218) = -0.56$, $p = .578$]. Thus, H1 was not supported.

Attitudes toward wind energy

The combined sample exhibited a slightly positive disposition toward wind energy based on their responses to 10 attitudinal statements ($M = 3.74$, $SD = 0.54$). Here, the negatively framed items were reverse-coded so that higher assessments indicate a more positive attitude. The participants agreed that wind offers clean energy. In general, they disagreed that wind turbines operate only for short periods of time and are therefore unreliable. Overall, they also tended to agree that the benefits of wind energy overshadow its drawbacks. The responses demonstrate a neutral to slightly positive attitudinal response to the other eight statements.

A series of independent samples *t*-test was conducted to determine differences between the two groups based on their responses to the 10 statements and on the attitude index. The results (Table 2) suggest that those in Group 2 (cartoons) found wind energy more quiet and cleaner, thought wind turbines would less likely spoil the scenery or lower local property values, judged it as more efficient in generating electricity, demonstrated a more positive outlook that wind farms will boost the local

Table 1. Comparative responses to knowledge items.

	Group 1: Photos ($n = 109$)		Group 2: Cartoons ($n = 115$)		*t*-Test results		
	Means	Std. dev.	Means	Std. dev.	*t* value	df	Sig.
1. Engineers and developers can create a virtual view of a wind farm before construction begins so that people can have a sense of how these farms may look like.	0.77	0.50	0.82	0.47	−0.72	222	0.473
2. In some hilly terrains where houses are located downwind from turbines, the sounds these turbines create are less audible.	0.19	0.83	0.05	0.88	1.18	220	0.241
3. There are studies showing that wind projects can increase property values.	0.31	0.79	0.38	0.77	−0.71	220	0.480
4. Wind turbines kill more birds than any other human activity.	0.54	0.71	0.60	0.70	−0.62	222	0.535
5. Wind farms are less efficient than nuclear plants in generating electricity because nuclear plants never suffer from unexpected outages.	0.58	0.74	0.63	0.68	−0.60	222	0.549
6. America's wind potential is larger than the total amount of electricity Americans now consume.	0.52	0.68	0.56	0.67	−0.38	222	0.708
Knowledge index scores	2.88	2.24	3.04	2.20	−0.56	218	0.578

Responses were scored from −1 to 1 where −1 = incorrect, 0 = partially correct and 1 = correct.

economy, and assessed wind energy as having benefits that overshadow the drawbacks. The two groups differed significantly in their assessment that 'wind turbines close to my community will lower local property values' [$t(216.168) = -2.93$, $p = .004$], with Group 2 (M = 3.78, SD = 0.86) showing a more positive attitude than Group 1 (M = 3.42, SD = 0.96). A statistically significant difference also was detected in the responses to the statement 'Overall, the benefits of wind energy overshadow its drawbacks' [$t(223) = -1.99$, $p = .048$], with Group 2 (M = 4.03, SD = 0.85) agreeing more with it than Group 1 (M = 3.80, SD = 0.93). The photo group agreed less that wind turbines operate only for short periods of time and are therefore unreliable, disagreed more that turbines kill bats and birds, and that they produce small amounts of electricity compared to coal plants. The difference between the two groups based on the attitude index, however, was not statistically significant. Thus, H2 was not supported.

Behavioural intentions regarding wind energy

The combined sample generated relatively neutral behavioural intentions based on their responses to the seven statements (M = 3.48, SD = 0.57) listed in Table 3. Most participants said they were willing to support government initiatives, investments related to wind energy and wind projects in their community. The majority also said they were likely to vote for candidates who advocate for wind energy, and are willing to pay a little more to support wind energy initiatives in their area. They also want to learn more about wind energy. However, the majority also said they were not willing

Table 2. Comparative responses to attitude items.

	Group 1: Photos ($n = 111$)		Group 2: Cartoons ($n = 115$)		*t*-Test results		
	Means	Std. dev.	Means	Std. dev.	*t*-value	df	Sig.
1. Wind turbines are as quiet as a refrigerator one normally finds in the kitchen.	0.44	10.07	0.52	0.95	0.565	223	0.573
2. Wind turbines spoil the scenery.	0.54	1.01	0.70	1.02	1.151	224	0.251
3. Wind turbines close to my community will lower local property values.	**0.42**	**0.96**	**0.78**	**0.86**	**2.933**	**216**	**0.004**
4. Wind turbines are more efficient in generating electricity than coal plants.	0.62	1.00	0.63	.89	0.270	219	0.787
5. Wind turbines operate only for short periods of time and are therefore unreliable.	0.93	0.88	0.85	0.75	0.714	219	0.476
6. Wind turbines kill a lot of bats and birds.	0.61	1.01	0.59	1.07	0.155	220	0.877
7. Wind turbines produce small amounts of electricity compared to coal plants.	0.54	1.02	0.43	.97	0.770	221	0.442
8. Wind energy is clean energy.	0.35	0.67	0.47	0.69	1.304	224	0.193
9. Overall, the benefits of wind energy overshadow its drawbacks.	**0.80**	**0.93**	**0.03**	**0.85**	**1.985**	**223**	**0.048**
10. Wind farms will boost the local economy.	0.75	0.73	0.79	0.70	0.387	223	0.699
Attitude index (average of ten items)	**0.69**	**0.55**	**0.79**	**0.53**	**1.251**	**205**	**0.212**

Response items ranged from 1 (strongly disagree) to 5 (strongly agree). Negatively framed statements were reverse-coded.
Figures in bold signify items for which the *t*-Test results were significant.

Table 3. Comparative responses to behavioural intention items.

	Group 1: Photos ($n = 111$)		Group 2: Cartoons ($n = 115$)		*t*-Test results		
	Means	Std. dev.	Means	Std. dev.	*t*-value	df	Sig.
1. I will support government initiatives to make wind energy a significant part of national efforts to meet America's future energy needs	**3.65**	**0.89**	**3.95**	**0.67**	**−2.773**	**203**	**0.006**
2. I will support more investments in wind energy projects in the U.S.	3.72	0.76	0.83	0.63	−1.177	211	0.241
3. I will support a wind project in my community	3.62	0.85	0.83	0.64	−1.966	202	0.051
4. I will vote for candidates for public office who are in favour of wind energy	3.55	0.82	0.75	0.70	−1.900	214	0.059
5. I will join groups and organizations that will advocate for the development of wind energy	2.95	0.81	0.96	0.85	−0.007	222	0.994
6. I intend to learn more about wind energy by seeking more information about it	3.15	0.87	0.35	0.81	−1.836	220	0.068
7. I am willing to pay a little more to support wind energy initiatives in my community	3.17	0.85	3.28	0.89	−0.922	224	0.358
Behavioural intention index (average of seven items)	**3.39**	**0.60**	**3.57**	**0.54**	**−2.348**	**212**	**0.020**

Response items ranged from 1 (strongly disagree) to 5 (strongly agree). Negatively framed statements were reverse-coded.
Figures in bold signify items for which the *t*-Test results were significant.

to join groups and organizations that will work to develop this alternative energy source.

A series of independent samples *t*-test was conducted to evaluate if there were significant differences between the two groups on their responses to the seven behavioural statements. The results show that Group 2 indicated greater willingness to support wind energy initiatives, investments and projects, and are likely to vote for pro-wind energy political candidates. Compared to those in Group 1, Group 2 members also showed greater willingness to pay more for wind energy. The two groups statistically differed only in terms of their attitude toward supporting government initiatives to make wind energy a significant part of efforts to meet the country's future energy needs [$t(202.553) = -2.773$, $p = .006$], with Group 2 (M = 3.95, SD = 0.67) agreeing more with the statement than Group 1 (M = 3.65, SD = 0.89). The *t*-test results also show a statistically significant difference between the two groups in terms of the combined measure of behavioural intentions [$t(212) = -2.348$, $p = .020$]. That is, Group 2 (M = 3.57, SD = 0.54) showed stronger behavioural intentions than Group 1 (M = 3.39, SD = 0.60). Thus, H3 was supported.

Evaluation of the brochure

The combined sample generated a relatively positive evaluation of the brochure to which they were exposed (M = 3.54, SD = 0.50). An independent samples *t*-test was conducted to detect significant differences between Group 1 and Group 2 regarding their evaluation of the brochure as an information aid. The descriptive statistics (Table 4) suggest that Group 2 found the cartoon-aided presentation more informative, interesting, and cognitively engaging. However, these differences were not statistically significant. In terms of emotional engagement, both groups exhibited the same mean value (3.64). Group 1 found the photo version more credible although the two groups' ratings of the brochure's credibility were also not statistically different. This may be because cartoons are still viewed as art for fun rather than for serious matters, which may have lowered their estimation of its credibility as a science communication tool. The *t*-test results show no statistically significant difference between the photo group (M = 3.52, SD = 0.47) and the cartoon group (M = 3.57, SD = 0.54) in terms of overall brochure evaluation (Table 4). Thus, H4 was not supported.

Table 4. Comparative evaluations of the brochure.

	Group 1: Photos ($n = 110$)		Group 2: Cartoons ($n = 115$)		*t*-Test results		
	Means	Std. dev.	Means	Std. dev.	*t* value	df	Sig.
1. Content	3.53	0.58	3.59	0.63	0.733	19	0.464
2. Interest	3.48	0.72	3.62	0.74	−1.410	20	0.160
3. Credibility	3.63	0.67	3.52	0.71	1.153	18	0.250
4. Emotional Engagement	3.64	0.57	3.64	0.72	−0.046	13	0.963
5. Cognitive Engagement	3.33	0.54	3.42	0.59	−1.177	17	0.240
Evaluation index (average of five criteria)	3.52	0.47	3.57	0.54	−0.678	01	0.990

Response items ranged from 1 (strongly disagree) to 5 (strongly agree).

Conclusions

Several conclusions can be drawn from the results. First, there was a clear indication that prior exposure to wind energy was relatively low. This suggests that future campaign efforts must expand the reach and frequency of message dissemination.

Second, although the cartoon/comics version outperformed the highly photographic presentation in improving audience members' knowledge of wind energy in absolute terms, the difference in knowledge scores between the two groups was not statistically significant.

Third, the same can be said about the treatments' impact on attitude toward wind as an energy source. A more detailed analysis of attitudinal dispositions indicates that the photo group did not think that wind turbines close to their community will lower local property values. Group 2 members expressed more optimism that overall, the benefits of wind energy overshadow its drawbacks. On the other hand, those in the photo group were more likely to think that wind energy is unreliable, that wind turbines kill bats and birds, and that the turbines can produce only small amounts of electricity. Those who saw the cartoon-aided brochure, therefore, tended to have more positive dispositions toward wind energy although these differences were not statistically significant.

Fourth, the present study found evidence that cartoons have the capacity to motivate people to promote favourable behavioural intentions, such as supporting government initiatives and investments in wind energy projects. Group 2 (cartoons) showed stronger behavioural intentions than Group 1 (photos), and this difference was statistically significant. On closer inspection, those exposed to the cartoon version indicated greater willingness to support government initiatives to make wind energy a significant part of national efforts to meet America's future energy needs, and indicated greater willingness to support investments in wind energy development, including wind projects that may be cited locally. They were also more likely to vote for candidates with pro-wind energy platforms, pay more for wind energy and learn more about it. Both groups, however, said they were not likely to join groups and organizations that will advocate for the development of wind energy. This finding suggests that although people were in favour of developing this resource, they do not see themselves as being directly involved with the process. Nonetheless, the comics version clearly produced stronger intentions to take actions in support of wind energy development.

Fifth, both groups positively evaluated the quality of the brochure they have read. A more detailed examination reveals that those exposed to the cartoon version found the brochure more informative, interesting and cognitively engaging. However, those presented with the photo version found the brochure more credible. This suggests that cartoons may still be viewed as appropriate for entertainment or light-hearted content, but not for serious-minded topics.

The participants reported a very low media exposure and low familiarity with wind energy even though most claimed having seen wind turbines or having visited wind farms before. This is consistent with Klick and Smith's (2009) finding of low knowledge levels about wind energy in their survey that involved a non-probability national sample. The low exposure to wind energy media content suggests the need to heighten audiences' literacy about this relatively new energy source. This may be done through informational materials that promote the personal relevance, local significance and national importance of wind energy among audiences.

As shown in this study, those who were exposed to the comics-aided brochure assessed it as more informative, interesting and cognitively engaging. Clever cartoons have been known to motivate people to actually read news reports and editorial viewpoints. Duus (2001) asserts that cartoons have an increased chance of becoming viral and therefore usually have wider circulation, a longer life and a greater influence than written stories among the public. Such characteristics can be tapped to advance the public's literacy about wind energy.

The respondents demonstrated close to neutral attitudinal dispositions, with no significant differences between the two groups. The findings suggest a lack of attitude commitment that risk communicators can exploit. Studies (e.g. Bord & O'Connor, 1990) have shown that such attitudes are more transient and are easier to adjust or secure. It is important to note, however, that those exposed to the cartoon-enhanced brochure more strongly supported the statement that the benefits of wind energy overshadow its drawbacks, an important objective for an information material that aims to debunk commonly held misgivings about wind energy.

It is said that the simplicity with which cartoons portray even complex issues aids readers' comprehension of these issues because readers can understand their message faster. The results of the study, however, show no differences between the two groups in terms of knowledge gain. One can also surmise that the use of humour allows the spectator to easily elaborate on the image and develop an opinion and attitude about the subject (Bal, Pitt, Berthon, & DesAutels, 2009). Again, the results of the study show no differences between the two groups in terms of attitude.

Unexpectedly, however, the group exposed to the comics version demonstrated stronger behavioural intentions. This resulted, perhaps, because like urban graffiti, jokes and other genres of popular culture, cartoons expose viewers to a serious point of view presented in a humorous way. Condensing wind energy myths and concepts within a single frame, a cartoon can re-contextualize myths and evoke reference points in ways that photographs or even films cannot. Cartoons aim not just to inform but also to make people reflect on current events and issues. Such a reflection also may have enhanced behavioural intentions.

The present study involved a relatively large proportion of students in the sample, which boosted the reported educational attainment level to some college and above. Thus, the results cannot be generalized to the population of American audiences.

The study did not take into account the sample's pre-existing knowledge about wind energy, their political orientation and the extent to which they identify with the 'environmentalist' label, which may have influenced the results. To be able to evaluate the effectiveness of a brochure with the communication goal of clarifying myths, misunderstandings and/or misgivings about wind energy, pre-exposure benchmarks would have provided stronger statements of effects.

An experiment in a laboratory setting or a focus group approach may be better able to capture participants' attention and hold it longer. Deeper insights about the independent and/or combined influence of the two treatments can be gleaned from open-ended, unprompted and more free-wheeling responses that can be gathered through intensive interviews and other qualitative approaches.

Considering that the visual representation of risk is still a nascent field of study, an interdisciplinary approach is necessary to develop an overarching framework that encompasses the psychological processes individuals go through when presented with visual stimuli. The findings of cross-disciplinary research should begin to bridge the gap between scientific experts and the general public when it comes to risk assessment pertaining to a relatively new energy source.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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